**GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)**

(Deemed to be University)

VISAKHAPATNAM * HYDERABAD * BENGALURU

Accredited by NAAC with $A^{++}$ Grade

# GITAM School of Technology

## CURRICULUM AND SYLLABUS

# 4 Year Undergraduate Programme
# UMECH01: B.Tech. Mechanical Engineering

w.e.f. 2023-24 Admitted Batch

(Updated on Nov 2024)

# Academic Regulations

Applicable for the Undergraduate Programmes in the Schools of Business, Humanities & Social Sciences, Science, Technology

https://www.gitam.edu/academic-regulations

## Vision

To become a global leader in higher education.

## Mission

To impart futuristic and comprehensive education of global standards with a high sense of discipline and social relevance in a serene and invigorating environment.

## Quality Policy

To achieve global standards and excellence in teaching, research, and consultancy by creating an environment in which the faculty and students share a passion for creating, sharing and applying knowledge to continuously improve the quality of education.

# VISION AND MISSION OF THE SCHOOL

## VISION

To become a global leader in holistic engineering education and research

## MISSION

1. To impart a strong academic foundation and practical education through a flexible curriculum, state-of-the-art infrastructure, and best learning resources
2. To actively pursue academic and collaborative research with industries and research institutions, both in India and abroad
3. To build a congenial and innovative eco system by enabling the latest technologies, thus helping the students, to solve the challenges of societal importance
4. To provide our students with the appropriate leadership, management, communication skills and professional ethics for career success and to continuously impact the global lives

# UMECH01: B.Tech. Mechanical Engineering

**(w.e.f. academic year 2023-24 admitted batch)**

## Programme Educational Objectives (PEOs)

| | |
|---|---|
| PEO 01 | Thrive as professional engineers in core mechanical engineering and other allied fields. |
| PEO 02 | Learn new knowledge and skills through professional development prospects or pursue advanced education |
| PEO 03 | Learn new knowledge and skills through professional development prospects or pursue advanced education |
| PEO 04 | Follow to the highest level of professional code of ethics |

**Mapping of the Mission of the School with the PEOs**

| | **PEO1** | **PEO2** | **PEO3** | **PEO4** |
|---|---|---|---|---|
| **M1** | H | M | M | M |
| **M2** | M | H | H | H |
| **M3** | M | H | H | H |
| **M4** | H | H | M | H |

H – High, M – Medium, L – Low

## Programme Outcomes (POs) and Programme Specific Outcomes (PSOs):

At the end of the Programme the students would be able to:

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

| | |
|---|---|
| PO11 | Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| PO12 | Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

| | |
|---|---|
| PSO1 | Competency to diagnose, interpret and unravel engineering problems in the fields of mechanical design, thermal engineering, and manufacturing technology along with allied multi-disciplinary streams. |
| PSO2 | Ability to develop state-of-the-art technologies in futuristic areas of engineering through ground-breaking research. |
| PSO3 | Aptitude for nation-building by accomplishing technological and managerial skills and becoming Technocrats and Entrepreneurs. |

# Curriculum Structure

*(Flexible Credit System)*

| UNIVERSITY CORE (UC) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course code** | **Level** | **Course title** | **L** | **T** | **P** | **S** | **J** | **C** |
| CSEN1001 | 1 | IT Productivity Tools^ | 0 | 0 | 2 | 0 | 0 | 1* |
| CLAD1001 | 1 | Emotional Intelligence & Reasoning Skills (Soft Skills 1) | 0 | 0 | 2 | 0 | 0 | 1 |
| CLAD1011 | 1 | Leadership Skills & Quantitative Aptitude (Soft Skills 2) | 0 | 0 | 2 | 0 | 0 | 1 |
| CLAD1021 | 1 | Verbal Ability & Quantitative Ability (Soft Skills 3) | 0 | 0 | 2 | 0 | 0 | 1 |
| CLAD1031 | 1 | Practicing Verbal Ability & Quantitative Aptitude (Soft Skills 4) | 0 | 0 | 2 | 0 | 0 | 1 |
| CLAD20XX | 2 | Soft skills 5A/5B/5C | 0 | 0 | 2 | 0 | 0 | 1 |
| CLAD20XX | 2 | Soft skills 6A/6B/6C | 0 | 0 | 2 | 0 | 0 | 1 |
| DOSP10XX | 1 | Sports 1# | 0 | 0 | 0 | 2 | 0 | 2* |
| DOSL10XX | 1 | Club Activity# | 0 | 0 | 0 | 2 | 0 | 2* |
| DOSL10XX | 1 | Community Service# | 0 | 0 | 0 | 0 | 2 | 2* |
| ENVS1001 | 1 | Environmental Studies^ | 3 | 0 | 0 | 0 | 0 | 3* |
| FINA3001 | 3 | Personal Financial Planning# | 0 | 0 | 2 | 0 | 0 | 1* |
| LANG1012 | 1 | Communication Skills in English – Intermediate | 0 | 0 | 4 | 0 | 0 | 2 |
| LANG1022 | 1 | Communication Skills in English – Advanced | 0 | 0 | 4 | 0 | 0 | 2 |
| MFST1001 | 1 | Health and Wellbeing# | 0 | 0 | 2 | 0 | 0 | 1* |
| POLS1001 | 1 | Indian Constitution and History | 2 | 0 | 0 | 0 | 0 | 2* |
| PHPY1001 | 1 | Gandhi for the 21st Century | 2 | 0 | 0 | 0 | 0 | 2* |
| VEDC1001 | 1 | Venture Development | 0 | 0 | 0 | 2 | 0 | 2 |

* Pass/Fail courses
# Opt any two courses among the five
^ Online/Swayam/NPTEL Courses

| Soft skills courses 5 and 6 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course code** | **Level** | **Course title** | **L** | **T** | **P** | **S** | **J** | **C** |
| CLAD2001 | 2 | Preparation for Campus Placement-1 (Soft skills 5A) | 0 | 0 | 2 | 0 | 0 | 1 |
| CLAD2011 | 2 | Preparation for Higher Education (GRE/ GMAT)-1 (Soft skills 5B) | 0 | 0 | 2 | 0 | 0 | 1 |
| CLAD2021 | 2 | Preparation for CAT/ MAT – 1 (Soft skills 5C) | 0 | 0 | 2 | 0 | 0 | 1 |
| CLAD2031 | 2 | Preparation for Campus Placement-2 (Soft skills 6A) | 0 | 0 | 2 | 0 | 0 | 1 |
| CLAD2041 | 2 | Preparation for Higher Education (GRE/ GMAT)-2 (Soft skills 6B) | 0 | 0 | 2 | 0 | 0 | 1 |
| CLAD2051 | 2 | Preparation for CAT/ MAT – 2 (Soft skills 6C) | 0 | 0 | 2 | 0 | 0 | 1 |

| Sports Courses | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course code** | **Level** | **Course title** | **L** | **T** | **P** | **S** | **J** | **C** |
| DOSP1001 | 1 | Badminton | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSP1011 | 1 | Chess | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSP1021 | 1 | Carrom | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSP1031 | 1 | Football | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSP1041 | 1 | Volleyball | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSP1051 | 1 | Kabaddi | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSP1061 | 1 | Kho Kho | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSP1071 | 1 | Table Tennis | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSP1081 | 1 | Handball | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSP1091 | 1 | Basketball | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSP1101 | 1 | Tennis | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSP1111 | 1 | Throwball | 0 | 0 | 0 | 2 | 0 | 2 |

| Club Activity Courses | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course code** | **Level** | **Course title** | **L** | **T** | **P** | **S** | **J** | **C** |
| DOSL1001 | 1 | Club Activity (Participant) | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSL1011 | 1 | Club Activity (Member of the Club) | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSL1021 | 1 | Club Activity (Leader of the Club) | 0 | 0 | 0 | 2 | 0 | 2 |
| DOSL1031 | 1 | Club Activity (Competitor) | 0 | 0 | 0 | 2 | 0 | 2 |
| | | | | | | | | |

| Community Service courses | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course code** | **Level** | **Course title** | **L** | **T** | **P** | **S** | **J** | **C** |
| DOSL1041 | 1 | Community Services – Volunteer | 0 | 0 | 0 | 0 | 2 | 2 |
| DOSL1051 | 1 | Community Services – Mobilizer | 0 | 0 | 0 | 0 | 2 | 2 |

| FACULTY CORE (FC) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course code** | **Level** | **Course title** | **L** | **T** | **P** | **S** | **J** | **C** |
| CHEM1001 | 1 | Chemistry | 2 | 1 | 2 | 0 | 0 | 4 |
| CSEN1011 | 1 | Problem Solving and Programming with C | 0 | 0 | 6 | 0 | 0 | 3 |
| CSEN1021 | 1 | Programming with Python | 0 | 0 | 6 | 0 | 0 | 3 |
| CSEN1031 | 1 | Artificial Intelligence Applications | 0 | 0 | 2 | 0 | 0 | 1 |
| EECE1001 | 1 | Basic Electrical and Electronics Engineering | 2 | 1 | 2 | 0 | 0 | 4 |
| HSMCH102 | 1 | Universal Human Values | 3 | 0 | 0 | 0 | 0 | 3 |
| INTN2333 | 2 | Internship 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| INTN3444 | 3 | Internship 2 | 0 | 0 | 0 | 0 | 1 | 3 |
| MATHXXXX | X | Mathematics Basket 1 | 2 | 0 | 0 | 0 | 0 | 2 |
| MATHXXXX | X | Mathematics Basket 2 | 2 | 0 | 0 | 0 | 0 | 2 |
| MATHXXXX | X | Mathematics Basket 3 | 2 | 0 | 0 | 0 | 0 | 2 |
| MATHXXXX | X | Mathematics Basket 4 | 2 | 0 | 0 | 0 | 0 | 2 |
| MATHXXXX | X | Mathematics Basket 5 | 2 | 0 | 0 | 0 | 0 | 2 |
| MATHXXXX | X | Mathematics Basket 6 | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH2361 | 2 | Probability and Statistics | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH1011 | 1 | Engineering Visualization and Product Realization | 0 | 0 | 4 | 0 | 0 | 2 |
| MECH1041 | 1 | Technology Exploration & Product Engineering | 0 | 0 | 4 | 0 | 0 | 2 |
| MECH1001 | 1 | Design Thinking | 0 | 0 | 2 | 0 | 0 | 1 |
| PHYS1001 | 1 | Physics | 2 | 1 | 2 | 0 | 0 | 4 |
| PHYSXXXX | 1 | Physics Basket | 3 | 1 | 0 | 0 | 0 | 4 |
| PROJ2999 | 2 | Capstone Project – Introduction | 0 | 0 | 0 | 0 | 2 | 2 |
| PROJ3999 | 3 | Capstone Project – Final | 0 | 0 | 0 | 0 | 6 | 6 |
| PROJ2888 | 2 | Project Exhibition 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| PROJ3888 | 3 | Project Exhibition 2 | 0 | 0 | 0 | 0 | 1 | 1 |
| VIVA3555 | 3 | Comprehensive Examination | 1 | 0 | 0 | 0 | 0 | 1 |
| XXXXXXXX | X | Management Basket | 3 | 0 | 0 | 0 | 0 | 3 |
| BTEN1001 | 1 | Introduction to Biotechnology-I | 2 | 0 | 0 | 0 | 0 | 2 |
| BTEN1021 | 1 | Introduction to Biotechnology-II | 2 | 0 | 0 | 0 | 0 | 2 |

| Mathematics Basket | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course code** | **Level** | **Course title** | **L** | **T** | **P** | **S** | **J** | **C** |
| MATH1001 | 1 | Single Variable Calculus | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH1011 | 1 | Several Variable Calculus | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH2371 | 2 | Difference Equations | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH1031 | 1 | Differential Equations | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH2281 | 2 | Numerical techniques | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH1021 | 1 | Transform Techniques | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH2381 | 2 | Operations Research | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH2301 | 2 | Complex Variables | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH1041 | 1 | Discrete Mathematics | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH1051 | 1 | Graph Theory | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH2311 | 2 | Number Theory | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH2291 | 2 | Linear Algebra | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH2341 | 2 | Probability Theory and Random Variables | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH2321 | 2 | Random Processes | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH2351 | 2 | Optimization Methods | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH2331 | 2 | Computational Methods | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH1061 | 1 | Introduction to Mathematics – I | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH1071 | 1 | Introduction to Mathematics – II | 2 | 0 | 0 | 0 | 0 | 2 |
| MATH2361 | 2 | Probability and Statistics | 3 | 0 | 0 | 0 | 0 | 3 |
| **Physics Basket** | | | | | | | | |
| **Course code** | **Level** | **Course title** | **L** | **T** | **P** | **S** | **J** | **C** |
| PHYS1001 | 1 | Physics | 2 | 1 | 2 | 0 | 0 | 4 |
| PHYS1011 | 1 | Mechanics and Properties of Matter | 3 | 1 | 0 | 0 | 0 | 4 |
| PHYS1021 | 1 | Principles of Quantum Mechanics | 3 | 1 | 0 | 0 | 0 | 4 |
| PHYS1031 | 1 | Physics of Semi Conducting devices | 3 | 1 | 0 | 0 | 0 | 4 |
| PHYS1041 | 1 | Mechanics and Modern Physics | 3 | 1 | 0 | 0 | 0 | 4 |
| **Management Basket** | | | | | | | | |
| **Course code** | **Level** | **Course title** | **L** | **T** | **P** | **S** | **J** | **C** |
| FINA1031 | 1 | Principles and Practice of Banking | 3 | 0 | 0 | 0 | 0 | 3 |
| HRMG1021 | 1 | Human Resource Management | 3 | 0 | 0 | 0 | 0 | 3 |
| MKTG3011 | 3 | Sales and Distribution Management | 3 | 0 | 0 | 0 | 0 | 3 |

| Programme Core (PC) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course code** | **Level** | **Course Title** | **L** | **T** | **P** | **S** | **J** | **C** |
| MECH2001 | 2 | Engineering Mechanics | 2 | 1 | 0 | 0 | 0 | 3 |
| MECH2011 | 2 | Thermodynamics | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2021 | 2 | Material Science and Engineering | 2 | 0 | 2 | 0 | 0 | 3 |
| MECH2031 | 2 | Computer aided machine drawing | 0 | 0 | 4 | 0 | 0 | 2 |
| MECH2041 | 2 | Manufacturing Processes | 3 | 0 | 2 | 0 | 0 | 4 |
| MECH2051 | 2 | Strength of Materials | 4 | 0 | 2 | 0 | 0 | 5 |
| MECH2061 | 2 | Applied Thermodynamics | 3 | 0 | 2 | 0 | 0 | 4 |
| MECH3001 | 3 | Mechanics of Machinery | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3011 | 3 | Fluid Mechanics and Machinery | 4 | 0 | 2 | 0 | 0 | 5 |
| MECH3021 | 3 | Measurements and Metrology | 3 | 0 | 2 | 0 | 0 | 4 |
| MECH3031 | 3 | Design of Machine Elements | 4 | 0 | 0 | 0 | 0 | 4 |
| MECH3041 | 3 | Heat and Mass Transfer | 3 | 0 | 2 | 0 | 0 | 4 |
| MECH3051 | 3 | Introduction to CAD, CAM, and CNC machining | 3 | 0 | 2 | 0 | 0 | 4 |
| MECH3061 | 3 | Industrial engineering and management | 3 | 0 | 2 | 0 | 0 | 4 |

| Programme Elective (PE) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course code** | **Level** | **Course Title** | **L** | **T** | **P** | **S** | **J** | **C** |
| **Smart manufacturing basket** | | | | | | | | |
| MECH3071 | 3 | Advances in welding technology | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3081 | 3 | Manufacturing of Automobile Components | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3091 | 3 | Additive Manufacturing | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3101 | 3 | Computer Integrated Manufacturing | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3111 | 3 | Automation in Manufacturing | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3121 | 3 | IoT in Manufacturing | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3131 | 3 | Modern Manufacturing Methods | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3141 | 3 | Smart manufacturing systems | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3272 | 3 | Lean Manufacturing | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3273 | 3 | Non-Destructive Testing | 3 | 0 | 0 | 0 | 0 | 3 |
| 24MECH4141 | 4 | Alloys for Additive Manufacturing | 3 | 0 | 0 | 0 | 0 | 3 |
| **Design engineering** | | | | | | | | |
| MECH3151 | 3 | Product Design | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2071 | 2 | Introduction to Robotics | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2081 | 2 | Advanced Strength of Materials | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2091 | 2 | Finite element analysis | 3 | 0 | 0 | 0 | 0 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MECH3161 | 3 | Product life cycle management | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2101 | 2 | Mechanical Vibrations | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3171 | 3 | Mobile Robotics | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2111 | 2 | Computational Methods | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2121 | 2 | Control Systems Engineering | 3 | 0 | 0 | 0 | 0 | 3 |
| **Thermal Engineering** | | | | | | | | |
| MECH2131 | 2 | Turbo Machinery | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2141 | 2 | Computational Fluid Dynamics | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2151 | 2 | refrigeration and air conditioning | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2161 | 2 | cryogenics | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3181 | 3 | Vehicle technology | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2171 | 2 | Power Plant Engineering | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2181 | 2 | Renewable Energy Technology | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2191 | 2 | Alternative fuels and emission control | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2201 | 2 | Solar Energy | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3191 | 3 | Waste to energy | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3201 | 3 | Energy Conservation and Management | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3274 | 3 | Wind Energy | 3 | 0 | 0 | 0 | 0 | 3 |
| **Electric and Hybrid vehicles** | | | | | | | | |
| MECH1031 | 1 | Fundamentals of Electric and Hybrid vehicles | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2211 | 2 | Fuel Cell technology and Hydrogen Storage system | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3211 | 3 | Vehicle Electrical Power systems | 3 | 0 | 0 | 0 | 0 | 3 |
| **AI and ML** | | | | | | | | |
| MECH2221 | 2 | Introduction to machine learning | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2231 | 3 | Introduction to autonomous vehicles | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3275 | 3 | Mechatronics | 3 | 0 | 0 | 0 | 0 | 3 |
| **Industrial engineering** | | | | | | | | |
| MECH3221 | 2 | Statistical Quality Control | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2241 | 2 | Operations Research | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2251 | 2 | Plant Layout and Facilities Planning | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2261 | 2 | Production Planning and Control | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2271 | 2 | Inventory control | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2281 | 3 | Supply Chain Management | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3231 | 3 | Enterprise Resource Planning | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3241 | 3 | Management Information Systems | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3251 | 2 | Engineering Optimization | 3 | 0 | 0 | 0 | 0 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MECH2291 | 3 | Project Planning and Management | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3261 | 2 | Decision Modelling | 3 | 0 | 0 | 0 | 0 | 3 |
| ENVS 3041 | 3 | Industrial Safety | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3271 | 2 | Total Quality management | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3276 | 3 | Autonomous Maintenance | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH3277 | 3 | Mechanical Engineering systems | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2321 | 2 | Basics of Industrial Engineering | 2 | 1 | 0 | 0 | 0 | 3 |
| MECH2301 | 2 | Engineering Economics | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2311 | 2 | Fundamentals of Project Management | 3 | 0 | 0 | 0 | 0 | 3 |
| MECH2331 | 2 | Introduction To Operations Research | 3 | 0 | 0 | 0 | 0 | 3 |
| # Opt any five courses from Programme Elective basket<br># Opt eligible PC/PE courses from other programmes as an open elective course and earn 24 credits | | | | | | | | |

## PROGRAMME STRUCTURE

BTech Programme consists of courses which could be grouped under University Core (UC), Faculty Core (FC), Major/Programme Core (PC), Major/Programme Electives (PE) and Open Electives (OE) as the below breakup.

| Category | Credits | % of Program (in credits) |
|---|---|---|
| University Core (UC) | 12 | 8% |
| Faculty Core (FC) | 57 | 35% |
| Programme Core (PC) | 52 | 33% |
| Programme Electives (PE) | 15 | 9% |
| Open Electives (OE) | 24 | 15% |
| **Total** | **160** | |

Courses offered under University Core are common to all undergraduate level programmes offered by GITAM. Courses offered under Faculty core are common to all BTech programmes offered by GITAM and are meant to acquaint the student with general engineering principles in all disciplines of engineering. Based on the chosen BTech Programme, the student shall complete courses under Programme Core (specific to be chosen branch of engineering).

Each course is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week. In general,

- **Theory:** A student attending classroom lecture/ tutorial/ skill development activity of 50 minutes' duration per week, spread over the entire semester is awarded one credit.
- **Practical:** A student attending a minimum of 100 minutes per week of laboratory session/ practical is awarded - one credit.
- **Project Work:** A student working for 50 minutes of project work per week with 3 hours of work performed independent of the instructor during the entire semester is awarded - one credit
- **Internship:** 8 hours in a day for four weeks is required for earning internship credits

## Course PO Mapping

| Course Code | Course Name | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECH1001 | Design Thinking | H | H | M | H | H | M | M | M | H | H | L | M | H | H | H |
| MECH1011 | Engineering Visualization and Product Realization | H | H | H | M | H | H | H | M | H | H | H | H | H | H | H |
| MECH1041 | Technology Exploration & Product Engineering | H | H | H | H | H | H | M | M | H | M | H | H | H | H | H |
| MECH2001 | Engineering Mechanics | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH2011 | Thermodynamics | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH2021 | Material Science and Engineering | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH2031 | Computer aided machine drawing | H | H | H | M | H | H | H | M | H | H | H | H | H | H | H |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECH2041 | Manufacturing Processes | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH2051 | Strength of Materials | H | M | M | M | L | H | M | L | L | L | L | L | H | M | H |
| MECH2061 | Applied Thermodynamics | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |
| MECH3001 | Mechanics of Machinery | H | M | M | M | L | H | M | L | L | L | L | L | H | M | H |
| MECH3011 | Fluid Mechanics and Machinery | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |
| MECH3021 | Measurements and Metrology | H | M | M | M | L | H | M | L | L | L | L | L | H | M | H |
| MECH3031 | Design of Machine Elements | H | M | M | M | L | H | M | L | L | L | L | L | H | M | H |
| MECH3041 | Heat and Mass Transfer | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |
| MECH3051 | Introduction to CAD, CAM, and CNC machining | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH3061 | Industrial engineering and management | H | M | M | L | L | M | L | M | H | H | H | H | H | M | H |
| MECH3071 | Advances in welding technology | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |
| MECH3081 | Manufacturing of Automobile Components | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH3091 | Additive Manufacturing | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH3101 | Computer Integrated Manufacturing | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH3111 | Automation in Manufacturing | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECH3121 | IoT in Manufacturing | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH3131 | Modern Manufacturing Methods | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH3141 | Smart manufacturing systems | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH3272 | Lean Manufacturing | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH3273 | Non-Destructive Testing | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH3151 | Product Design | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH2071 | Introduction to Robotics | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH2081 | Advanced Strength of Materials | H | M | M | M | L | H | M | L | L | L | L | M | H | M | M |
| MECH2091 | Finite element analysis | H | H | H | M | H | L | L | L | L | L | L | L | H | M | M |
| MECH3161 | Product life cycle management | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH2101 | Mechanical Vibrations | H | H | H | M | H | L | L | L | L | L | L | L | H | M | M |
| MECH3171 | Mobile Robotics | H | H | H | H | M | M | H | M | M | M | M | H | H | H | H |
| MECH2111 | Computational Methods | H | H | H | M | H | L | L | L | L | L | L | L | H | M | M |
| MECH2121 | Control Systems Engineering | H | H | H | M | H | L | L | L | L | L | L | L | H | M | M |
| MECH2131 | Turbo Machinery | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |
| MECH2141 | Computational Fluid Dynamics | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |
| MECH2151 | Refrigeration and air conditioning | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |
| MECH2161 | Cryogenics | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECH3181 | Vehicle technology | M | H | H | M | M | M | H | M | L | L | L | H | H | H | H |
| MECH2171 | Power Plant Engineering | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |
| MECH2181 | Renewable Energy Technology | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |
| MECH2191 | Alternative fuels and emission control | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |
| MECH2201 | Solar Energy | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |
| MECH3191 | Waste to energy | H | H | H | H | M | M | H | M | L | L | L | H | H | H | H |
| MECH3201 | Energy Conservation and Management | M | H | H | M | M | M | H | M | L | L | L | H | H | H | H |
| MECH3274 | Wind energy | M | H | H | M | M | M | H | M | L | L | L | H | H | H | H |
| MECH1031 | Fundamentals of Electric and Hybrid vehicles | M | H | H | M | M | M | H | M | L | L | L | H | H | H | H |
| MECH2211 | Fuel Cell technology and Hydrogen Storage system | H | H | H | M | M | M | H | M | L | L | L | H | H | H | H |
| MECH3211 | Vehicle Electrical Power systems | M | H | H | M | M | M | H | M | L | L | L | H | H | H | H |
| MECH2221 | Introduction to AI and ML | H | H | H | M | M | M | H | M | L | L | L | H | H | H | H |
| MECH2231 | Introduction to autonomous vehicles | H | H | H | M | M | M | H | M | L | L | L | H | H | H | H |
| MECH3275 | Mechatronics | H | M | M | L | L | M | L | M | H | H | H | H | H | H | H |
| MECH3221 | Statistical Quality Control | H | M | M | L | L | M | L | M | H | H | H | H | H | H | H |
| MECH2241 | Operations Research | H | M | M | L | L | M | L | M | H | H | H | H | H | M | H |
| MECH2251 | Plant Layout and Facilities Planning | H | M | M | L | L | M | L | M | H | H | H | H | H | H | H |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MECH2261 | Production Planning and Control | H | M | M | L | L | M | L | M | H | H | H | H | H | H | H |
| MECH2271 | Inventory control | H | M | M | L | L | M | L | M | H | H | H | H | H | H | H |
| MECH2281 | Supply Chain Management | H | M | M | L | L | M | L | M | H | H | H | H | H | H | H |
| MECH3231 | Enterprise Resource Planning | H | M | M | L | L | M | L | M | H | H | H | H | H | H | H |
| MECH3241 | Management Information Systems | H | M | M | L | L | M | L | M | H | H | H | H | H | H | H |
| MECH3251 | Engineering Optimization | H | M | M | L | L | M | L | M | H | H | H | H | H | H | H |
| MECH2291 | Project Planning and Management | H | M | M | L | L | M | L | M | H | H | H | H | H | H | H |
| MECH3261 | Decision Modelling | H | M | M | L | L | M | L | M | H | H | H | H | H | H | H |
| ENVS 3041 | Industrial Safety | L | M | M | L | L | M | L | M | H | H | H | H | H | M | H |
| MECH3271 | Total Quality management | H | M | M | L | L | M | L | M | H | H | H | H | H | M | H |
| MECH3276 | Autonomous Maintenance | M | H | H | M | M | M | H | L | L | L | M | H | H | H | H |
| MECH3277 | Mechanical Engineering systems | M | H | H | M | M | M | H | L | L | L | M | H | H | H | H |
| MECH2321 | Basics of Industrial Engineering | L | M | M | L | L | M | L | M | H | H | H | H | H | M | H |
| MECH2301 | Engineering Economics | H | M | M | L | L | M | L | M | H | H | H | H | H | M | H |
| MECH2311 | Fundamentals of Project Management | M | H | H | M | M | M | H | L | L | L | M | H | H | H | H |
| MECH2331 | Introduction To Operations Research | M | H | H | M | M | M | H | L | L | L | M | H | H | H | H |

# Syllabus

# University Core

<table>
<tr><td rowspan="2">CSEN1001</td><td rowspan="2">IT Productivity Tools</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>0</td><td>0</td><td>1*</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Familiarity with Computer system and its operation.</td></tr>
</table>

**Course Description:**

*This course introduces all software tools that improve the productivity of a student in enhancing his learning experience with all the activities taken up as part of his coursework.*

**Course Educational Objectives:**

- To enable the learner, the skill in preparing technical documents of professional quality using docs, sheets and forms.
- To involve the student in designing and creating of websites and acquaint the student with the skill of processing audio, images, documents etc.
- To create awareness in analyzing data using pivot tables, query manager etc.
- To create awareness in composing emails, mail merge, e-mail merge etc.
- To provide the exposure to work with collaborative tools.

**List of Experiments:**

1. Create a typical document consisting of text, tables, pictures, multiple columns, with different page orientations.
2. Create a technical paper / technical report consisting of table of contents, table of figures,table of tables, bibliography, index, etc.
3. Compose and send customized mail / e-mail using mail-merge.
4. Create / modify a power point presentation with text, multimedia using templates withanimation.
5. Create spreadsheet with basic calculations with relative reference, absolute reference, andmixed reference methods.
6. Simple report preparation using filtering tool / advanced filtering commands / pivot tables in spreadsheet application.
7. Analyse the results of a examination student wise, teacher wise, course wise, institute-wise.
8. Collecting and consolidating data using collaborative tools like google docs, sheets, forms.
9. Create charts / pictures using online tools like: www.draw.io or smart draw
10. Create a website of his interest.

**Textbooks:**

1. Katherin Murray, 'Microsoft Office 365 Connect and collaborate virtually anywhere, anytime', Microsoft Press, ISBN: 978-0-7356-5694-9
2. EXCEL 2021 The Comprehensive Beginners to Advanced Users Guide to Master Microsoft Excel 2021. Learn the Essential Functions, New Features, Formulas, Tips and Tricks, and Many More
3. https://drawio-app.com/tutorials/video-tutorials/
4. Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and WebGraphics Fourth Edition ISBN-13: 978-1449319274

**References/Online Resources:**

1. https://www.coursera.org/learn/introduction-to-computers-and-office-productivity-software
2. https://www.coursera.org/projects/analyze-data-pivot-tables-crosstabs-google-sheets
3. https://www.coursera.org/learn/excel-advanced#syllabus
4. https://www.coursera.org/learn/how-to-create-a-website
5. https://support.microsoft.com/en-us/office
6. https://www.diagrams.net/
7. https://edu.google.com/

**Course Outcomes:**

1. Create / alter documents / Technical Paper / Project report with text, pictures, graphs ofdifferent styles.
2. Create / modify power point presentations with text, multimedia and to add animationusing / creating templates.
3. Perform basic calculations / retrieve data / createpivot tables / chart using a spreadsheetapplication.
4. Create simple diagrams / charts using online tools like: www.draw.io .
5. Manage documents, presentations, spreadsheets and websites in collaborative mode.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PS12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | 2 | | | | 1 | 1 | | | | | |
| CO2 | | | | | 2 | | | | 1 | 1 | | | | | |
| CO3 | 2 | 1 | 1 | | 2 | | | | 1 | 1 | | | | | |
| CO4 | | | | | 2 | | | | 1 | 1 | | | | | |
| CO5 | | | | | 2 | | | | 3 | 3 | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : September 6, 2021**

**ACADEMIC COUNCIL: 21st AC(September 17, 2021**

**SDG No. & Statement: 4** Quality Education

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

The students can perform simple document preparation to complex calculations in isolated mode and collaborative mode that are useful throughout their career.

| CLAD1001 | EMOTIONAL INTELLIGENCE & REASONING SKILLS (SOFT SKILLS 1) | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 0 | 0 | 1 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*Emotional intelligence is a set of skills that are thought to contribute to the appraisal of emotions in oneself and others. It can also help contribute to the effective regulation of emotions as well as feelings (Salovey & Mayer, 1990). In terms of emotional intelligence, self-awareness and self- management have to do with our ability to relate to ourselves. Social awareness and relationship management have to do with our ability to relate to others. Similarly, the ability to solve questions on Analytical Reasoning and Data Sufficiency is a critical area tested in almost all competitive examinations and admission tests. Upon completion, students should be able (1) to deal with theirown emotions as well as the emotions of others and relate better with both. Using better knowledgeof EI, students will also be able to set more meaningful goals for themselves, choose suitable time management techniques that work best for them and work in teams more effectively. (2) to apply different concepts, ideas, and methods to solve questions in reasoning and data sufficiency*

**Course Educational Objectives:**

- Use EI to relate more effectively to themselves, their colleagues and to others. Apply self-awareness and self-assessment (SWOT) to better understand and manage their own emotions. Apply social awareness to empathize with others and build stronger relationships with others.
- Set meaningful goals based on their strengths and weaknesses and apply time management techniques, such as Q4 organizing to put first things first.
- Manage conflicts and work in teams in an emotionally intelligent manner.
- Solve questions on non-verbal and analytical reasoning, data sufficiency and puzzles

**List of Activities & Tasks for Assessment:**

| Unit | Topics | Hours |
|---|---|---|
| 1 | Self-Awareness & Self-Regulation: Introduction to Emotional Intelligence, *Self-Awareness:* Self-Motivation, Accurate Self-Assessment (SWOT Analysis),Self-Regulation: *Self Control, Trustworthiness & Adaptability* | 3 |
| 2 | Importance, Practising Social Awareness, Building Relationships, Healthy andUnhealthy Relationships, Relationship Management Competencies-Influence, Empathy, Communication, Types of Conflicts, Causes, Conflict Management | 3 |

| | | |
|---|---|---|
| 3 | Social Media: Creating a blog, use of messaging applications, creating awebsite to showcase individual talent, creation of a LinkedIn Profile | 2 |
| 4 | Goal Setting & Time Management: Setting SMART Goals, Time Wasters, Prioritization, Urgent Vs Important, Q2 Organization | 3 |
| 5 | Teamwork: Team Spirit, Difference Between Effective and Ineffective Teams, Characteristics of High Performance Teams, Team Bonding, Persuasion, Team Culture, Building Trust, Emotional Bank Account | 4 |
| 6 | Verbal Reasoning: Introduction, Coding-decoding, Blood relations, Ranking Directions, Group Reasoning | 6 |
| 7 | Analytical Reasoning: Cubes and Dices, Counting of Geometrical figures | 3 |
| 8 | Logical Deduction: Venn diagrams, Syllogisms, Data Sufficiency, Binary logic | 4 |
| 9 | Spatial Reasoning: Shapes, Paper Cutting/Folding, Mirror images, Water images and Rotation of figures | 2 |

**References:**

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, Career Launcher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

**Course Outcomes:**

1. Students will be able to relate more effectively to themselves, their colleagues and to others
2. Students will be able to set their short term and long term goals and better manage their time
3. Students will be able to manage conflicts in an emotionally intelligent manner and work inteams effectively
4. Students will be able to solve questions based on non-verbal and analytical reasoning, datasufficiency and puzzle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 3 | | 2 | | | |
| CO2 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | | 3 | 3 | | 3 | | | |
| CO3 | 2 | | 2 | 3 | | | | | 3 | 2 | 2 | 2 | | | |
| CO4 | 2 | 2 | 2 | 3 | | 1 | | | | | 2 | 3 | | | |
| CO5 | | | | | | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :17-09-2021** **ACADEMIC COUNCIL:17-09-201**

**SDG No. & Statement:4**

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

Emotional Intelligence and reasoning skills are essential for achieving inclusive and equitable education and lifelong learning opportunities for oneself and others.

| CLAD1011 | LEADERSHIP SKILLS & QUANTITATIVE APTITUDE (SOFT SKILLS 2) | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 0 | 0 | 1 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*Communication Skills is having the ability to convey information to others so that messages are understood, and outcomes delivered. Some essential qualities of Communication Skills include understanding the needs of others, clearly communicating messages, adapting the communication style, and using a range of communication methods. Presentation Skills is having the ability to confidently deliver an engaging messageto a group of people which achieves the objectives. Some essential qualities of Presentation Skills include a thorough preparation of content, structuring content logically, managing nerves, engaging your audience, delivering presentation objectives, positively influencing the audience, and responding to audience needs.Tackling questions based on numbers, arithmetic, data interpretation and puzzles requires the application of different rules and concepts of numerical computation, numerical estimation, and data estimation.*

**Course Educational Objectives:**

- Learn and apply, through different individual and group activities, different ideas, and skills tocommunicate in a positive and impressive manner.
- Apply the goal setting process (based on SWOT) and Q2 organizing for effective time management.
- Apply different concepts in numbers, numerical computation, and numerical estimation to solvequestions that often appear in various competitive examinations and admission tests.
- Apply different concepts for tackling questions based on data interpretation, progression and series thatare frequently given in various competitive examinations and admission tests.

**List of Activities & Tasks for Assessment:**

| Unit | Topics | Hours |
|---|---|---|
| 1 | Communication Skills: The Communication Process, Elements of Interpersonal Communication, Non-Verbal Communication: Body Language, Posture, Eye Contact, Smile, Tone of Voice, Barriers to Communication. Effective Listening Skills: Active Listening, Passive | 5 |

| | | |
|---|---|---|
| | Listening, Asking Questions, Empathizing, Being Non-Judgmental, Being Open Minded, Mass Communication: Design of Posters, Advertisements, notices, writing formal and informal invitations | |
| 2 | Focus on Audience Needs, focus on the Core Message, Use Body Language andVoice, Start Strongly, Organizing Ideas & Using Visual Aids: SPAM Model, EffectiveOpening and Closing Techniques, Guy Kawasaki's Rule (10-20-30 Rule), Overcoming Stage Fear, Story Telling | 3 |
| 3 | Problem Solving & Decision Making: Difference Between the Two, Steps in RationalApproach to Problem Solving: Defining the Problem, Identifying the Root Causes, Generating Alternative Solutions, Evaluating and Selecting Solutions, Implementingand Following-Up, Case Studies | 3 |
| 4 | Group Discussion: Understanding GD, Evaluation Criteria, Nine Essential Qualities for Success, Positive and Negative Roles, Mind Mapping, structuring a Response, Methods of Generating Fresh Ideas | 4 |
| 5 | Number Theory: Number System, Divisibility rules, Remainders and LCM & HCF | 3 |
| 6 | Numerical Computation and Estimation - I: Chain Rule, Ratio Proportions, Partnerships & Averages, Percentages, Profit-Loss & Discounts, Mixtures, Problem on Numbers & ages | 6 |
| 7 | Data Interpretation: Interpretation and analysis of data in Tables, Caselets, Line- graphs, Pie-graphs, Boxplots, Scatterplots and Data Sufficiency | 3 |
| 8 | Mental Ability: Series (Number, Letter and Alphanumeric), Analogy (Number, Letter and Alphanumeric) and Classifications | 3 |

**References:**


1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, Career Launcher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications


**Course Outcomes:**

1. Students will be able to communicate 'one-on-one' and 'one-on-many' confidently using both verbal and non-verbal messages and deliver impressive talks/ presentations to a group both with and without the use of PPTs and create posters, advertisements, etc.
2. Students will be able to apply the rational model of problem solving and decision makingin their problem solving and decision-making efforts.

3. Students will be able to solve questions based on numbers and arithmetic given in various competitive examinations
4. Students will be able to solve questions based on data interpretation, progressions, and series.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 2 | | | 2 | 3 | | 2 | | | |
| CO2 | 2 | 2 | 3 | 2 | | 3 | 3 | | 3 | 3 | | 2 | | | |
| CO3 | 2 | 2 | 2 | 2 | | 2 | | | | | | 3 | | | |
| CO4 | 2 | 2 | 2 | 2 | | 2 | | | | | | | | | |
| CO5 | | | | | | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :17-09-2021** **ACADEMIC COUNCIL:17-09-2021**

**SDG No. & Statement:4**

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

Leadership and quantitative aptitude skills are essential skills for achieving inclusive and equitable education and lifelong learning opportunities for oneself and others.

| CLAD1021 | VERBAL ABILITY & QUANTITATIVE ABILITY (SOFT SKILLS 3) | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 0 | 0 | 1 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*Vocabulary is an important part of verbal ability. An understanding of word formation, prefixes, suffixes, and roots is necessary to remember and use a vast repository of words. Approaching words through word families and other ways of groupings is an effective way of gaining mastery over vocabulary. Understanding and getting acquainted with the different rules and exceptions in the use of grammar and structure, especially from the relevant examination point of view, is crucial to cracking questions given in many competitive tests. Similarly, improving reading comprehension skills and test taking abilities in this area takes time and effort, especially given the fact that most students do not possess strong reading habits. In so far as quantitative aptitude is concerned, students need to develop a strong foundation on the basic mathematical concepts of numerical estimation, geometry, mensuration, data sufficiency, etc. to be able to crack different round 1 tests of major recruiters and admission tests of top Indian and foreign universities.*

**Course Educational Objectives:**

- List and discuss the different word formation methods, word denotation, connotation, collocation, etc. and introduce selected high frequency words, their antonyms, synonyms, etc.
- Apply different advanced reading skills to solve questions based on author's tone, main ideas and sub-ideas, inferences, Para jumbles, etc. that are frequently asked in various competitive exams and admission tests.
- Solve different types of questions based on vocabulary, such as word analogy; structure, grammar, and verbal reasoning; introduce common errors and their detection and correction.
- Solve questions on numerical estimation, mensuration, data sufficiency based on quantitative aptitude. This includes questions on time and work, time and distance, pipes and cisterns, lines and angles, triangles, quadrilaterals, polygons and circles, 2- & 3-dimensional mensuration.

**List of Activities & Tasks for Assessment:**

1. **Vocabulary Builder:** Understanding Word Formation, Prefixes, Suffixes and Roots, Etymology, Word Denotation, Connotation and Collocation, Synonyms and Antonyms

2. **Reading Comprehension:** Advanced Reading Comprehension: Types of RC passages, Types of Text Structures, Types of RC Questions: Distinguishing Between Major Ideas and Sub Ideas, Identifying the Tone and Purpose of the Author, Reading Between the Lines and Beyond the Lines, Techniques for Answering Different Types of Questions
3. **Para Jumbles:** Coherence and Cohesion, Idea Organization Styles, Concept of Mandatory Pairs and Its Application: Transitional Words, Antecedent-Pronoun Reference, Article Reference, Cause and Effect, Chronological Order, General to Specify, Specify to General, Idea-Example, Idea-Explanation, Etc.
4. **Grammar Usage:** Rules Governing the Usage of Nouns, Pronouns, Adjectives, Adverbs, Conjunctions, Prepositions and Articles
5. **Numerical Computation and Estimation - II:** Time and Work, Pipes and Cisterns, Time and Distance, Problems on Trains, Boats and Streams, Races and Games of Skill, Simple Interest& Compound Interest
6. **Geometry:** Lines and Angles, Triangles, Quadrilaterals & Polygons, and Circles
7. **Mensuration:** 2-Dimensional Mensuration (Triangles, Quadrilaterals and Circles), 3-Dimensional Mensuration (Cubes, Cuboids, Cylinder, Cone, Sphere)

**References:**


1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, Career Launcher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications


**Course Outcomes:**

1. List and discuss word formation methods, selected high frequency words, their antonyms, synonyms, etc.
2. Analyze reading passages and quickly find out the correct responses to questions asked, including para jumbles, by using reading skills like skimming, scanning, reading between the lines, etc.
3. Solve different types of questions based on vocabulary, structure, grammar and verbal reasoning
4. Solve questions on numerical estimation, mensuration, data sufficiency based on quantitative aptitude

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 1 | 3 | | 2 | | | |
| CO2 | | | | 2 | | 2 | | | | 2 | | 3 | | | |
| CO3 | | | | | | | | | 1 | 2 | | 3 | | | |
| CO4 | 2 | 2 | 3 | | | 2 | | | | | | 1 | | | |
| CO5 | | | | | | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :17-09-2021** **ACADEMIC COUNCIL:17-09-2021**

**SDG No. & Statement:4**

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

English language and quantitative aptitude skills are essential skills for achieving inclusive and equitable education and lifelong learning opportunities for oneself and others.

<table>
<tr><td rowspan="2">CLAD1031</td><td rowspan="2">PRACTICING VERBAL ABILITY & QUANTITATIVE APTITUDE (SOFT SKILLS 4)</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*A sound knowledge of the rules of English grammar, structure and style and its application in detecting errors in writing are important areas of Verbal Ability frequently tested as a part of the written test in many competitive examinations and admission tests of major recruiters and universities respectively. This module focuses on all important areas of grammar and structure commonly asked in major tests, such as GMAT, CAT, XLRI, CRT, etc. Similarly, in the area of Quantitative Aptitude, different kinds of questions are asked from Combinatorics (Permutations & Combinations, Probability], Cryptarithmetic & Modular Arithmetic (Cryptarithmetic, Application of base system (7, 24), Clocks (Base 24), Calendars (Base 7), and Mental Ability (Number series, Letter series & Alpha numeric series, Analogies ( Numbers, letters), Classifications, Algebra (Exponents, Logarithms, Problems related to Equations, Special Equations, and Statistics) . This module focuses on all these areas by building on what the students already learnt in their earlier studies.*

**Course Educational Objectives:**

- Apply the rules of grammar to solve questions in Error Detection, Sentence Correction and Sentence Improvement.
- Apply the rules of structure to solve questions in Error Detection, Sentence Correction and Sentence Improvement, Fill-in-blanks and Cloze Passages.
- Explain methods of solving problems in Combinatorics (Permutations & Combinations, Probability], Cryptarithmetic & Modular Arithmetic (Cryptarithmetic, Application of basesystem (7, 24), Clocks (Base 24), Calendars (Base 7)]
- Explain how to solve questions in Mental Ability (Number series, Letter series & Alpha numeric series, Analogies, Numbers, letters, Classifications] and Algebra (Exponents, Logarithms, Problems related to Equations, Special Equations, Statistics)

**List of Activities & Tasks for Assessment:**

1. Error Detection: Pronouns, Conjunctions, Prepositions and Articles
2. Error Detection: Tenses and their Uses
3. Sentence Correction: Subject-Verb Agreement, Antecedent-Pronoun Agreement, Conditional Clauses
4. Sentence Correction: Modifiers (Misplaced and Dangling) & Determiners, Parallelism & WordOrder, and Degrees of Comparison
5. Combinatorics: Permutations & Combinations, Probability

6. Crypt arithmetic & Modular Arithmetic: Crypt arithmetic, Application of Base System (7, 24),Clocks (Base 24), Calendars (Base 7)
7. Algebra: Exponents, Logarithms, Word-problems related to equations, Special Equations,Progressions, Statistics

**References:**

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, Career Launcher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

**Course Outcomes:**

1. Identify and correct errors in English grammar and sentence construction
2. Identify and correct errors in Structure, Style and Composition
3. Solve problems in Combinatorics, Cryptarithmetic, and Modular Arithmetic
4. Solve problems in Mental Ability and Algebra

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 1 | 3 | | 1 | | | |
| CO2 | | | | | | | | | 1 | 3 | | 1 | | | |
| CO3 | | 2 | 3 | 2 | | 2 | | | | | | 2 | | | |
| CO4 | | 3 | 2 | 2 | | 2 | | | | | | 2 | | | |
| CO5 | | | | | | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :17-09-2021** **ACADEMIC COUNCIL:17-09-2021**

**SDG No. & Statement:4**

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

English language and quantitative aptitude skills are essential skills for achieving inclusive and equitable education and lifelong learning opportunities for oneself and others.

| CLAD2001 | PREPARATION FOR CAMPUS PLACMENT -1 (SOFT SKILLS 5A) | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 0 | 0 | 1 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*The course addresses all relevant areas related to campus placements and readies them to ace their upcoming/ ongoing recruitment drives. Specifically, it focuses on students' career preparedness, interview skills, test preparedness, etc.*

**Course Educational Objectives:**

Prepare the students for their upcoming/ ongoing campus recruitment drives.

**List of Activities & Tasks for Assessment:**

1. Career Preparedness: Resume & Cover Letter Writing, Interview Skills: Elevator Pitch, Making the First Impression, Being Other-Oriented, Being Positive and Curious, communicating with Confidence and Poise, Frequently Asked Questions & How to Answer Them, Pitfalls to Avoid, Etc. Etiquette: Hygiene, Courtesy, Culture differences, Workplace, use of cell phone, Profanity, Slang, Protocol.
2. Verbal Ability: Practicing Reading Comprehension, Error Detection, Sentence Completion, MCQs, FIBs, Para jumbles, Cloze Test, Critical Reasoning.
3. Quantitative Aptitude: Number Systems, Algebra, Geometry, Data Handling, Data Sufficiency, Word Problems
4. Reasoning: Logical and Verbal Reasoning

**References:**

1. Verbal Ability & Reading Comprehension by Arun Sharma and MeenakshiUpadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMSetc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

**Course Outcomes:**

1. Write a power resume and covering letter
2. Answer interview questions with confidence and poise
3. Exhibit appropriate social mannerisms in interviews
4. Solve placement test questions on verbal ability, quantitative aptitude and reasoning

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 1 | | | |
| CO2 | | | | | | 3 | | | 2 | | | 1 | | | |
| CO3 | | | | | | 2 | | | 1 | 3 | | 3 | | | |
| CO4 | | 3 | | 2 | | 2 | | | 1 | | | 3 | | | |
| CO5 | | | | | | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :17-09-2021** **ACADEMIC COUNCIL:17-09-2021**

**SDG No. & Statement:4**

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

Quantitative aptitude, reasoning, verbal and language skills practiced during the preparation for campus placement tests provide essential skills for achieving inclusive and equitable education and lifelong learning opportunities for oneself and others.

<table>
<tr><td rowspan="2">CLAD2011</td><td rowspan="2">PREPARATION FOR HIGHER EDUCATION (GRE/ GMAT)-1 (SOFT SKILLS 5B)</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*The course offers a special track for students who aspire to go abroad in pursuit of their higher education for which a GRE/ GMAT score is a prerequisite. It covers all four topical areas of these tests and includes fully solved mock tests as well.*

**Course Educational Objectives:**

- Prepare the students to solve questions from all four broad areas of GRE/ GMAT
- Orient the students for GRE/ GMAT through mock tests

**List of Activities & Tasks for Assessment:**

1. Verbal Reasoning: Reading Comprehension, Sentence Equivalence, TextCompletion, Sentence Correction, Critical Reasoning
2. Quantitative Reasoning: Arithmetic, Algebra, Geometry, Data Analysis
3. Analytical Writing Assessment: Issue/ Argument
4. Integrated Reasoning

**References:**

1. Verbal Ability & Reading Comprehension by Arun Sharma and MeenakshiUpadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMSetc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

**Course Outcomes:**

1. Solve questions from all four broad areas of GRE/ GMAT
2. Practice answering several mock tests

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | 2 | 2 | 2 | | | | | 3 | | | 3 | | | |
| CO2 | | 2 | 2 | 2 | | | | | 3 | | | 3 | | | |
| CO3 | | | | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :17-09-2021** **ACADEMIC COUNCIL:17-09-2021**

**SDG No. & Statement:4**

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

Quantitative aptitude, reasoning, verbal and language skills practiced during the preparation for GRE/GMAT tests provide essential skills for achieving inclusive and equitable education and lifelong learning opportunities for oneself and others.

| CLAD2021 | PREPARATION FOR CAT/ MAT – 1 (SOFT SKILLS 5C) | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 0 | 0 | 1 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*The course offers a special track for UG students who aspire to go for higher education in business management in India for which cracking CAT/ MAT/ other related test is mandatory. It covers all four topical areas of these tests and includes fully solved mock testsas well.*

**Course Educational Objectives:**

- Prepare the students to solve questions from all four relevant areas of CAT/ XAT/MAT, etc.
- Orient the students for CAT/ XAT, etc. through mock tests

**List of Activities & Tasks for Assessment:**

1. Quantitative Ability: Arithmetic, Algebra, Geometry, Mensuration, Calculus, Trigonometry
2. Data Interpretation: Data Interpretation and Data Sufficiency
3. Logical Reasoning: Data Management, Deductions, Verbal Reasoning and Non-Verbal Reasoning
4. Verbal Ability: Critical Reasoning, Sentence Correction, Para Completion, Para Jumbles, Reading Comprehension

**References:**

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, Career Launcher andIMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

**Course Outcomes:**

1. Solve questions from all four relevant areas of CAT/ MAT as listed above
2. Practice test-cracking techniques through relevant mock tests

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | | 2 | | | 3 | 3 | 3 | 3 | | | |
| CO2 | 2 | 2 | 2 | 2 | | 1 | | | 2 | | 2 | 3 | | | |
| CO3 | | | | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :17-09-2021** **ACADEMIC COUNCIL:17-09-2021**

**SDG No. & Statement:4**

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

Quantitative aptitude, reasoning, verbal and language skills practiced during the preparation for CAT/ MAT tests provide essential skills for achieving inclusive and equitable education and lifelong learning opportunities for oneself and others.

| CLAD2031 | PREPARATION FOR CAMPUS PLACEMENT-2 (SOFT SKILLS 6A) | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 0 | 0 | 1 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course builds on the previous course and focuses on all four major areas of campus placements, including career preparedness, mock interviews, verbal ability, quantitative aptitude, and logical reasoning.*

**Course Educational Objectives:**

- To comprehensively prepare all eligible and aspiring students for landing their dream jobs.
- To sharpen the test-taking skills in all four major areas of all campus drives

**List of Activities & Tasks for Assessment:**

1. Career Preparedness II: Mock Interviews, Feedback and Placement Readiness
2. Verbal Ability II: Practising Reading Comprehension, Error Detection, Sentence Completion, MCQs, FIBs, Para jumbles, Cloze Test, Critical Reasoning
3. Quantitative Aptitude II: Number Systems, Algebra, Geometry, Data Handling,Data Sufficiency, Word Problems
4. Reasoning II: Logical and Verbal Reasoning

**References:**

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMSetc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

**Course Outcomes:**

1. Demonstrate career preparedness and confidence in tackling campus interviews
2. Solve placement test questions of a higher difficulty level in verbal ability, quantitative aptitude and logical reasoning.
3. Practice test-taking skills by solving relevant questions accurately and within time.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 2 | 3 | | 2 | | | |
| CO2 | 2 | 2 | 2 | 3 | | 3 | | | 2 | 2 | 3 | 2 | | | |
| CO3 | 2 | 2 | 2 | 3 | | 2 | | | 1 | | 2 | 3 | | | |
| CO4 | | | | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :17-09-2021** **ACADEMIC COUNCIL:17-09-2021**

**SDG No. & Statement:4**

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

Quantitative aptitude, reasoning, verbal and language skills practiced during the preparation for campus placement tests provide essential skills for achieving inclusive and equitable education and lifelong learning opportunities for oneself and others.

| CLAD2041 | PREPARATION FOR HIGHER EDUCATION (GRE/GMAT)-2 (SOFT SKILLS 6B) | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 0 | 0 | 1 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*The course offers a special track for students who aspire to go abroad in pursuit of theirhigher education for which a GRE/ GMAT score is a prerequisite. It covers all four topical areas of these tests at a higher difficulty-level and includes fully solved mock tests as well.*

**Course Educational Objectives:**

- Prepare the students to solve higher level questions from all four broad areas of GRE/ GMAT
- Orient the students for GRE/ GMAT through mock tests

**List of Activities & Tasks for Assessment:**

1. Verbal Reasoning II: Reading Comprehension, Sentence Equivalence, Text Completion, Sentence Correction, Critical Reasoning
2. Quantitative Reasoning II: Arithmetic, Algebra, Geometry, Data Analysis
3. Analytical Writing Assessment II: Issue/ Argument
4. Integrated Reasoning II

**References:**

1. Verbal Ability & Reading Comprehension by Arun Sharma and MeenakshiUpadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMSetc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

**Course Outcomes:**

1. Solve higher level questions from all four broad areas of GRE/ GMAT
2. Practice answering several mock tests

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | 2 | | 3 | | 2 | | | 2 | 2 | 2 | 2 | | | |
| CO2 | | 2 | | 2 | | 2 | | | 2 | 2 | 2 | 2 | | | |
| CO3 | | | | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :17-09-2021** **ACADEMIC COUNCIL:17-09-2021**

**SDG No. & Statement:4**

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

Quantitative aptitude, reasoning, verbal and language skills practiced during the preparation for GRE/GMAT tests provide essential skills for achieving inclusive and equitable education and lifelong learning opportunities for oneself and others.

| CLAD2051 | PREPARATION FOR CAT/ MAT – 2 (SOFT SKILLS 6C) | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 0 | 0 | 1 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*The course offers a special track for UG students who aspire to go for higher education in business management in India for which cracking CAT/ MAT/ other related test is mandatory. It covers all four topical areas of these tests at a higher level of difficulty and includes fully solved mock tests as well.*

**Course Educational Objectives:**

- Prepare the students to solve all types of questions from all four relevant areas of CAT/ XAT/ MAT, etc.

**List of Activities & Tasks for Assessment:**

1. Quantitative Ability II: Arithmetic, Algebra, Geometry, Mensuration, Calculus, Trigonometry
2. Data Interpretation II: Data Interpretation and Data Sufficiency
3. Logical Reasoning II: Data Management, Deductions, Verbal Reasoning and Non-Verbal Reasoning
4. Verbal Ability II: Critical Reasoning, Sentence Correction, Para Completion, Para Jumbles, Reading Comprehension

**References:**


1. Verbal Ability & Reading Comprehension by Arun Sharma and MeenakshiUpadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMSetc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications


**Course Outcomes:**

1. Solve higher difficulty level questions from all four relevant areas of CAT/ MAT aslisted above
2. Practice test-cracking techniques through relevant mock tests

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | | 3 | | | | | 3 | 3 | 3 | 2 | | | |
| CO2 | 1 | 2 | | 2 | | | | | 2 | 3 | 2 | 2 | | | |
| CO3 | | | | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :17-09-2021** **ACADEMIC COUNCIL:17-09-2021**

**SDG No. & Statement:4**

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

Quantitative aptitude, reasoning, verbal and language skills practiced during the preparation for CAT/ MAT tests provide essential skills for achieving inclusive and equitable education and lifelong learning opportunities for oneself and others.

| DOSL1001 | CLUB ACTIVITY – PARTICIPANT | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course recognizes student participation in multiple activities organized by various student organizations that pursue specific co-curricular and extra-curricular interests. These activities allow students to engage in and identify and pursue their personal interests and hobbies.*

**Course Educational Objectives:**

- Create opportunities for students to participate in a variety of non-academic experiences
- Interact with and learn from peers in a setting without an external performance pressure
- Allow exploration of interesting activities and reflection about these experiences
- Learn to manage time effectively

**List of Student Club Activities:**

1. Music (vocals, instruments, technical, recording, mixing, production, management)
2. Dance (Indian classical, western, jazz, latin, contemporary, folk, production, event management)
3. Theatre (classical, experimental, one-act, street, production, direction, casting, etc.)
4. Arts (fine arts, painting, calligraphy, sketching, caricaturing, etc)
5. Craft (origami, model making, sculpture, pottery, etc)
6. Cooking (home-style, baking, confectionery, Indian, intercontinental, etc.)
7. Graffiti (street, mural, collage, multi media, etc)
8. Workshops, quizzes, debates, elocution, etc
9. Filmmaking (adventure, drama, film appreciation, documentary, etc)
10. Photography (conventional, immersive (360), landscape, portrait, technical, editing, etc.)
11. College Fests
12. Designing (graphic design, landscape, interior, etc)
13. Competitive coding
14. Recreational sports activities
15. Other club activities organized by student clubs

**List of Activities:**

1. Participation in various club-based activities
2. Weekly reflection paper
3. Portfolio (on social media using an Instagram account)
4. Two learning papers (one per semester)

**Textbooks:**

1. Small move: big Change (Caroline Arnold)
2. How to Win at College: Surprising Secrets for Success from the Country's Top Students (Cal Newport)

**References:**

1. Making the most of college: Students speak their minds (author - Richard Light)
2. Failing Forward: Turning Mistakes into Stepping Stones for Success (John C Maxwell)
3. The Last Lecture (Randy Pausch)
4. Lean in (Sheryl Sandberg)
5. YouTube- Introduction to various club activities

**Course Outcomes:**

Upon successful completion of the course, student will be able to

1. Identify personal interest areas
2. Learn from diverse perspectives and experiences
3. Gain exposure to various activities and opportunities for extra-curicular activities
4. Learn to manage time effectively
5. gain confidence

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | 3 | 3 | 2 | 3 | 2 | | | |
| CO2 | | | | | | | | | 3 | 3 | | 2 | | | |
| CO3 | | | | | | | | | 3 | 3 | 2 | 3 | | | |
| CO4 | | | | | | | | | 3 | 3 | | 3 | | | |
| CO5 | | | | | | | | 3 | 3 | 3 | | 2 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:**

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

This course recognizes student participation in non-academic events and activities which focus on inclusive partnerships and collaborations with all stakeholders by using all sustainable means to promote lifelong learning.

| DOSL1011 | CLUB ACTIVITY – MEMBER OF THE CLUB | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course encourages and acknowledges student members' work in organizing events and activities organized by various student organizations that pursue specific co-curricular and extra- curricular interests. These activities allow students to actively learn from the process of conceptualizing and organizing such activities as part of a team.*

**Course Educational Objectives:**

- Create opportunities for students to learn from organizing club activities
- Learn teamwork, leadership, planning and management of events and activities
- Learn to appreciate multiple perspectives, cultures, and individual capabilities
- Learn to manage time effectively

**List of Student Club Activities:**

1. Music (vocals, instruments, technical, recording, mixing, production, management)
2. Dance (Indian classical, western, jazz, latin, contemporary, folk, production, event management)
3. Theatre (classical, experimental, one-act, street, production, direction, casting, etc.)
4. Arts (fine arts, painting, calligraphy, sketching, caricaturing, etc)
5. Craft (origami, model making, sculpture, pottery, etc)
6. Cooking (home-style, baking, confectionery, Indian, intercontinental, etc.)
7. Graffiti (street, mural, collage, multi media, etc)
8. Workshops, quizzes, debates, elocution, etc
9. Filmmaking (adventure, drama, film appreciation, documentary, etc)
10. Photography (conventional, immersive (360), landscape, portrait, technical, editing, etc.)
11. College Fests
12. Designing (graphic design, landscape, interior, etc)
13. Competitive coding
14. Recreational sports activities
15. Other club activities organized by student clubs

**List of Activities:**

1. Be a member of a club and organize activities in that particular interest area
2. Learn from diverse perspectives and experiences
3. Learn to design and execute extra-curricular activities
4. Develop management skills through hands on experience
5. Explore different managerial roles and develop competencies

**Textbooks:**

1. Small move: big Change (Caroline Arnold)
2. How to Win at College: Surprising Secrets for Success from the Country's Top Students (Cal Newport)

**References:**

1. Making the most of college: Students speak their minds (author - Richard Light)
2. Failing Forward: Turning Mistakes into Stepping Stones for Success (John C Maxwell)
3. The Last Lecture (Randy Pausch)
4. Lean in (Sheryl Sandberg)
5. Youtube- Introduction to various club activities

**Course Outcomes:**

Upon successful completion of the course, student will be able to

- Be a member of a club and organize activities in that particular interest area
- Learn from diverse perspectives and experiences
- Learn to design and execute extra-curricular activities
- Develop management skills through hands on experience
- Explore different managerial roles and develop competencies

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | 3 | 3 | 3 | | 3 | | | |
| CO2 | | | | | | | | | 3 | 2 | | 3 | | | |
| CO3 | | | | | | | | 3 | 3 | 2 | | | | | |
| CO4 | | | | | | | | | | 2 | 3 | 3 | | | |
| CO5 | | | | | | | | 2 | | | | 3 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:**

SDG 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

SDG17 : Strengthen the means of implementation and revitalize the global partnership for sustainable development

**SDG Justification:**

This course recognizes student participation in community service endeavours focussing on sustainable development, service to communities. This allows students to develop empathy, citizenship behaviour and inclusive community values.

| DOSL1021 | CLUB ACTIVITY – LEADER OF THE CLUB | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course encourages and recognizes student members' work in leading the student organizationsthrough various leadership roles. As leaders they work not just to organize events and activities in specific co-curricular and extra-curricular interests, but also lead the teams that form the core members of the clubs. These activities allow students to learn and practice leadership and management skills through real world experience.*

**Course Educational Objectives:**

- Create opportunities for students to learn from organizing club activities
- Learn teamwork, leadership, planning and management of events and activities
- Learn to appreciate multiple perspectives, cultures, and individual capabilities
- Learn to manage time effectively

**List of Student Club Activities:**

1. Music (vocals, instruments, technical, recording, mixing, production, management)
2. Dance (Indian classical, western, jazz, latin, contemporary, folk, production, event management)
3. Theatre (classical, experimental, one-act, street, production, direction, casting, etc.)
4. Arts (fine arts, painting, calligraphy, sketching, caricaturing, etc)
5. Craft (origami, model making, sculpture, pottery, etc)
6. Cooking (home-style, baking, confectionery, Indian, intercontinental, etc.)
7. Graffiti (street, mural, collage, multimedia, etc)
8. Workshops, quizzes, debates, elocution, etc
9. Filmmaking (adventure, drama, film appreciation, documentary, etc)
10. Photography (conventional, immersive (360), landscape, portrait, technical, editing, etc.)
11. College Fests
12. Designing (graphic design, landscape, interior, etc)
13. Competitive coding
14. Recreational sports activities
15. Other club activities organized by student clubs

**List of Activities:**

1. Be the leader of the club and implement the charter, vision and mission of the club
2. Learn from diverse perspectives and experiences
3. Learn to lead the team, design and execute extra-curricular activities
4. Develop management skills through hands on experience
5. Explore different managerial roles and develop competencies

**Textbooks:**

1. Small move: big Change (Caroline Arnold)
2. How to Win at College: Surprising Secrets for Success from the Country's Top Students(Cal Newport)

**References:**

1. Making the most of college: Students speak their minds (author - Richard Light)
2. Failing Forward: Turning Mistakes into Stepping Stones for Success (John C Maxwell)
3. The Last Lecture (Randy Pausch)
4. Lean in (Sheryl Sandberg)
5. Youtube- Introduction to various club activities

**Course Outcomes:**

Upon successful completion of the course, student will be able to

- Be the leader of the club and implement the charter, vision and mission of the club
- Learn from diverse perspectives and experiences
- Learn to lead the team, design and execute extra-curricular activities
- Develop management skills through hands on experience
- Explore different managerial roles and develop competencies

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | 3 | 3 | 3 | | 3 | | | |
| CO2 | | | | | | | | | 3 | 2 | | 3 | | | |
| CO3 | | | | | | | | 3 | 3 | 2 | | | | | |
| CO4 | | | | | | | | | | 2 | 3 | 3 | | | |
| CO5 | | | | | | | | 2 | | | | 3 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:**

SDG 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

SDG17 : Strengthen the means of implementation and revitalize the global partnership for sustainable development

**SDG Justification:**

This course recognizes student participation in community service endeavours focussing on sustainable development, service to communities. This allows students to develop empathy, citizenship behaviour and inclusive community values.

<table>
<tr><td rowspan="2">DOSL1031</td><td rowspan="2">CLUB ACTIVITY – COMPETITOR</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*This course encourages and recognizes student members' work in leading the student organizationsthrough various leadership roles. As leaders they work not just to organize events and activities in specific co-curricular and extra-curricular interests, but also lead the teams that form the core members of the clubs. These activities allow students to learn and practice leadership and management skills through real world experience.*

**Course Educational Objectives:**

- Create opportunities for students to learn from organizing club activities
- Learn teamwork, leadership, planning and management of events and activities
- Learn to appreciate multiple perspectives, cultures, and individual capabilities
- Learn to manage time effectively

**List of Student Club Activities:**

1. Music (vocals, instruments, technical, recording, mixing, production, management)
2. Dance (Indian classical, western, jazz, latin, contemporary, folk, production, event management)
3. Theatre (classical, experimental, one-act, street, production, direction, casting, etc.)
4. Arts (fine arts, painting, calligraphy, sketching, caricaturing, etc)
5. Craft (origami, model making, sculpture, pottery, etc)
6. Cooking (home-style, baking, confectionery, Indian, intercontinental, etc.)
7. Graffiti (street, mural, collage, multimedia, etc)
8. Workshops, quizzes, debates, elocution, etc
9. Filmmaking (adventure, drama, film appreciation, documentary, etc)
10. Photography (conventional, immersive (360), landscape, portrait, technical, editing, etc.)
11. College Fests
12. Designing (graphic design, landscape, interior, etc)
13. Competitive coding
14. Recreational sports activities
15. Other club activities organized by student clubs

**List of Activities:**

1. Be the leader of the club and implement the charter, vision and mission of the club
2. Learn from diverse perspectives and experiences
3. Learn to lead the team, design and execute extra-curicular activities
4. Develop management skills through hands on experience
5. Explore different managerial roles and develop competencies

**Textbooks:**

1. Small move: big Change (Caroline Arnold)
2. How to Win at College: Surprising Secrets for Success from the Country's Top Students (Cal Newport)

**References:**

1. Making the most of college: Students speak their minds (author - Richard Light)
2. Failing Forward: Turning Mistakes into Stepping Stones for Success (John C Maxwell)
3. The Last Lecture (Randy Pausch)
4. Lean in (Sheryl Sandberg)
5. Youtube- Introduction to various club activities

**Course Outcomes:**

Upon successful completion of the course, student will be able to

1. Be the leader of the club and implement the charter, vision and mission of the club
2. Learn from diverse perspectives and experiences
3. Learn to lead the team, design and execute extra-curricular activities
4. Develop management skills through hands on experience
5. Explore different managerial roles and develop competencies

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | 3 | 3 | 3 | | 3 | | | |
| CO2 | | | | | | | | | 3 | 2 | | 3 | | | |
| CO3 | | | | | | | | 3 | 3 | 2 | | | | | |
| CO4 | | | | | | | | | | 2 | 3 | 3 | | | |
| CO5 | | | | | | | | 2 | | | | 3 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:**

SDG 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

SDG17 : Strengthen the means of implementation and revitalize the global partnership for sustainable development

**SDG Justification:**

This course recognizes student participation in community service endeavours focussing on sustainable development, service to communities. This allows students to develop empathy, citizenship behaviour and inclusive community values.

| DOSL1041 | COMMUNITY SERVICES - VOLUNTEER | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 0 | 2 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course recognizes student participation in Community service activities organized by various student organizations and other Government and non-government organizations that exist for providing service to communities. These activities allow students to develop empathy, citizenship behavior and community values.*

**Course Educational Objectives:**

- To help students develop empathy and citizenship behavior
- Enable students to develop an altruistic attitude and community development sensibility
- Allow exploration of community service activities and reflect about these experiences
- Learn to work in small and large teams for achieving community objectives

**List of Community Service Activities:**

1. Community Health Services
2. Swachh Bharat Abhiyan and other Cleanliness drives
3. Tree Plantation and similar environmental conservation initiatives
4. Rain water harvesting awareness and implementation
5. Fundraising and visits to Orphanages, Old-age homes, etc.
6. Health and disease awareness programs
7. Working with NGOs
8. Disaster mitigation and management training and relief work
9. Rural Upliftment projects
10. Campus awareness and action projects (cleanliness, anti-ragging, blood donation, etc)
11. Community investigations and surveys for development research
12. Educational support for underprivileged (remedial classes, coaching, training, etc)
13. Service camps
14. Advocacy and information literacy initiatives
15. Other activities serving local communities

**List of Activities:**

1. Participation in various community service activities
2. Weekly reflection paper

3. Portfolio (on social media using an instagram account)
4. Two learning papers (one per semester)

**Text Books:**

1. Soul of a citizen: living with conviction in Challenging times (author: Paul Rogat Loeb)
2. Community Services intervention: Vera Lloyd

**References:**

1. A path appears: Transforming lives, creating opportunities (Nicholas Kristof and SherylWuDunn)
2. The story of My Experiments with Truth (author: M. K. Gandhi)

**Course Outcomes:**

1. Experience of volunteering in a variety of Community service activities
2. Gaining empathy for lesser privileged sections of society by experience
3. Understanding the process of generating community awareness
4. Understanding Disaster management and relief through training and experience
5. Developing environmental and sustainability awareness

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | 3 | 3 | 3 | | 3 | | | |
| CO2 | | | | | | | | | 3 | 2 | | 3 | | | |
| CO3 | | | | | | | | 3 | 3 | 2 | | | | | |
| CO4 | | | | | | | | | | 2 | 3 | 3 | | | |
| CO5 | | | | | | | | 2 | | | | 3 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:**

SDG 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

SDG17 : Strengthen the means of implementation and revitalize the global partnership for sustainable development

**SDG Justification:**

This course recognizes student participation in community service endeavours focussing on sustainable development, service to communities. This allows students to develop empathy, citizenship behaviour and inclusive community values.

<table>
<tr><td rowspan="2">DOSL1051</td><td rowspan="2">COMMUNITY SERVICES - MOBILIZER</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*This course recognizes student leadership in mobilizing community service activities as members of various student organizations or other Government and non-government organizations that existfor providing service to communities. These activities allow students to develop leadership, management skills, empathy, citizenship behavior and community values.*

**Course Educational Objectives:**

- To help students understand leadership in a community environment
- Enable students to develop an altruistic attitude and community development sensibility
- Allow deep understanding of community service through practical experience
- Learn to lead small and large teams for achieving community objectives

**List of Community Service Activities:**

1. Community Health Services
2. Swachh Bharat Abhiyan and other Cleanliness drives
3. Tree Plantation and similar environmental conservation initiatives
4. Rain water harvesting awareness and implementation
5. Fundraising and visits to Orphanages, Old-age homes, etc.
6. Health and disease awareness programs
7. Working with NGOs
8. Disaster mitigation and management training and relief work
9. Rural Upliftment projects
10. Campus awareness and action projects (cleanliness, anti-ragging, blood donation, etc)
11. Community investigations and surveys for development research
12. Educational support for underprivileged (remedial classes, coaching, training, etc)
13. Service camps
14. Advocacy and information literacy initiatives
15. Other activities serving local communities

**List of Activities:**

1. Organizing and leading teams in various community service activities
2. Fortnightly reflection paper

3. Portfolio (on social media using an instagram account)
4. Two learning papers (one per semester)

**Textbooks:**

1. Soul of a citizen: living with conviction in Challenging times (author: Paul Rogat Loeb)
2. Community Services intervention: Vera Lloyd

**References:**

1. A path appears: Transforming lives, creating opportunities (Nicholas Kristof and SherylWuDunn)
2. The story of My Experiments with Truth (author: M. K. Gandhi)
3. List of student run and other Government and non- government community service organizations

**Course Outcomes:**

1. Experience of mobilizing and executing Community service activities
2. Providing opportunities for community service volunteering for other fellowstudents
3. Understanding the process of mobilizing cash, kind and volunteer support
4. Building leadership and management skills
5. Building empathy and citizenship behavior

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | 3 | 3 | 3 | | 3 | | | |
| CO2 | | | | | | | | | 3 | 2 | | 3 | | | |
| CO3 | | | | | | | | 3 | 3 | 2 | | | | | |
| CO4 | | | | | | | | | | 2 | 3 | 3 | | | |
| CO5 | | | | | | | | 2 | | | | 3 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:**

SDG 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

SDG17 : Strengthen the means of implementation and revitalize the global partnership for sustainable development

**SDG Justification:**

This course recognizes student participation in community service endeavours focussing on sustainable development, service to communities. This allows students to develop empathy, citizenship behaviour and inclusive community values.

| DOSP1001 | BADMINTON | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| Pre-requisite | None | | | | | | |
| Co-requisite | None | | | | | | |
| Preferable exposure | None | | | | | | |

**Course Description:**

*This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.*

**Course Educational Objectives:**

- Understand training principles used in the sport
- Demonstrate knowledge of the game in a recreational /competitive play setting
- Organize an event around the sport
- Demonstrate concepts of warm up, game conditioning, training plans

**List of Activities:**

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

**Instructional Plan:**

1. Introduction to Badminton - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Badminton: Grips - Racket, shuttle
4. Sports Specific fitness and warmup drills
5. Stances and footwork
6. Badminton Gameplay: Service, Forehand, Backhand
7. Preparatory Drills and Fun Games
8. Game Variations: Singles/ Doubles/ Mixed

**References:**

1. Handbook of the Badminton World Federation (BWF)

**Course Outcomes:**

1. Learn to play Badminton
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 3 | | | |
| CO2 | | | | | | | | | | | | 2 | | | |
| CO3 | | | | | | | | | | | | 2 | | | |
| CO4 | | | | | | | 2 | | 3 | 3 | 2 | | | | |
| CO5 | | | | | | 2 | 2 | | 3 | | | 3 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:4**

Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

**SDG Justification:**

The nature of the course facilitates students to engage in various forms of fitness activities and sports-related movements that work on their overall health and wellness. The course focuses on inculcating active living as a lifestyle by making sports fun, engaging and meaningful.

| DOSP1011 | CHESS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.*

**Course Educational Objectives:**

- Understand training principles used in the sport
- Demonstrate knowledge of the game in a recreational /competitive play setting
- Organize an event around the sport
- Demonstrate concepts of warm up, game conditioning, training plans

**List of Activities:**

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

**Instructional Plan:**

1. Introduction to Chess - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Chess: Pieces & functions, basic play
4. Chess board moves & terminology
5. Chess Gameplay: Openings, castling, strategies & tactics
6. Preparatory Drills and Fun Games
7. Game Variations & Officiating

**References:**

1. International Chess Federation (FIDE) Handbook

**Course Outcomes:**

1. Learn to play Chess
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 3 | | | |
| CO2 | | | | | | | | | | | | 2 | | | |
| CO3 | | | | | | | | | | | | 2 | | | |
| CO4 | | | | | | | 2 | | 3 | 3 | 2 | | | | |
| CO5 | | | | | | 2 | 2 | | 3 | | | 3 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:4**

Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

**SDG Justification:**

The nature of the course facilitates students to engage in various forms of fitness activities and sports-related movements that work on their overall health and wellness. The course focuses on inculcating active living as a lifestyle by making sports fun, engaging and meaningful.

| DOSP1021 | CARROM | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.*

**Course Educational Objectives:**

- Understand training principles used in the sport
- Demonstrate knowledge of the game in a recreational /competitive play setting
- Organize an event around the sport
- Demonstrate concepts of warm up, game conditioning, training plans

**List of Activities:**

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

**Instructional Plan:**

1. Introduction to Carrom - History and development
2. Rules of the Game, Board components & dimensions
3. Fundamental Skills - Carrom: - Striking
4. Gameplay – General
5. Preparatory Drills and Fun Games
6. Game Variations: Singles/ Doubles/ Mixed
7. Preparatory Drills and Fun Games

**References:**

1. Indian Carrom Federation Handbook - Laws

**Course Outcomes:**

1. Learn to play Carrom
2. Understanding of the fundamental concepts such as rules of play, game variations

3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 3 | | | |
| CO2 | | | | | | | | | | | | 2 | | | |
| CO3 | | | | | | | | | | | | 2 | | | |
| CO4 | | | | | | | 2 | | 3 | 3 | 2 | | | | |
| CO5 | | | | | | 2 | 2 | | 3 | | | 3 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:4**

Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

**SDG Justification:**

The nature of the course facilitates students to engage in various forms of fitness activities and sports-related movements that work on their overall health and wellness. The course focuses on inculcating active living as a lifestyle by making sports fun, engaging and meaningful.

| DOSP1031 | FOOTBALL | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.*

**Course Educational Objectives:**

- Understand training principles used in the sport
- Demonstrate knowledge of the game in a recreational /competitive play setting
- Organize an event around the sport
- Demonstrate concepts of warm up, game conditioning, training plans

**List of Activities:**

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

**Instructional Plan:**

1. Introduction to Football - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Kicking, heading, ball control, Keeping
4. Movement, throwins, tackling, defense, scoring, defense
5. Gameplay- Formations, passing, FKs, CKs, PK, tactics
6. Preparatory Drills and Fun Games
7. Game Variations: Small sided games, 7v7, 11v11

**References:**

1. FIFA Laws of the Game

**Course Outcomes:**

1. Learn to play Football
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 3 | | | |
| CO2 | | | | | | | | | | | | 2 | | | |
| CO3 | | | | | | | | | | | | 2 | | | |
| CO4 | | | | | | | 2 | | 3 | 3 | 2 | | | | |
| CO5 | | | | | | 2 | 2 | | 3 | | | 3 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:4**

Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

**SDG Justification:**

The nature of the course facilitates students to engage in various forms of fitness activities and sports-related movements that work on their overall health and wellness. The course focuses on inculcating active living as a lifestyle by making sports fun, engaging and meaningful.

| DOSP1041 | VOLLEYBALL | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.*

**Course Educational Objectives:**

- Understand training principles used in the sport
- Demonstrate knowledge of the game in a recreational /competitive play setting
- Organize an event around the sport
- Demonstrate concepts of warm up, game conditioning, training plans

**List of Activities:**

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

**Instructional Plan:**

1. Introduction to Volley - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Striking, Ball control, Lifting
4. Sports Specific fitness and warmup drills
5. Stances and footwork
6. Preparatory Drills and Fun Games
7. Gameplay: Jumps, strikes, layoffs, attack, defense

**References:**

1. FIVB - Official Volleyball Rules

**Course Outcomes:**

1. Learn to play Volleyball
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 3 | | | |
| CO2 | | | | | | | | | | | | 2 | | | |
| CO3 | | | | | | | | | | | | 2 | | | |
| CO4 | | | | | | | 2 | | 3 | 3 | 2 | | | | |
| CO5 | | | | | | 2 | 2 | | 3 | | | 3 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:4**

Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

**SDG Justification:**

The nature of the course facilitates students to engage in various forms of fitness activities and sports-related movements that work on their overall health and wellness. The course focuses on inculcating active living as a lifestyle by making sports fun, engaging and meaningful.

| DOSP1051 | KABADDI | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.*

**Course Educational Objectives:**

- Understand training principles used in the sport
- Demonstrate knowledge of the game in a recreational /competitive play setting
- Organize an event around the sport
- Demonstrate concepts of warm up, game conditioning, training plans

**List of Activities:**

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

**Instructional Plan:**

1. Introduction to Kabaddi - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Raiding, catching
4. Sports Specific fitness and warmup drills
5. Stances and footwork
6. Preparatory Drills and Fun Games
7. Gameplay: Chain system movement

**References:**

1. Amateur Kabaddi Federation of India (AKFI) - Official Rules

2. Rules of Kabaddi - International Kabaddi Federation

**Course Outcomes:**

1. Learn to play Kabaddi
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 3 | | | | |
| CO2 | | | | | | | | | | | | 2 | | | | |
| CO3 | | | | | | | | | | | | 2 | | | | |
| CO4 | | | | | | | 2 | | 3 | 3 | 2 | | | | | |
| CO5 | | | | | | 2 | 2 | | 3 | | | 3 | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:4**

Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

**SDG Justification:**

The nature of the course facilitates students to engage in various forms of fitness activities and sports-related movements that work on their overall health and wellness. The course focuses on inculcating active living as a lifestyle by making sports fun, engaging and meaningful.

| DOSP1061 | KHO KHO | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.*

**Course Educational Objectives:**

- Understand training principles used in the sport
- Demonstrate knowledge of the game in a recreational /competitive play setting
- Organize an event around the sport
- Demonstrate concepts of warm up, game conditioning, training plans

**List of Activities:**

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

**Instructional Plan:**

1. Introduction to Kho Kho - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills: Sitting, giving Kho, Pole dive
4. Sports Specific fitness and warmup drills
5. Stances and footwork: Running, sitting
6. Gameplay: Running strategies, ring method, chain method
7. Preparatory Drills and Fun Games

**References:**

1. Khelo India Official Rulebook of Kho Kho

**Course Outcomes:**

1. Learn to play Kho Kho
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 3 | | | | |
| CO2 | | | | | | | | | | | | 2 | | | | |
| CO3 | | | | | | | | | | | | 2 | | | | |
| CO4 | | | | | | | 2 | | 3 | 3 | 2 | | | | | |
| CO5 | | | | | | 2 | 2 | | 3 | | | 3 | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:4**

Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

**SDG Justification:**

The nature of the course facilitates students to engage in various forms of fitness activities and sports-related movements that work on their overall health and wellness. The course focuses on inculcating active living as a lifestyle by making sports fun, engaging and meaningful.

| DOSP1071 | TABLE TENNIS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.*

**Course Educational Objectives:**

- Understand training principles used in the sport
- Demonstrate knowledge of the game in a recreational /competitive play setting
- Organize an event around the sport
- Demonstrate concepts of warm up, game conditioning, training plans

**List of Activities:**

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

**Instructional Plan:**

1. Introduction to Table Tennis - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - TT: Grips - Racket, ball
4. Stances and footwork
5. TT Gameplay- Forehand, Backhand, Side Spin, High Toss. Strokes-Push, Chop, Drive, Half Volley, Smash, Drop-shot, Balloon, Flick, Loop Drive.
6. Preparatory Drills and Fun Games
7. Game Variations: Singles/ Doubles/ Mixed

**References:**

1. Handbook of the International Table Tennis Federation (ITTF)

**Course Outcomes:**

1. Learn to play Table Tennis
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 3 | | | | |
| CO2 | | | | | | | | | | | | 2 | | | | |
| CO3 | | | | | | | | | | | | 2 | | | | |
| CO4 | | | | | | | 2 | | 3 | 3 | 2 | | | | | |
| CO5 | | | | | | 2 | 2 | | 3 | | | 3 | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:4**

Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

**SDG Justification:**

The nature of the course facilitates students to engage in various forms of fitness activities and sports-related movements that work on their overall health and wellness. The course focuses on inculcating active living as a lifestyle by making sports fun, engaging and meaningful.

| DOSP1081 | HANDBALL | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.*

**Course Educational Objectives:**

- Understand training principles used in the sport
- Demonstrate knowledge of the game in a recreational /competitive play setting
- Organize an event around the sport
- Demonstrate concepts of warm up, game conditioning, training plans

**List of Activities:**

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

**Instructional Plan:**

1. Introduction to Handball - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Handball: Throwing, Ball control, Movement
4. Sports Specific fitness and warmup drills
5. Stances and footwork: Jumps, dribbles, catching, throws
6. Gameplay: Shots, throws, movements, attack, defense
7. Preparatory Drills and Fun Games

**References:**

1. International Handball Federation - Rules of the Game & Regulations

**Course Outcomes:**

1. Learn to play Handball
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 3 | | | | |
| CO2 | | | | | | | | | | | | 2 | | | | |
| CO3 | | | | | | | | | | | | 2 | | | | |
| CO4 | | | | | | | 2 | | 3 | 3 | 2 | | | | | |
| CO5 | | | | | | 2 | 2 | | 3 | | | 3 | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:4**

Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

**SDG Justification:**

The nature of the course facilitates students to engage in various forms of fitness activities and sports-related movements that work on their overall health and wellness. The course focuses on inculcating active living as a lifestyle by making sports fun, engaging and meaningful.

<table>
<tr><td rowspan="2">DOSP1091</td><td rowspan="2">BASKETBALL</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.*

**Course Educational Objectives:**

- Understand training principles used in the sport
- Demonstrate knowledge of the game in a recreational /competitive play setting
- Organize an event around the sport
- Demonstrate concepts of warm up, game conditioning, training plans

**List of Activities:**

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

**Instructional Plan:**

1. Introduction to Basketball - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Passing, Receiving, Dribbling
4. Sports Specific fitness and warmup drills
5. Stances and footwork: Jumps, dribbles, catching, throws
6. Preparatory Drills and Fun Games
7. Gameplay: Shots, throws, movements, attack, defense

**References:**

1. FIBA Basketball Official Rules

**Course Outcomes:**

1. Learn to play Basketball
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 3 | | | | |
| CO2 | | | | | | | | | | | | 2 | | | | |
| CO3 | | | | | | | | | | | | 2 | | | | |
| CO4 | | | | | | | 2 | | 3 | 3 | 2 | | | | | |
| CO5 | | | | | | 2 | 2 | | 3 | | | 3 | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:4**

Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

**SDG Justification:**

The nature of the course facilitates students to engage in various forms of fitness activities and sports-related movements that work on their overall health and wellness. The course focuses on inculcating active living as a lifestyle by making sports fun, engaging and meaningful.

<table>
<tr><td rowspan="2">DOSP1101</td><td rowspan="2">TENNIS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.*

**Course Educational Objectives:**

- Understand training principles used in the sport
- Demonstrate knowledge of the game in a recreational /competitive play setting
- Organize an event around the sport
- Demonstrate concepts of warm up, game conditioning, training plans

**List of Activities:**

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

**Instructional Plan:**

1. Introduction to Tennis - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Tennis: Grips - Racket, ball
4. Stances and footwork
5. Gameplay- Forehand, Backhand, Service, volley, smash
6. Preparatory Drills and Fun Games
7. Game Variations: Singles/ Doubles/ Mixed

**References:**

1. Handbook of the International Tennis Federation (ITF)

**Course Outcomes:**

1. Learn to play Tennis
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 3 | | | | |
| CO2 | | | | | | | | | | | | 2 | | | | |
| CO3 | | | | | | | | | | | | 2 | | | | |
| CO4 | | | | | | | 2 | | 3 | 3 | 2 | | | | | |
| CO5 | | | | | | 2 | 2 | | 3 | | | 3 | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:4**

Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

**SDG Justification:**

The nature of the course facilitates students to engage in various forms of fitness activities and sports-related movements that work on their overall health and wellness. The course focuses on inculcating active living as a lifestyle by making sports fun, engaging and meaningful.

| DOSP1111 | THROWBALL | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 2 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.*

**Course Educational Objectives:**

- Understand training principles used in the sport
- Demonstrate knowledge of the game in a recreational /competitive play setting
- Organize an event around the sport
- Demonstrate concepts of warm up, game conditioning, training plans

**List of Activities:**

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

**Instructional Plan:**

1. Introduction to Throwball - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Throwing, Receiving
4. Sports Specific fitness and warmup drills
5. Stances and footwork
6. Preparatory Drills and Fun Games
7. Gameplay: Shots, throws, movements, control

**References:**

1. World Throwball Federation - Rules of the Game

**Course Outcomes:**

1. Learn to play Throwball
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 3 | 2 | | 3 | | | |
| CO2 | | | | | | | | | | | | 2 | | | |
| CO3 | | | | | | | | | | | | 2 | | | |
| CO4 | | | | | | | 2 | | 3 | 3 | 2 | | | | |
| CO5 | | | | | | 2 | 2 | | 3 | | | 3 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :19-07-2021** **ACADEMIC COUNCIL:19-07-2021**

**SDG No. & Statement:4**

Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages.

**SDG Justification:**

The nature of the course facilitates students to engage in various forms of fitness activities and sports-related movements that work on their overall health and wellness. The course focuses on inculcating active living as a lifestyle by making sports fun, engaging and meaningful.

| ENVS1001 | ENVIRONMENTAL STUDIES | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3* |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*The course enables the students to adapt eco-centric thinking and actions rather than human-centric thinking on natural resources, their utilization and conservation. The course also focuses on the importance of ecosystems, biodiversity and their degradation led to pollution. This course helps in finding solutions through application of control measures to combat pollution and legal measures to achieve sustainable development.*

**Course Educational Objectives:**

- To impart knowledge on natural resources and its associated problems.
- To familiarize learners about ecosystem, biodiversity, and their conservation.
- To introduce learners about environment pollution.
- To acquaint learners on different social issues such as conservation of water, green buildingconcept.
- To make learners understand about the present population scenario, its impacts and role ofinformational technology on environment and human health.
- To make learners understand about the importance of field visit.

**UNIT 1 Multidisciplinary nature of environmental studies & Natural Resources 10 hours**

Multidisciplinary nature of environmental studies Definition, scope and importance. Need for public awareness. Natural resources and associated problems. Uses and over exploitation of Forest resources, Water resources, Mineral resources, Food resources, Energy resources. Role of an individual in conservation of natural resources.

Activity:

1. Planting tree saplings
2. Identification of water leakage in house and institute-Rectify or report
3. Observing any one day of a week as Car/bike/vehicle free day.

**UNIT 2 Ecosystem and biodiversity 10 hours**

**Ecosystem:** Structure components of ecosystem: Biotic and Abiotic components. Functional components of an ecosystem: Food chains, Food webs, Ecological pyramids, Energy flow in the ecosystem (10% law), Ecological succession.

**Biodiversity:** Definition, Biogeographical classification of India, Values of biodiversity: consumptive use, productive use, social, ethical, aesthetic. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching, man wildlife conflicts. Conservation of biodiversity: In – situ and Ex-situ

Activity:

1. Visit to Zoological Park-Noting different ecosystem
2. Biodiversity register- Flora and fauna in the campus

**UNIT 3 Environmental Pollution 10 hours**

Definition Causes, effects, and control measures of: -Air pollution. Water pollution. Soil pollution. Marine pollution. Noise pollution. Nuclear hazards. Solid waste Management: Causes, effects, and control measures. Role of an individual in prevention of pollution. Pollution case studies.

Activity:

1. Visit to treatment plant and documentation.
2. Documentation of segregation of solid waste-Dry and Wet

**UNIT 4 Social Issues and the Environment 10 hours**

From Unsustainable to Sustainable development Urban problems related to energy. Water conservation, rainwater harvesting, watershed management. Environmental ethics: Issues and possible solutions. Green building concept.

Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies.

Activity:

1. Observing zero hour at individual level-documentation.
2. Eco friendly idols.
3. Rainwater harvesting-creating storage pits in nearby area.

**UNIT 5 Human Population and the Environment and Environment Protection Act and Field work 10 hours**

Population growth, variation among nations. Environment and human health. HIV/AIDS, Human rights. Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health. Environment Legislation. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Environmental Protection Act, Issues involved in enforcement of environmental legislation.

Activity:

1. Visit to a local polluted site-industry/agriculture
2. Identifying diseases due to inappropriate environmental conditions

**Text Book(s):**

1. Erach Bharucha. Textbook of environmental studies for undergraduates courses-Universities Press,India Private Limited. 2019.
2. Kaushik A and Kaushik C.P. Perspectives in Environmental Studies. New Age InternationalPublishers Edition-VI. 2018.
3. Dave D Katewa S.S. Textbook of Environmental Studies, 2nd Edition. Cengage Learning India. 2012.

**Additional Reading:**

1. Benny Joseph. Textbook of Environmental Studies 3rd edition, McGraw Hill Publishing company limited. 2017.

**Reference Book(s):**

1. McKinney M.L., Schoch R.M., Yonavjak L. Mincy G. Environmental Science: Systems andSolutions. Jones and Bartlett Publishers. 6th Edition. 2017.
2. Botkin D.B. Environmental Science: Earth as a Living Planet. John Wiley and Sons. 5th edition. 2005.

**Journal(s):**

1. https://www.tandfonline.com/loi/genv20
2. https://library.lclark.edu/envs/corejournals

**Website(s):**

https://www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf From Climate Science to Action | Coursera

**Course Outcomes:**

After the completion of the course student will be able to

1. List different natural resources and their uses
2. Summarize the structure and function of terrestrial and aquatic ecosystems.
3. Identify causes, effects, and control measures of pollution (air, water & soil).

4. Function of green building concept.
5. Adapt value education

**CO-PO Mapping:**

| | Programme Objectives (POs) | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| CO1 | 2 | | | | | | | | | | | | 2 | | |
| CO2 | | 2 | | | | 1 | | | | | | | 2 | | |
| CO3 | | | 1 | | | | | | 1 | | | | | 1 | |
| CO4 | | | | 2 | | | | | | | 2 | | | | 1 |
| CO5 | 1 | | | | | | | | | | | | | 1 | |
| CO6 | | | | | 2 | | | | | | | 1 | | | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN: BOS**

**BOS: 04-07-22** **ACADEMIC COUNCIL:14-07-22**

**SDG No. & Statement:**

1. SDG-6-Clean water and Sanitation
2. SDG-7-Affordable and clean energy
3. SDG-13 - Climate change
4. SDG-14 - Life below water
5. SDG-15 - Life on Land

**SDG Justification:**

1. The learner will understand the importance of clean water and sanitation through this course and apply in their daily activities – SDG-6

2. The learner will make use of renewable resources to reduce pollution achieves SDG-7

3. The learner will understand present situation in climate change and takes appropriate steps to combat climate change – SDG-13

4. The learner will understand the existence of life below water – SDG-14

5. The learner will understand to promote sustainable terrestrial ecosystem – SDG15

| FINA3001 | PERSONAL FINANCIAL PLANNING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 0 | 0 | 1* |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | Risk Management in Personal financing<br>Fundamentals of Investing<br>Saving Money for the future<br>Personal and Family Financial Planning<br>Introduction to Personal Finance | | | | | | |

**Course Description:**

*Personal Financial Planning is one of the most significant factors in our lives. It is essential that funds are available as and when required at various stages of life. Unavailability of funds at critical stages of our life leads to financial distress and leads to many medical and non- medical problems. There are certain planned and unplanned events in our life. On the one hand,education of our children, their marriage, our retirement etc. are some of the planned events ofour life, but at the same time, some medical urgency, accident or death of an earning member might be some unplanned events. Many of these events are beyond our control, but the availability of funds can be planned to avoid any financial distress. In other words, we cannot stop the rain but can plan for an umbrella.*
*This course looks at the many challenges an individual faces in a complex financial environment and the rising uncertainties of one's life. It focuses on achieving long-term financial comfort of individual and family through goal setting, developing financial and life strategies, acquiring personal financial planning knowledge and managing risk throughout one's life.*

**Course Educational Objectives:**

- To build students' ability to plan for long-term financial comfort of individual andfamily through goal setting, developing financial and life strategies.
- To provide students with knowledge on terms, techniques to evaluate investment avenues.
- To build the skill set of the student to enable them to file their tax returns.

**UNIT 1 Basics of Financial Planning**

Financial Planning Meaning, Need, Objectives, Financial Planning Process, Time Value of Money and its application using excel (NP)

**UNIT 2 Risk and Insurance Management**

Need for insurance, Requirement of insurance interest, Role of insurance in personal finance, Steps in insurance planning, Life and Non-life insurance products, Life insurance needs analysis (NP)

**UNIT 3 Investment Products and Measuring Investment Returns**

**Investment Products:** Small Saving Instruments, Fixed Income Instruments, Alternate Investments, Direct Equity
**Measuring Investment Returns:** Understanding Return and its concept, Compounding concept, Real vs Nominal Rate of Return, Tax Adjusted Return, Risk-Adjusted Return (NP)

**UNIT 4 Retirement Planning**

Introduction to the retirement planning process, estimating retirement corpus, Determining the retirement corpus, Retirement Products (NP)

**UNIT 5 Tax Planning**

**Income Tax:** Income tax principles: Heads of Incomes, Exemptions and Deductions, Types of Assesses, Rates of Taxation, Obligations for Filing and Reporting, Tax aspects of Investment Products, Wealth Tax

**Textbooks:**

1. National Institute of Securities Management (NISM) Module 1 & XA
2. Madhu Sinha, Financial Planning, 2 Edition, McGraw Hill India
3. Simplified Financial Management by Vinay Bhagwat, The Times Group

**References:**

1. Personal Financial Planning (Wealth Management) by S Murali and K R Subbakrishna, Himalaya Publishing House.
2. Mishra K.C., Doss S, (2009). Basics of Personal Financial Planning 1e. NationalInsurance Academy, New Delhi: Cengage Learning.
3. Risk Analysis, Insurance and Retirement Planning by Indian Institute of Banking andFinance.

**Course Outcomes:**

1. Describe the financial planning process and application of time value of money
2. Application of life and non-life insurance products in financial planning
3. Understand the investment avenues and analysis of investment returns
4. Understand the retirement planning and its application
5. Describe and analysis the Tax Planning

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 3 | 1 | 1 | 3 |
| CO2 | 2 | 2 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 3 | 1 | 1 | 2 |
| CO3 | 3 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 3 | 2 | 2 | 3 |
| CO4 | 3 | 2 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 2 | 2 | 3 | 2 |
| CO5 | 3 | 3 | 0 | 1 | 1 | 1 | 2 | 1 | 0 | 1 | 1 | 1 | 2 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 01-02-2022** **ACADEMIC COUNCIL: 01-04-2022**

**SDG No. & Statement:**

Goal 4: Quality education

Goal 12: Responsible consumption and Production

**SDG Justification:**

Goal 4: This course enables the students to attain their financial literacy that builds in the discipline of saving and improves their lifelong learnings.

Goal 12: This course ensures sustainable consumption and helps in providing them their life long financial requirements .

<table>
<tr><td rowspan="2">LANG1012</td><td rowspan="2">COMMUNICATION SKILLS IN ENGLISH – INTERMEDIATE</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description**

Communication Skills in English (Intermediate) is the second of the three-level graded courses for the developmental enhancement of communication skills in English. Based on the learning outcomes set in the beginner-level syllabus, this course focuses on giving learners more exposure to the use of language for communicative purposes and equipping them with next level skills (ref. Bloom's taxonomy) and practice in complexity and cognitive engagement. This course also includes the inferential level of comprehension (listening and reading) that involves analysis and application of language skills and decision-making skills while speaking/writing with an awareness of social and personality-based communication variations. This course emphasizesguided writing through adequate pre- and post-context building tasks. The focus is on the stimulation and application of critical thinking in addition to schematic review for communication in real-life situations.

**Course Educational Objectives**

- Train learners to listen to short audio texts with familiar content actively; guided activity like question-making and responding to others' questions based on the audio text would help learners engage in transactional dialogue; extended activities like extrapolating/critiquing the responses would help learners enhance their schematic thinking. (Bloom's Taxonomy Level/s: 2 & 4)
- Equip learners with strategies to read actively and critically and understand the writers’ viewpoints and attitude by providing reading comprehension tasks using authentic texts such as op-ed articles from newspapers, and reports on contemporary problems. (Bloom'sTaxonomy Level/s: 4 & 5)
- Help learners understand various aspects and techniques of effective presentations (group/individual) through demonstration and modelling, enabling them to develop their presentation skills by providing training in using the tips and strategies. Learners would be encouraged to observe and express opinion on teacher-modelling. Reflection on issues like anxiety, stage-fear, confidence, and levels of familiarity with topic and audience would be addressed. Practice would be given on tone, pitch, clarity and other speech aspects. Detailed peer feedback and instructor's feedback would cover all the significant aspects. (Bloom's Taxonomy Level/s: 2 & 4)
- Enable learners to become aware of the structure and conventions of academic writing through reading, demonstration, scaffolding activities, and

discussion. Corrective individual feedback would be given to the learners on their writing. (Bloom's Taxonomy Level/s: 2 & 3)

**List of Tasks and Activities**

| S. No. | Tasks | Activities |
|---|---|---|
| 1 | Listening to subject related short discussions/explanations/ speech for comprehension | Pre-reading group discussion, Silent reading (Note-making), Modelling (questioning), Post-reading reflection /Presentation |
| 2 | Asking for information: asking questions related tothe content, context maintaining modalities | Group role-play in a context (i.e. Identifying the situation and different roles and enacting theirroles) |
| 3 | Information transfer: Visual to verbal (unfamiliarcontext); demonstration by teacher, learners' task(guided with scaffolding), learners' task (free), presentation and feedback | Pre-reading game/modelling, discussion in smallgroups, individual writing, and feedback |
| 4 | Introducing officials to peers and vice versa - Formal context | AV support, noticing, individual performance (3-4), pair work (in context), teacher modelling, group work for Introducing self and others in a formal context |
| 5 | Vocabulary in context: Find clues in a text and usethem to guess the meaning of words/phrases.<br>Apply the newly learnt vocabulary in communication (speaking and writing). | Comprehending verbal communication: Identifying the contextual clues in oral and written texts; guessing the meaning of words/phrases in context while reading texts andlistening to discussions/talks |
| 6 | Follow the essentials of lectures, talks, discussions, reports and other forms of academicpresentations and mark individual and group presentations aided with images, audio, video, tabular data, etc. | Making power point presentation aided with images, audio, video, etc. with a small group bylistening to academic lectures/talks/ discussions,etc. |
| 7 | Collaborative work (speaking and writing) in small groups of 3 or 4 learners: discussing a general/discipline-specific topic: creating outline,assigning specific roles to members of the group;and group presentation followed by peer and<br>instructor feedback | Pre-task modelling (peer/teacher), general discussion on structure, group work (collaboration), feedback |
| 8 | Independent reading of different text types using appropriate reference sources by adapting suitable reading styles and speed. Focus on active reading for vocabulary: low-frequency collocations and<br>idiomatic expressions. | Brain-storming, mapping of key terms (content specific), reading and note-making (individual),oral questioning, discussion |

| | | |
|---|---|---|
| 9 | Role-play (specific social and academic situations): planning (making notes), understanding nuances of speaking in context,coordinating with situational clues and fellow speakers/participants | Peer discussion for outline, A-V support, observing (teacher modelling), role play (guided), role-play (free), feedback |
| 10 | Writing a short reflective report of an event - incident/meeting/celebration | Writing a report on meetings/celebrations/events etc. by actively involved in such events and giving a short oral presentation. |
| 11 | Formal Group Discussion on topics of current interest and relevance; focus on effective participation, reflection on control over argument/counter argument, and adherence tothe conventions of formal GD | Noticing strategies from AV modelling, teacher scaffolding thoughopen-house discussion, Note-making(Group work), Group Discussion (free), post-performance discussion,Feedback |
| 12 | Speaking spontaneously on topics of interest and writing short structured essays on the same topicsadopting appropriate academic conventions and grammatical accuracy. Make sure to write accurate paragraph and essay by following: cohesion and coherence, topic sentence, introduction and conclusion | Reading for task preparation, note-making, reflection and corrective peer andteacher feedback. Practice paragraph and essay writing in groups; maintain rubrics of writing |

**Reference Books**

1. P. Kiranmayi Dutt, Geetha Rajeevan. (2007). Basic Communication Skills. FoundationBooks. CUP
2. Harmer, J. (1998). How to teach English. Longman
3. Sanjay Kumar & Pushp Lata. (2018). Communication Skills: A Workbook. OUP.
4. Cambridge IGCSE: English as a Second Language Teacher’s Book Fourth Edition.By Peter Lucantoni. CUP (2014).
5. Cambrdige Academic English: An Integrated Skills Course for EAP (Upper Intermediate)By Martin Hewings, CUP (2012)
6. Richards, J.C. and Bohlke, D. (2012). Four Corners-3. Cambridge: CUP.
7. Headway Academic Skills: Reading, Writing, and Study Skills Student's Book, Level-2 bySarah Philpot. OUP
8. Latham-Koenig, C. & Oxenden, C. (2014). American English File. Oxfor: OUP.
9. McCarthy, M. & O' Dell. F. (2016). Academic Vocabulary in Use. Cambridge: CUP

**Online Resources**

1. https://www.grammarly.com/blog/
2. https://www.nationalgeographic.org/education/
3. https://www.bbc.co.uk/teach/skillswise/english/zjg4scw
4. https://www.englishclub.com/
5. https://www.oxfordlearnersdictionaries.com/
6. https://dictionary.cambridge.org/
7. learnenglishteens.britishcouncil.org
8. https://freerice.com/categories/english-vocabulary

9. http://www.5minuteenglish.com/
10. https://breakingnewsenglish.com/
11. https://www.digitalbook.io/
12. https://librivox.org/

**Course Outcomes**

- Understand the speaker's point of view in fairly extended talks on general or discipline-specifictopics, and follow simple lines of argument in discussions on familiar contemporary issues. (Bloom's Taxonomy Level/s: 3)

- "Read and demonstrate understanding of articles and reports on limited range of contemporaryissues in which the writers adopt particular stances. Also provide samples of written communication containing fairly complex information and reasons for choices/opinions/stances. (Bloom's Taxonomy Level/s: 2 & 3)"

- Make short presentations on a limited range of general topics using slides, and engage in small group discussions sharing experiences/views on familiar contemporary issues and give reasons for choices/opinions/plans. (Bloom's Taxonomy Level/s: 3 & 4)

- Write clear, fairly detailed text (a short essay) on a limited range of general topics, and subjects of interest, and communicate clearly through email/letter to seek/pass on information or givereasons for choices/opinions/plans/actions. (Bloom's Taxonomy Level/s: 3)

- Reflect on others' performance, give peer feedback on fellow learners' presentations, responsesto writing tasks and reading comprehension questions. (Bloom's Taxonomy Level/s: 5)

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PO13 | PO14 | PO15 | PO16 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 1 |
| **CO2** | 2 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 2 | 1 |
| **CO3** | 2 | 3 | 2 | 3 | 3 | 1 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 2 | 1 |
| **CO4** | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 1 | 1 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 1 | 3 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 3 | 1 | 2 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :** **ACADEMIC COUNCIL:**

**SDG No. & Statement:**

SDG 16 Peace and Justice Strong Institutions. Promote peaceful and inclusive societies for sustainable development, provide
access to justice for all and build effective, accountable and inclusive institutions at all levels.

**SDG Justification:** By relating to people with empathy, employing creative problem-solving strategies and engaging meaningfully in a diverse world will create inclusive societies for sustainable development.

| LANG1022 | COMMUNICATION SKILLS IN ENGLISH – ADVANCED | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 0 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description**

Communication Skills in English (Advanced) is the third of the three-level graded courses for the developmental enhancement of communication skills in English. Based on the learning outcomes set in the upper-intermediate syllabus, this course focuses on giving learners exposure to higher levels of skills/input processing (ref. Bloom's taxonomy) and practice in terms of complexity and cognitive engagement. This course includes an advanced level of comprehension i.e. anaytical, evaluative, and extrapolative processing (listening and reading). It involves problem-solving, logical reasoning, and decision-making skills in terms of the application of the learning (speaking/writing) with an awareness of social and personality-based variations in communication. This course provides opportunities for activity-based practice of advanced oraland written communicative skills besides building awareness of the finer nuances of language usefor various purposes. This course emhasizes free writing through meaningfully engaging pre- and post-context-building tasks. There is ample scope for applying critical thinking through simulated activities for effective communication in real-life situations.

**Course Objectives**

1. Enable learners to listen actively, become aware of tone and attitude in speech, and demonstrate their comprehension of fairly complex lines of argument presented by a variety of speakers in talks/presentations/discussions. (Bloom's Taxonomy Level/s: 2 & 4)

2. Enable learners to become aware of tone and attitude in written texts, and demonstrate theircomprehension of fairly complex lines of argument and points of view presented in a variety of texts by equipping them with upper intermediate to advanced level reading skillsand strategies.

3. Make effective presentations, engage in formal group discussions, and write structured essays/ short reports to highlight the significance of actions/decisions/experiences, and sustain views by providing relevant evidence and argument.

4. Equip learners with the skills and strategies to communicate effectively in speech and writing using the language with a degree of fluency, accuracy and spontaneity, and fairly good grammatical control adopting a level of formality appropriate to the context. Encourage learners to apply their knowledge of language and their communication skills in real life situations.

## List of Activities & Tasks for Assessment

| S.No. | Tasks | Activities | CO |
|---|---|---|---|
| 1 | Evaluative and extrapolative reading of a longtext/short text on a current topic related to technology and society, identifying and questioning the author's intention, post- reading discussion in small groups, maintaining group dynamics, arriving at aconsensus. Understanging and inferring the meaning. | Pre-reading group discussion, silent reading (Note-making), modelling (questioning), post-reading reflectionand brief presentation of thoughts/ideas/opinions on the themeof the text | 3 |
| 2 | Debate in pairs based on listening to two recorded contemporary speeches by well-known leaders in different fields. Peer feedback and instructor feedback. | Pre-recorded audio/video for listening,student checklist for noticing keywords/concepts, pre-task orientation (by teacher), pair work, feedback | 1 |
| 3 | Information transfer: Visual to verbal (unfamiliar context); demonstration by teacher, learners' task (guided with scaffolding), learners' task (free), presentation, question-answer (among students), modification, editing, proofreading,and feedback before the final version is done | Pre-reading game/modelling, discussion in small groups, independent writing and feedback | 4 |
| 4 | Expressing opinion on a short argumentative text (e.g. a journal article or a newspaper editorial) and justifying one's opinion/stance; focus on the use of appropriate conventions offormal and polite speech, and managing bias | Listening to group discussions/debates,reading news-paper articles on current issues and expressing opinions in favour or against the topic (in GDs, debates or writing argumentative essays). | 3 |
| 5 | Collaborative writing in groups of 3 -4 on topics that would require data collection andreading followed by recorded peer-reflectionand peer-feedback, group presentation and feedback | Pre-task modelling (peer), general discussion on structure, group work(collaboration), presentation, peer feedback, Open-class discussion | 5 |
| 6 | Writing a statement of purpose<br><br>Discuss all details about the student academic and professional background, highlighting the student accomplishments, | Reading & discussion of sample statement of purposes. Discuss the content in groups and know whether all mentioned details are present. Do practice writing after lecture and discussion. | 2 |

| | | | |
|---|---|---|---|
| | goals, and how a student fit to the education applied to. | Make sure to adopt a proper writing style. | |

| | | | |
|---|---|---|---|
| 7 | Mind-mapping for advanced reading, making correlations across texts, extending the author'spoint of view | Reading texts on abstract topics and comprehending the author's perspectiveby inferring the unknown words' meaning in the context and making notes using mind-map strategy and presenting it orally. | 3 |
| 8 | Handling question and answer sessions after presentations: justifying arguments, taking counter-arguments, agreeing and disagreeingwith rationale | Listening to some lectures, talks, and presentations in the academic seminarsand adapting some strategies to handlethe Q&A sessions using polite and formal expressions to agree or disagree with the statements. | 1 |
| 9 | Learn resume and cover letter format & introduce different interview modes. Modelling an interview: with a panel of fourjudges (peers) | Pre-task activity for orientation/strategies (controlled/guided), Model interview (AV support), Group work (role play), Interview in pair (one-to-one), Interview in group (many -to-one), oral corrective feedback (peer/teacher) | 2 |
| 10 | Speaking on abstract and complex topics beyond his/her own area of interest/field ofstudy, using the language flexibly and effectively. | Reading texts on abstract topics and comprehending the author's perspectives. Similarly, listening to talks and discussions on an abstract topic of other discipline and making short oral presentation by sharingviews and opinions. | 3 |
| 11 | Self-reflection on own speech in context(recorded): tone, pitch, relevance, content; extending the reflections/ideas toothers | Listening to selected general discussions (audios and videos) and observing the language production. Recording own speech on some generaltopic and providing a critical review (self-reflection) on it by focusing on the tone, expressions and relevance ofthe content, etc. | 1 |

| | | | |
|---|---|---|---|
| 12 | Collaborative and individual tasks: planning, preparing (preparing an outline, structure, setting objectives, and presenting the plan of action) and executing a mini-project, and submitting a brief report on the same peer and instructor feedback after the planning stage and on completion of the mini project | Pre-task modelling (peer/teacher), general discussion on structure, groupwork (collaboration), oral correction, task distribution, presentation, feedback | 5 |

**Reference Books**


1. Latham-Koenig, C. & Oxenden, C. (2014). American English File-5. Oxford: OUPRichards,
2. J.C. and Bohlke, D. (2012). Four Corners-4. Cambridge: CUP.
3. Cambrdige Academic English: An Integrated Skills Course for EAP (Advanced) By Martin Hewings and Craig Thaine, CUP (2012)
4. Berlin, A. (2016). 50 Conversation Classes: 50 Sets of Conversation Cards With an Accompanying Activity Sheet Containing Vocabulary, Idioms and Grammar. Poland: CreateSpace Independent Publishing Platform
5. Zemach, D. E., Islam, C. (2011). Writing Paragraphs: From Sentence to Paragraph. Germany: Macmillan Education.
6. Stewart, J. P., Fulop, D. (2019). Mastering the Art of Oral Presentations: Winning Orals, Speeches, and Stand-Up Presentations. United Kingdom: Wiley.
7. Kroehnert, Gary. (2010). Basic Presentation Skills. Sidney: McGraw Hill.
8. Cunninghum, S. & Moor, P. (nd). Cutting Edge (Advanced) With Phrase Builder. Longman Publishers. CUP
9. McCarthy, M & O'Dell, F. (2017). English Idioms in Use (Advanced). Cambridge: CUP. Online


**Resources**

1. https://www.grammarly.com/blog/
2. https://www.nationalgeographic.org/education/
3. https://www.bbc.co.uk/teach/skillswise/english/zjg4scw
4. https://www.englishclub.com/
5. https://www.oxfordlearnersdictionaries.com/
6. https://dictionary.cambridge.org/
7. learnenglishteens.britishcouncil.org
8. https://freerice.com/categories/english-vocabulary
9. http://www.5minuteenglish.com/
10. https://breakingnewsenglish.com/
11. https://www.digitalbook.io/

12. https://librivox.org/

**Course Outcomes**

- Listen to extended lectures, presentations, and discussions on a wide range of contemporary issues and demonstrate understanding of relatively complex lines of argument. (Bloom's Taxonomy Level/s: 2)
- Make presentations using suitable AV aids and engage in formal group discussions on a wide range of topics of contemporary interest, demonstrating awareness of standard/widely accepted conventions. (Bloom's Taxonomy Level/s: 3)
- Read and demonstrate understanding of the writer's stance/viewpoint in articles and reports on a wide range of contemporary issues and discipline-specific subjects. (Bloom's Taxonomy Level/s: 2 & 4)
- Write analytical essays on a wide range of general topics/subjects of interest, and engage in written communication (emails/concise reports) to exchange relatively complex information, giving reasons in support of or against a particular stance/point of view. (Bloom's Taxonomy Level/s: 3 & 4)
- Complete a mini project that necessitates the use of fairly advanced communication skills to accomplish a variety of tasks and submit a report in the given format. (Bloom's Taxonomy Level/s: 4 & 5

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PO13 | PO14 | PO15 | PO16 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 3 | 3 | 1 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 3 | 1 | 1 |
| CO2 | 2 | 3 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 3 | 1 | 1 |
| CO3 | 2 | 3 | 1 | 3 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | 3 | 2 | 1 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 | 1 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 3 | 3 | 2 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :** **ACADEMIC COUNCIL:**

**SDG No. & Statement:**

SDG 16 Peace and Justice Strong Institutions. Promote peaceful and inclusive societies for sustainable development, provide
access to justice for all and build effective, accountable and inclusive institutions at all levels.

**SDG Justification:** By relating to people with empathy, employing creative problem-solving strategies and engaging meaningfully in a diverse world will create inclusive societies for sustainable development.

| MFST1001 | HEALTH & WELLBEING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 0 | 0 | 1* |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*The course provides the students a better understanding of the role of a proper diet in maintenance of human health. This course emphasizes the composition of the food, and will help to understand how toexercise, the role of sports and physical fitness in development of a good health. The course also focuses on the importance of emotional well-being and mindfulness. This course helps in teaching the role of yoga in maintenance of physical balance.*

**Course Educational Objectives:**

- To provide an understanding of the relationship between food and nutrition
- To emphasize the role of exercise, sports and physical fitness in obtaining a good health
- To explain about the mindfulness and emotional well being
- To teach the role of yoga and meditation in maintaining the body balance

**UNIT 1**

Understand the relationship between Food and Nutrition and how food composition affects nutritional characteristics. Knowledge about regulatory principles in determining diets and recommended daily allowances. Understand how to create personalised diet/nutrition plans.

**UNIT 2**

Understand how exercise, activity and sports helps in developing good health. Experiential exposure to the role of proper, specific nutritional interventions along with structured activities on developing proper physical health. Practical exercises and assignments in sports and exercise regimes.

**UNIT 3**

Introduction to emotional wellbeing and mindfulness. Teaching of mindfulness practices to reduce stress, increase relaxation and improve mental wellbeing.

**UNIT 4**

Introduction to Yoga theory and how Yoga helps in maintaining balance in the body. Practice of Yoga and meditation to improve overall emotional and physical balance. Practical yoga exercises and meditation techniques

**Course Outcomes:**

By the end of the course, student will

1. Learn the role of nutrition and diet in maintaining a good health
2. understand how the exercise, sports and physical activities will improve health
3. learn mindfulness practices for reducing stress
4. know the importance of yoga and meditation

**APPROVED IN:**

**BOS :01-02-2022** **ACADEMIC COUNCIL: 01-04-2022**

**SDG No. & Statement:**

**SDG Justification:**

| PHPY1001 | GANDHI FOR THE 21ST CENTURY | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 | 0 | 2* |
| Pre-requisite | None | | | | | | |
| Co-requisite | None | | | | | | |
| Preferable exposure | None | | | | | | |

**Course Description:**

*This course provides the students with basic knowledge on Gandhi's early life, transformations in South Africa and his entry into India's national movement. While going through the social-political, economic, and educational philosophies of Gandhi, the course analyses how his ideologies are relevant even in the 21st century.*

**Course Educational Objectives:**

The objectives of the course are;

- To provide the students with the basic knowledge on Gandhi's life and his philosophies
- To understand the early influences and transformations in Gandhi
- To analyse the role of Gandhi in India's national movement
- To apply Gandhian Ethics while analysing the contemporary social/political issues
- To appreciate the conflict resolution techniques put forward by Gandhi and its significance in thecurrent scenario.

**UNIT 1 MK Gandhi: Childhood and Education**

M K Gandhi, Formative Years (1869-1893): Early childhood - study in England - Indian influences, early Western influences.

**UNIT 2 From Mohan to Mahatma-South African Experiences**

Gandhi in South Africa (1893-1914): South African Experiences - civil right movements in South Africa - invention of Satyagraha - Phoenix settlement- Tolstoy Farm - experiments in Sarvodaya, education, and sustainable livelihood.

**UNIT 3 Gandhi and Indian National Movement**

Gandhi and Indian National Movement (1915-1947): Introduction of Satyagraha in Indian soil -non- cooperation movement - call for women's participation - social boycott - Quit-India movement - fighting against un-touchability - Partition of India- independence.

**UNIT 4 Gandhi and Sustainable Development**

Gandhian Constructive Programs-Eleven Vows-Sarvodaya-Seven Social Sins-Gandhian Economics and Sustainable Development

**UNIT 5 Gandhi and Contemporary Issues**

Conflict Resolution Techniques of Gandhi-Ecological Challenges and Gandhian solutions-Gandhian Ethics-An Analysis

**References:**


1. Gandhi, M K. (1941). *Constructive Programme*. Ahmadabad: Navjivan Publishing House
2. Gandhi, M. K. (1948). *The Story of My Experiments with Truth*. Ahmadabad: Navjivan PublishingHouse
3. Gandhi, M K. (1968). *Satyagraha in South Africa*. Ahmadabad: Navjivan Publishing House.
4. Khoshoo, T N (1995). *Mahatma Gandhi: An Apostle of Applied Human Ecology*. New Delhi:TERI
5. Kripalani, J.B. (1970). *Gandhi: His Life and Thought*. New Delhi: Publications Division.
6. Narayan, Rajdeva (2011). *Ecological Perceptions in Gandhism and Marxism*. Muzaffarpur:NISLS
7. Pandey, J. (1998). *Gandhi and 21st Century*. New Delhi: Concept.
8. Weber, Thomas (2007).Gandhi as Disciple and Mentor. New Delhi: CUP


**Course Outcomes:**

After the successful completion of the course the students will be able to;

1. Understand the life of Gandhi
2. Appreciate the role of Gandhian non-violence and Satyagraha in India's freedom struggle.
3. Critically examine the philosophy of Gandhi on Education, Sarvodaya, and Satyagraha
4. Analyse the contemporary significance of Gandhian constructive programmes and eleven vows
5. Examine the possible solutions for some of the contemporary challenges like environmentalissues, moral degradation and ethical dilemmas.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 2 |
| CO4 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :01-02-2022** **ACADEMIC COUNCIL: 01-04-2022**

**SDG No. & Statement:**

SDG-4: Ensure Inclusive And Equitable Quality Education And Promote Lifelong Learning Opportunities For All.
Sdg-8: Promote Sustained, Inclusive And Sustainable Economic Growth, Full And Productive Employment And Decent Work For All

**SDG Justification:**

Statement: This course promotes the education for all the people without considering their religion, caste, gender and regional differences.

Statement: This course deals with the basic concepts of national income and employment to understand the national level scenario of how an economy is growing and providing employment.

| POLS1001 | Indian Constitution and History | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 | 0 | 2* |
| Pre-requisite | None | | | | | | |
| Co-requisite | None | | | | | | |
| Preferable exposure | None | | | | | | |

**Course Description:**

*This course analyzes the basic structure and operative dimensions of the Indian Constitution. It explores various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian Constitution. The course also deals with various challenges faced by the constitution and its coping mechanisms. Broadly, the students would understand and explain the working of different institutions and political debates ensuing from the operation of the Indian constitution in action.*

**Course Educational Objectives:**

- To introduce constitutional history of India.
- To explain the process of making Indian constitution
- To analyze Fundamental of Rights, Duties and other principles in constitution
- To create familiarity with political developments which shaped the constitution.

**UNIT 1 India as a Nation 6 hours**

Khilani, S. (2004). *Introduction, The Idea of India*, Chapter 1. New Delhi: Penguin Books, pp. 1-15.

Rowat, D. (1950). 'India: The Making of a Nation', International Journal, 5(2), 95-108. doi:10.2307/40194264

Brass, P. (2018). 'Continuities and Discontinuities between pre- and post-Independence India', Chapter 1.

*The Politics of Idea since independence*, New Delhi: Cambridge University Press. pp. 1-30.

**UNIT 2 Understanding the Constitution 6 hours**

Mehta, U.S. (2011). 'Constitutionalism' in *The Oxford Companion to Politics in India*, (ed) by Nirja Gopal Jayal, and Pratap Bhanu Mehta, New Delhi: Oxford University Press. pp. 15-27.

Austin, G. (2016), 'The Constituent Assembly: Microcosm in Action' *in The Indian Constitution: Cornerstone of a Nation*, New Delhi: Oxford University Press, pp. 1-25.

Beteille, Andre (2008): "Constitutional Morality," *Economic and Political Weekly*, Vol 43, Issue No 40

Prahladan, Vivek (2012): “Emergence of the Indian Constitution,” *Economic and Political Weekly*, Vol 47, Issue No 07.

**UNIT 3 The Preamble, Fundamental Rights and Directive Principles of State Policy 6 hours**

Bhakshi, P.M. (2011). ‘Preamble’ in *The Constitution of India*, New Delhi: Universal Law. Pp. 1-5. Laxmikanth, M. (2017). ‘Chapter IV: Preamble of the Constitution’ in *Indian Polity*, Chennai: McGraw Hills.

Kumar, Virendra (2007): “Basic Structure of The Indian Constitution: Doctrine of Constitutionally Controlled Governance [From Kesavananda Bharati to I.R. Coelho]” *Journal of the Indian Law Institute*, Vol 49, No 3, pp 365-398.

Austin, G (2016), ‘ ’ in *The Indian Constitution: Cornerstone of a Nation*, New Delhi: Oxford University Press, pp.63-105.

Reddy, S (1980). Fundamental Ness of Fundamental Rights and Directive Principles in the Indian Constitution. *Journal of the Indian Law Institute*, 22(3), pp. 399-407.

Bhatia, Gautam (2017): “The Supreme Court’s Right to Privacy Judgement,” *Economic and Political Weekly*, Vol 52, Issue No 44

**UNIT 4 Citizenship 6 hours**

Jayal, N.G. (2019). ‘Reconfiguring citizenship in contemporary India’ in *South Asia Journal of SouthAsian Studies*, pp.33-58.

Roy, Anupama. (2010). ‘Chapter I: Enframing the citizen in contemporary times’ in *Mapping Citizenship in India*, New Delhi: Oxford University Press.

Das, Veena (2010): “State, Citizenship and the Urban Poor,” *Citizenship Studies,* Vol 15, pp 319-333.Valerian Rodrigue

**UNIT 5 Separation and Distribution of Powers 6 hours**

Pal, Ruma. (2016). ‘Separation of Powers’ in *The Oxford Handbook of the Indian Constitution*, (ed) by Sujit Choudhry, Madhav Khosla, and Pratap Bhanu Mehta, Delhi: Oxford University Press.

Bakshi, P. (1956). ‘Comparative Law: Separation of Powers in India’. *American Bar Association Journal, 42*(6), 553-595.

Rao, P. (2005). ‘Separation of Powers in a Democracy: The Indian Experience’. *Peace Research, 37*(1),113-122.

Kumar, Ashwani (2019): “Constitutional Rights, Judicial Review and Parliamentary Democracy,”

*Economic and Political Weekly*, Vol 51, Issue 15

Tillin, Louise. (2015). ‘Introduction’ in *Indian Federalism*. New Delhi: Oxford University Press. pp.1-30.

Chakrabarty, Bidyut and Rajendra Kumar Pandey. (2008). *Federalism’ in Indian Government andPolitics*, New Delhi: Sage Publications. pp. 35-53.

Arora, B. and Kailash, K. K. (2018). ‘Beyond Quasi Federalism: Change and Continuity in IndianFederalism’, in *Studies in Indian Politics*, pp. 1-7.

Agrawal, Pankhuri (2020): “COVID-19 and dwindling Indian Federalism,” *Economic and PoliticalWeekly,* Vol 55, Issue No 26

**Recommended Readings:**

De, Rohit. (2018). *A People’s Constitution – The Everyday Life of Law in the Indian Republic*, USA:Princeton University Press.

Granville Austin, *The Indian Constitution: Cornerstone of a Nation*, Oxford University Press, Oxford, 1966.

Lahoti, R.C. (2004). *Preamble: The Spirit and Backbone of the Constitution of India*. Delhi: EasternBook Company.

Rajeev Bhargava (ed), *Ethics and Politics of the Indian Constitution*, Oxford University Press, NewDelhi, 2008.

Subhash C. Kashyap, *Our Constitution*, National Book Trust, New Delhi, 2011.Tillin, Louise. (2015). *Indian Federalism*. New Delhi: Oxford University Press.

Zoya Hassan, E. Sridharan and R. Sudarshan (eds), *India’s Living Constitution: Ideas, Practices,Controversies*, Permanent Black, New Delhi, 2002.

**Course Outcomes:**

On the successful completion of the course students would be able to:

1. Demonstrate an understanding of the Constitution of India and how constitutional governance iscarried out in India
2. Interpret knowledge of the Fundamental Rights and Duties of the Citizens as well as theObligation of the state towards its citizens
3. Correlate familiarity with key political developments that have shaped the

Constitution andamended it from time to time.
4. Equip themselves to take up other courses in law after having done a foundation course on IndianConstitution

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 1 | 2 | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 2 | 1 | 2 |
| CO2 | 1 | 1 | 2 | 1 | 2 | 2 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 2 | 1 |
| CO3 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | 3 | 1 | 1 | 1 | 2 | 1 | 2 |
| CO4 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 |
| CO5 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :01-02-2022** **ACADEMIC COUNCIL: 01-04-2022**

**SDG No. & Statement:**

SDG-16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

**SDG Justification:**

The course primarily talks about evolution of the constitutional institutions. Since the SDG-16 talks about the quality of the institutions, it is applicable here.

<table>
<tr><td rowspan="2">VEDC1001</td><td rowspan="2">VENTURE DEVELOPMENT</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*India as part of its "Make in India" initiative has been focusing on creating incubation centers within educational institutions, with an aim to generate successful start-ups. These start-ups will become employment creators than employment seekers, which is the need of the hour for our country. This common course (university core) for all the disciplines is a foundation on venture development. It is an experiential course that starts with students discovering their deeper self in terms of how they might contribute to society by creating exciting new products and services that can become the basis of real businesses. The students learn about the emerging areas of knowledge that are the foundations of any successful company. They will learn how to develop insight into the problems and desires of different types of target customers, and from this, to identify the design drivers for a specific innovation. Students will learn specific design methods for new products and services. The students will learn that as important as the product or service itself, is a strategy for monetizing the innovation – for generating revenue, structuring the operating costs, and creating the operating profit needed to support the business, hire new employees, and expand forward. This course is aimed to be the beginning of what might be the most important journey of personal and career discovery so far in a student's life, one with lasting impact. This is not just a course, but potentially, an important milestone in life that a student remembers warmly in the years to come.*

**Course Educational Objectives:**

Students have the opportunity to:

- Discover who they are – Values, Skills, and Contribution to Society
- Understand how creativity works and permeates the innovation process
- Learn the basic processes and frameworks for successful innovation.
- Gain experience in going through the innovation process.
- Conduct field research to test or validate innovation concepts with target customers.

**UNIT 1 PERSONAL DISCOVERY 4 hours**

Personal Values, Excite & Excel, Build a Team, Define Purpose, Mission Statement

**UNIT 2 IDEATION 10 hours**

Ideation & Impact, User Insights - Frameworks, Customer Interviews, Interpreting Results

**UNIT 3 SOLUTION DISCOVERY 8 hours**

Concept Design, Competitive Analysis, Product Line Strategy, Prototyping Solutions, Reality Check

**UNIT 4 BUSINESS MODEL DISCOVERY 4 hours**

Understand the Industry, Types of Business Model, Define Revenue Models, Define Operating Models, Define Customer Journey, Validate Business Model

**UNIT 5 DISCOVERY INTEGRATION**

Define Company Impact, Create Value, Tell Your Story

L – 15; Total Hours – 30

**Textbooks:**

1. Meyer and Lee, “Personal Discovery through Entrepreneurship”, The Institute for Enterprise Growth, LLC. Boston, MA., USA.

**References:**

1. Adi Ignatius (Editor-in-Chief), “Harvard Business Review”, Harvard Business Publishing, Brighton, Massachusetts,2021

**Course Outcomes:**

1. Identify one’s values, strengths and weaknesses and their will to contribute to the society
2. Formulate an idea and validate it with customers
3. Demonstrate prototyping and analyse the competition for the product
4. Create business models for revenue generation and sustainability of their business
5. Come up with a pitch that can used as the basis for actually starting a company based on an impactful innovation and societal impact

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 3 | 1 | 3 | 3 | 3 | | 3 | | | |
| CO2 | | 3 | | 3 | 1 | 3 | 2 | 1 | 3 | 3 | 1 | 3 | | | |
| CO3 | 1 | 3 | 3 | | 3 | | 3 | | 3 | 1 | 3 | 3 | | | |
| CO4 | | | | | 1 | 1 | 3 | 3 | 3 | 1 | 3 | 1 | | | |
| CO5 | | | | | 3 | 3 | | | 3 | 3 | 3 | 3 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :<< date >>** **ACADEMIC COUNCIL: <<date>>**

**SDG No. & Statement:**

4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

17. Strengthen the means of implementation and revitalize the global partnership for sustainable development.

**SDG Justification:**

4. The course involves identifying one’s personal values and working on real-life problems, thus forming the base to work on their passions even past the collegiate life.

17. The course is developed in collaboration with North-eastern University, USA and the training for the champions is being by North-eastern University.

# Faculty Core

| CHEM1001 | CHEMISTRY | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 1 | 2 | 0 | 0 | 4 |
| **Pre-requisite** | Nil | | | | | | |
| **Co- requisite** | Nil | | | | | | |
| **Preferable exposure** | Nil | | | | | | |

**Course Description:**

*This course enables the students to gain knowledge on various aspects of Water and its treatment, electrochemical energy systems, Construction of batteries, renewable energy sources, Semiconductors, Steel, Cement and Polymers, Corrosion and its control, nanomaterials, Analytical instruments, and applications. The knowledge gained in this course can be applied to the latest developments in technology.*

**Course Educational Objectives:**

1. To impart knowledge on various aspects of water and its treatment.
2. To study about electrochemical energy systems, renewable energy sources, solar cells, and their applications.
3. To gain knowledge on materials such as steel, cement, and polymers
4. To create awareness on corrosion and its control.
5. To introduce different types of nanomaterials.
6. To expose the students to latest instrumental techniques such as scanning electronic microscope (SEM) & transmission electron microscope (TEM).

**UNIT 1 Water and its treatment 9 Hours**

Water and its treatment: Introduction – hardness of water – Causes of hardness - Types of hardness: temporary and permanent – expression and units of hardness. Estimation of hardness of water by complexometric method. Potable water and its specifications. Steps involved in treatment of water – Disinfection of water by chlorination and ozonization-industrial water treatment- Boiler feed water and its treatment -internal conditioning– Calgon and Phosphate conditioning. External treatment of water – Ion exchange process. Desalination of water – Reverse osmosis.

**UNIT 2 Electrochemical Energy Systems 9 Hours**

Battery Technology: Basic concepts, battery characteristics, classification of batteries, Important applications of batteries, Classical batteries-dry/Leclanche cell, Modern batteries-zinc air, Lead-acid storage battery, lithium cells- Lithium-ion cell, Li $MnO_2$ cell. Fuel cells- Introduction - classification of fuel cells – hydrogen and oxygen fuel cell, propane, and oxygen fuel cell- Merits of fuel cell. **Renewable energy sources – Types of renewable energy sources. Semiconductors:** Definition, types of semiconductors: doping- n type and p – type semiconductors and applications. - **Solar cells:** Introduction, harnessing solar energy, Photovoltaic cell, solar water heaters.

**UNIT 3 Engineering materials and Polymer Chemistry 8 Hours**

**Steel** – Types of Steel, chemical composition – applications of alloy steels

**Cement:** Portland cement, constituents, Manufacture of Portland Cement, chemistry of setting and hardening of cement (hydration, hydrolysis, equations).

**Polymer Chemistry**: Concept of polymerization – Types of Polymerizations, Chain growth polymerization – mechanisms of free radical and cationic polymerizations, Thermoplastic resins and Thermosetting resins: examples- Polyethylene, Styrene, Nylon 6,6 and Bakelite. and applications, Conducting polymers:– Examples – and applications.

**UNIT 4 Corrosion and its control 8 Hours**

Corrosion and Its Prevention: Electrochemical theory of corrosion, Corrosion due to dissimilar metal cells (galvanic cells), Corrosion due to differential aeration cells, Uniform corrosion, pitting corrosion and stress corrosion cracking, Effect of pH, temperature and dissolved oxygen on corrosion rate. Corrosion prevention and control by cathodic protection- protective coatings- paints.

**UNIT 5 Nanomaterials and Analytical Instrumental Techniques 8 Hours**

**Nanomaterials:** Introduction to nanomaterial: nanoparticles, nanocluster, carbon nanotube (CNT) and nanowires. Chemical synthesis of nanomaterials: sol-gel method. Characterization: Principle and applications of scanning electron microscope (SEM) and transmission electron microscope (TEM)

**Analytical Instrumental Techniques**

Review of electromagnetic spectrum, Quantization of energy. Absorption of radiation: Beer-Lambert's law. Principle and applications of pH metry, potentiometry, conductometry, IR and UV-spectroscopy with examples.

**Text Books:**

1. P.C. Jain and M. Jain, Engineering Chemistry, 15/e, Dhanapat Rai & Sons, Delhi (2014).
2. B.K. Sharma, Engineering Chemistry, Krishna Prakashan, Meerut.
3. O G Palanna, Engineering Chemistry, Tata McGraw Hill Education Private Limited, (2009).

**References:**

1. Sashi chawla, A Textbook of Engineering Chemistry, Dhanapath Rai and sons, (2003)
2. B.S Murthy and P. Shankar, A Text Book of NanoScience and NanoTechnology, University Press (2013).
3. S.S. Dara, A Textbook of Engineering Chemistry, S.Chand & Co, (2010)
4. N.Krishna Murthy and Anuradha, A text book of Engineering Chemistry, Murthy Publications (2014).
5. K. Sesha Maheshwaramma and Mridula Chugh, Engineering Chemistry, Pearson India Edn services, (2016).

**Course Outcomes:**

After the completion of the course, the student will be able to

1. List the important purification methods of water.
2. Illustrate the principles and applications of batteries, solar energy.
3. Explain the importance of materials such as steel, cement, and polymers

4. Identify different protective coatings.
5. Analyze the importance of nano materials and the principles of SEM and TEM.

## CHEMISTRY LABORATORY

**List of Experiments:**

1. Determination of Mohr's salt by potentiometric method
2. Determination of strength of an acid by pH metric method
3. Determination of conductance by conductometric method
4. Determination of viscosity of a liquid
5. Determination of surface tension of a liquid
6. Determination of sulphuric acid in lead-acid storage cell
7. Determination of chromium (VI) in potassium dichromate
8. Determination of copper in a copper ore
9. Determination of Zinc by EDTA method.
10. Estimation of active chlorine content in Bleaching powder
11. Preparation of Phenol-Formaldehyde resin
12. Preparation of Urea-Formaldehyde resin
13. Thin layer chromatography
14. Preparation of TiO2/ZnO nano particles
15. SEM analysis of nano materials

**Textbooks:**

1. Mendham J, Denney RC, Barnes JD, Thosmas M and Sivasankar B Vogel's Quantitative Chemical Analysis 6/e, Pearson publishers (2000).
2. N.K Bhasin and Sudha Rani Laboratory Manual on Engineering Chemistry 3/e, Dhanpat Rai Publishing Company (2007).

**Course Outcomes:**

After the completion of the laboratory course, the student will be able to

1. explain the functioning of the instruments such as pH, Conductometric and Potentiometric methods.
2. identify different ores (Cr & Cu) and their usage in different fields (industry, software devices, electronic goods).
3. experiment with the physical parameter of organic compounds.
4. compare the viscosities of oils.
5. list the preparation of polymers and nano materials.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 2 | 2 | 2 | 3 | 1 | 1 | 2 | 2 | 3 | 1 | 3 | 2 |
| CO2 | 3 | 2 | 1 | 1 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 1 | 3 | 3 |
| CO3 | 3 | 2 | 1 | 1 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 3 | 3 | 1 | 2 |
| CO4 | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 2 |
| CO5 | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 2 | 3 | 1 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

<table>
<tr><td rowspan="2">CSEN1011</td><td rowspan="2">PROBLEM SOLVING AND PROGRAMMING WITH C</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>6</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Co-requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Familiarity with Computer system and its operation.</td></tr>
</table>

***Course Description***:
*The course is designed to enable the student to write programs for problem solving. After an introduction to program logic design using algorithms and flowcharts, converting the logic into programs is taught. The features of structured programming are explained with the C programming language as an example. This course lays the foundation both for developing program logic and for writing programs in C according to the developed logic.*

**Course objectives**:
1. Familiarize the student with the steps involved in writing and running a compiled program.
2. Enable the student to build program logic with algorithms and flowcharts.
3. Explain with the features and constructs of C programming such as data types, expressions, loops, functions, arrays, pointers, and files.
4. Demonstrate the handling of variables and input-output operations in C.
5. Train the student to convert program logic into C language code using a top-down approach.

**Module I:** **Introduction to Computer Problem-Solving** 12Hours
Introduction, the Problem-Solving Aspect, Top-Down Design, Introduction to the idea of an algorithm, Introduction to Flowchart using Raptor tool.
**Introduction to C Language** – Structure of a C Program, Keywords, Identifiers, Data Types (int, float, char, unsigned int) and Variable declaration, Constants, Input / Output function. Operators, Expressions, Precedence and Associativity, Expression Evaluation, Type conversions.
**Exercises: Construct a flowchart and write a program to**
- Develop a calculator to convert time, distance, area, volume and temperature from one unit to another.
- Calculate simple and compound interest for various parameters specified by the user
- To enter marks of five subjects and calculate total, average and percentage.
- Calculate net salary of employee given basic,da,hra,pf and lic
- retrieve remainder after division of two numbers without using mod operator
- Convert an upper-case character to a lower-case character.
- Swap two numbers
- Enter two angles of a triangle and find the third angle.
- Check Least Significant Bit (LSB) of a number
- Input any number from user and check whether nth bit of the given number is set (1) or not (0)(hint: Use bitwise operators)

**Module II: Control Structures** 15 Hours

- **Control Structures:** Selection Statements (making decisions) – if, if-else, nested if, else if ladder and switch statements. Repetition statements (loops)-while, for, do-while statements, Nested Loops.
- Unconditional statements-break, continue, goto.
- Pointers – Pointer variable, pointer declaration, Initialization of pointer, accessing variables through pointers, pointers to pointers, pointers to void.

**Exercises: Construct a Flowchart and Write a Program to**

- Check whether the triangle is equilateral, isosceles, or scalene triangle.
- Check whether entered year is a leap year or not
- Find minimum among three numbers.
- Check whether a number is divisible by 5 and 11 or not.
- Check whether a number is positive, negative or zero using switch case.
- Design a calculator that performs arithmetic operations on two numbers using switch case
- Find Roots of a Quadratic Equation
- Find factorial of a number
- Check whether number is a palindrome or not
- Check whether number is perfect or not
- Convert a decimal number to binary number
- To find the sum of the series [ 1-X^2/2!+X^4/4!...........].
- Print following patterns

```
*
*
* *
* * *
* * * *
A
B B
C CC
D D D D
E E E EE
1
2 3
4 5 6
7 8 9 10
```

- Calculate the greatest common divisor of two numbers
- Generate first n numbers in the Fibonacci series
- Generate n prime numbers
- Swap two numbers using pointers.
- Performs all the five arithmetic operations using Pointers.

**Module III: Functions** 15 Hours

Functions-Designing Structured Programs, user defined function- function definition, function prototype, function call, Types of functions. Parameter Passing by value, parameter passing by address, Recursive functions. Dynamic Memory allocation Functions, pointers to functions. Storage classes-auto, register, static, extern.

**Exercises: Write a program using functions to**

- Print even and odd numbers in a given range
- Find power of a number
- Return maximum of given two numbers
- To print all strong numbers between given interval using functions.
- Check whether a number is prime, Armstrong or perfect number using functions.
- Demonstrate call by value and call by reference mechanisms.
- Find power of any number using recursion.
- Generate Fibonacci series using recursion
- Find product of two numbers using recursion
- Find the sum of digits of a number. Number must be passed to a function using pointers.
- Find GCD (HCF) of two numbers using recursion.
- Find LCM of two numbers using recursion.

**Module IV: Arrays and Strings** 15 Hours

Arrays – Declaration and Definition of Array, accessing elements in array, Storing values in array, linear search, binary search, bubble sort, Two – dimensional arrays, multidimensional arrays. Arrays and Pointers, Pointer Arithmetic and arrays, array of pointers, Passing array to function.
Strings – Declaration and Definition of String, String Initialization, unformatted I/O functions, arrays of strings, string manipulation functions, string and pointers.

**Exercises: Write a program to**

- Find minimum and maximum element in an array
- Implement linear search.
- Sort an array in descending order.
- Given a two-dimensional array of integers and a row index, return the largest element in that row.
- Find transpose of a matrix.
- Perform multiplication of two matrices
- Count total number of vowels and consonants in a string.
- Reverse the given string without using String handling functions.
- Sort strings in dictionary order
- To perform addition of two matrices.
- Read an array of elements of size 'n' and find the largest and smallest number using functions
- find total number of alphabets, digits or special character in a string using function

**Module V: Structures and Files** 15Hours

Structures–Declaration, initialization, accessing structures, operations on structures, structures containing arrays, structures containing pointers, nested structures, self-referential structures, arrays of structures, structures and functions, structures and pointers, unions.
Files – Concept of a file, Opening and Closing files, file input / output functions (standard library input / output functions for text files)

Exercises: Write a program to

- Store information of a student using structure
- Add two complex numbers by passing structures to a function

- Store information of 10 students using structures
- Store Employee information using nested structure
- Read file contents and display on console.
- Read numbers from a file and write even and odd numbers to separate file.
- Count characters, words and lines in a text file.

Textbooks(s)

- B. A. Forouzan and R. F. Gilberg, Computer Science: A Structured Programming Approach Using C, 3/e, Cengage Learning

Reference Book(s)

1. Jeri R Hanly, Elliot B Koffman, Problem Solving and Program Design in C, 7/e, Pearson Education, 2012.
2. B.W. Kernighan and Dennis M. Ritchie, The C Programming Language, 2/E, Pearson education, 2015.
3. B. Gottfried, Programming with C, 3/e, Schaum's outlines, McGraw Hill (India), 2017.
4. P. Dey and M Ghosh, Programming in C, 2/e, Oxford University Press, 2011.

**Additional Exercises:**

1. Given numbers x, y, and target, return whichever of x and y is closer to the target. If they have the same distance, return the smaller of the two
2. There are three friends Ram, Raheem and Robert. Ram's age is 20, Raheem is aged three times more than his friend Ram. After 8 years, he would be two and a half times of Ram's age. After further 8 years, how many times would he be of Rams age? Robert's age is 25 now. Now program your computer to determine the final ages of all the three people after 16 years and also show who is elder.
3. Given an actual time and an alarm clock time, both in "military" format (such as 0730 for 7:30am), print how many more minutes before the alarm rings. But if the time is after the alarm, print "Alarm already went off".
4. Let there be a scenario where you and your friend are going to a restaurant. You have lunch there every fourth day, and he has his lunch there every sixth day. How many days before you meet again for lunch at the same restaurant?
5. Two friends Suresh and Ramesh have **m** red candies and **n** green candies respectively. They want to arrange the candies in such a way that each row contains equal number of candies and also each row should have only red candies or green candies. Help them to arrange the candies in such a way that there are maximum number of candies in each row.
6. On a chessboard, positions are marked with a letter between a and h for the column and a number between 1 and 8 for the row. Given two position strings, return true if they have the same colour.
7. Given two strings s0 and s1, return whether they are anagrams of each other.
8. Write a program to encrypt and decrypt a password which is alphanumeric
9. Given a string, return the string with the first and second half swapped. If the string has odd length, leave the middle character in place.
10. Given an array of integers, return the second-largest element.
11. Given lists of integers people, jobs, profits. Each person i in people have people[i] amount of strength, and performing job j requires jobs[j] amount of strength and nets profits[j] amount of profit. Given that each person can perform at most one job, although a job can be assigned to more than one person, return the maximum amount of profit that can be attained.

12. Mr. Roxy has arranged a party at his house on the New Year's Eve. He has invited all his friends - both men and women (men in more number). Your task is to generate the number of ways in which the invitees stand in a line so that no two women stand next to each other. Note that the number of men is more than the number of women and Roxy doesn't invite more than 20 guests. If there are more than 20 guests or an arrangement as per the given constraints is not possible, print 'invalid'.
13. Two friends have entered their date of birth and they want to know who is elder among them. Make a structure named Date to store the elements day, month and year to store the dates.

**Case Study:**

**1.** Create a structure containing book information like accession number, name of author, book title and flag to know whether book is issued or not. Create a menu in which the following functions can be done: Display book information, Add a new book, Display all the books in the library of a particular author, Display the number of books of a particular title, Display the total number of books in the library, Issue a book (If we issue a book, then its number gets decreased by 1 and if we add a book, its number gets increased by 1)

2. Ranjan is maintaining a store. Whenever a customer purchases from the store, a bill is generated. Record the customer name, amount due, the amount paid, mobile number with purchased items in file. At the end of day print the total income generated by store.
3. Contact Management System- Create structure to store Contact information like name, gender,mail,phone number and address. Users can add new contact and can also edit and delete existing contact. (Hint: Use Files to store data)

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PS12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | | 1 | | | | 2 | | | 2 | 3 | 2 | 2 |
| CO2 | 2 | 2 | 2 | | 1 | | | | 2 | | | 2 | 2 | 2 | 2 |
| CO3 | 2 | 3 | 2 | | 1 | | | | 2 | | | 2 | 2 | 2 | 2 |
| CO4 | 2 | 3 | 2 | | 1 | | | | 2 | | | 2 | 3 | 2 | 2 |
| CO5 | 2 | 2 | 2 | | 1 | | | | 2 | | | 2 | 2 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : September 6, 2021** **ACADEMIC COUNCIL: 21st AC(September 17, 2021)**

**SDG No. & Statement: 4** Quality Education, Decent Work and Economic Growth

4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

**SDG Justification:**

Learning various problem-solving techniques will lead to become a good problem solver.

| CSEN1021 | PROGRAMMING WITH PYTHON | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 6 | 0 | 0 | 3 |
| **Pre-requisite** | Nil | | | | | | |
| **Co-requisite** | Nil | | | | | | |
| **Preferable exposure** | Familiarity with Computer system and its operation. | | | | | | |

**Course Educational objectives:**

1. To elucidate problem solving through python programming language
2. To introduce function-oriented programming paradigm through python
3. To train in development of solutions using modul ar concepts
4. To teach practical Python solution patterns

**Module I:** Introduction to Python 18 **Hours**

Python – Numbers, Strings, Variables, operators, expressions, statements, String operations, Math function calls, Input/output statements, Conditional If, while and for loops.

Exercises:

1. Accept input from user and store it in variable and print the value.
2. Use of print statements and use of (.format )for printing different data types.
3. Take 2 numbers as user input and add, multiply, divide, subtract, remainder and print the output (Same operations on floating point input as well)
4. Conversion of one unit to another (such as hours to minutes, miles to km and etc)
5. Usage of mathematical functions in python like math.ceil, floor, fabs, fmod, trunc, pow, sqrt etc.
6. Building a mathematical calculator that can perform operations according to user input. Use decision making statement.
7. Accepting 5 different subject marks from user and displaying the grade of the student.
8. Printing all even numbers, odd numbers, count of even numbers, count of odd numbers within a given range.
9. a) Compute the factorial of a given number. b) Compute GCD of two given numbers. c) Generate Fibonacci series up to N numbers.
10. Check whether the given input is a) palindrome b) strong c) perfect
11. Compute compound interest using loop for a certain principal and interest amount

**Module II:** Functions **18 Hours**

User defined Functions, parameters to functions, recursive functions. Lists, Tuples, Dictionaries, Strings.

Exercises:

- Create a function which accepts two inputs from the user and compute ${}^{n}C_{r}$
- Recursive function to compute GCD of 2 numbers
- Recursive function to find product of two numbers
- Recursive function to generate Fibonacci series
- Program to print a specified list after removing the 0th, 4th and 5th elements.
  Sample List : ['Red', 'Green', 'White', 'Black', 'Pink', 'Yellow']
  Expected Output : ['Green', 'White', 'Black']
- Program to get the difference between the two lists.
- Program to find the second smallest number and second largest number in a list.
- Given a list of numbers of list, write a Python program to create a list of tuples having first element as the number and second element as the square of the number.
- Given list of tuples, remove all the tuples with length K.
  Input : test_list = [(4, 5), (4, ), (8, 6, 7), (1, ), (3, 4, 6, 7)], K = 2
  Output : [(4, ), (8, 6, 7), (1, ), (3, 4, 6, 7)]
  Explanation : (4, 5) of len = 2 is removed.
- Program to generate and print a dictionary that contains a number (between 1 and n) in the form (x, x*x).
  Sample Input: (n=5) :
  Expected Output : {1: 1, 2: 4, 3: 9, 4: 16, 5: 25}
- Program to remove a key from a dictionary
- Program to get the maximum and minimum value in a dictionary.
- Program to perform operations on string using unicodes ,splitting of string,accessing elements of string using locations
- Program for Counting occurrence of a certain element in a string, getting indexes that have matching elements.For ex -.In Rabbit count how many times b has occurred . Example-I have to go to a doctor and get myself checked. Count the number of occurrences of ‘to’.
- Program for replacing one substring by another For example - Rabbit - Replace ‘bb’ by ‘cc’
- Program to Acronym generator for any user input (ex-input is Random memory access then output should be RMA).Example - Random number (RN)
- Python function that accepts a string and calculates the number of uppercase letters and lowercase letters.
- Program to count the number of strings where the string length is 2 or more and the first and last character are same from a given list of strings

  Sample List : ['abc', 'xyz', 'aba', '1221'] Expected Result : 2

**Module III: Files and Packages** **18 Hours**

Files—Python Read Files, Python Write/create Files, Python Delete Files.

Pandas -- Read/write from csv, excel, json files, add/ drop columns/rows, aggregations, applying functions.

Exercises

- read an entire text file.
- read the first n lines of a file.
- append text to a file and display the text.
- Read numbers from a file and write even and odd numbers to separate files.
- Count characters, words and lines in a text file.
- To write a list to a file.
- Given a CSV file or excel file to read it into a data frame and display it.
- Given a data frame, select rows based on a condition.
- Given is a data frame showing the name, occupation, salary of people. Find the average salary per occupation.
- To convert Python objects into JSON strings. Print all the values.
- Write a Pandas program to read specific columns from a given excel file.

**Module IV:** Operations in database with suitable libraries **18 Hours**

SQLite3: CRUD operations (Create, Read, Update, and Delete) to manage data stored in a database.

Matplotlib -- Visualizing data with different plots, use of subplots. User defined packages, define test cases.

Exercises

Special commands to sqlite3 (dot-commands)
Rules for "dot-commands"
Changing Output Formats
Querying the database schema
Redirecting I/O
Writing results to a file
Reading SQL from a file
File I/O Functions
The edit() SQL function
Importing CSV files
Export to CSV
Export to Excel

Reference - https://www.sqlite.org/cli.html

Matplotlib can be practiced by considering a dataset and visualizing it.
It is left to the instructor to choose appropriate dataset.

**Module V:** Regular Expressions **18 Hours**

Regular expression: meta character, regEx functions, special sequences, Web scrapping, Extracting data.

Exercises

Write a Python program to check that a string contains only a certain set of characters (in this case a-z, A-Z and 0-9).
Write a Python program that matches a string that has an a followed by zero or more b's
Write a Python program that matches a string that has an a followed by one or more b's
Write a Python program that matches a string that has an a followed by zero or one 'b'
Write a Python program that matches a string that has an a followed by three 'b'
Write a Python program to find sequences of lowercase letters joined with an underscore

Write a Python program to test if a given page is found or not on the server.
Write a Python program to download and display the content of robot.txt for en.wikipedia.org.
Write a Python program to get the number of datasets currently listed on data.gov
Write a Python program to extract and display all the header tags from en.wikipedia.org/wiki/Main_Page
.
Textbooks(s)

1. Programming with python, T R Padmanabhan, Springer
2. Python Programming: Using Problem Solving Approach, Reema Thareja, Oxford University Press

Reference Book(s)

1. Programming with python, T R Padmanabhan, Springer
2. Python Programming: Using Problem Solving Approach, Reema Thareja, Oxford University Press
3. Python for Data Analysis, Wes McKinney, O.Reeilly

Course Outcomes:
After completion of this course the student will be able to

- Define variables and construct expressions.
- Utilize arrays, storing and manipulating data.
- Develop efficient, modular programs using functions.
- Write programs to store and retrieve data using files.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PS12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | | 1 | | | | 2 | | | 2 | 3 | 2 | 2 |
| CO2 | 2 | 2 | 2 | | 1 | | | | 2 | | | 2 | 2 | 2 | 2 |
| CO3 | 2 | 3 | 2 | | 1 | | | | 2 | | | 2 | 2 | 2 | 2 |
| CO4 | 2 | 3 | 2 | | 1 | | | | 2 | | | 2 | 3 | 2 | 2 |
| CO5 | 2 | 2 | 2 | | 1 | | | | 2 | | | 2 | 2 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : September 6, 2021** **ACADEMIC COUNCIL: 21st AC(September 17, 2021)**

**SDG No. & Statement: 4** Quality Education

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

**SDG Justification:**

Learning a programming language like Python students can get decent jobs in different fields.

| CSEN1031 | ARTIFICIAL INTELLIGENCE APPLICATIONS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 0 | 0 | 1 |
| **Pre-requisite** | CSEN1011: Problem Solving and Programming with C<br>CSEN1021: Programming with Python | | | | | | |
| **Co- requisite** | Nil | | | | | | |
| **Preferable exposure** | Programming | | | | | | |

**Course Description:**

*The surge in the production of data has led to the development of various technologies. The term "Artificial Intelligence (AI)" has become ubiquitous in everyday applications from virtual assistants to self-driving cars. Several applications such as Healthcare, Finance, Bioinformatics etc. are benefitting from the advances in the domain. The global market for artificial intelligence is going to face a phenomenal growth over the coming years with organizations across the world capitalizing on the disruptive technologies that AI is offering. This course introduces the recent applications of AI namely, Virtual Assistants, Computer Vision, along with trending topics such as Deep Learning and Reinforcement Learning. The idea of the course is to introduce the basic concepts of AI as well as latest trends in the domain. This course is envisaged to provide a basic understanding on latest developments of AI to all disciplines engineering undergraduates.*

**Course Educational Objectives:**

1. Provide introduction to basic concepts of artificial intelligence.
2. Explore applications of AI
3. Explore the scope, advantages of intelligent systems
4. Experiment with different machine learning concept
5. Exposure to AI-intensive computing and information system framework

**UNIT 1** **2 Hours**

Introduction to Artificial intelligence: Basics of AL Agents and Environment, The Nature of Environment.

**List of Experiment(s):**

Implementation of toy Problems (8-Puzzle, Wumpus World, Vacuum-clean Example, etc)

**UNIT 2** **2 Hours**

Applications of AI: Game Playing, [Deep Blue in Chess, IBM Watson in Jeopardy, Google's Deep Mind in AlphaGo]

**List of Experiment(s):**

1. Implementation of (Sudoku, Crossword Puzzle, or Wumpus World, etc)

**UNIT 3** **2 Hours**

Conceptual introduction to Machine Learning: Supervised, Unsupervised, and Semi-Supervised Learning.

**List of Experiment(s):**

1. Supervise - Perform Data Labelling for various images using object recognition

**UNIT 4** **2 Hours**

Reinforcement Learning, Introduction to Neural Networks, Deep Learning

**List of Experiment(s):**

1. Explore the effect of different hyperparameters while implementing a Simple Fully Connected Neural Network. (https://playground.tensorflow.org)

**UNIT 5** **2 Hours**

Image Processing & Computer Vision: Introduction to Image processing, Image Noise, Removal of Noise from Images, Color Enhancement, Edge Detection.

**List of Experiment(s):**

1. Lobe.ai - Build custom models using the visual tool for Object recognition and sentiment analysis that can convert facial expressions into emoticons

**UNIT 6** **2 Hours**

Segmentation. Feature Detection & Recognition. Classification of images. Face recognition, Deep Learning algorithms for Object detection & Recognition.

**List of Experiment(s):**

1. Teachable Machine Brain.JS In Browser Object Recognition through
2. Haar Cascade Object detection for Eye and Face in Python using Open CV

**UNIT 7** **2 Hours**

Conceptual introduction to Natural Language Processing: Speech Recognition & Synthesis: Speech Fundamentals, Speech Analysis, Speech Modelling.

**List of Experiment(s):**

1. Sentiment Analysis and Polarity detection

**UNIT 8** **2 Hours**

Speech Recognition, Speech Synthesis, Text-to-Speech, Sentiment Analysis, Segmentation and recognition.

**List of Experiment(s):**

1. Text to Speech recognition and Synthesis through APIs

**UNIT 9** **2 Hours**

Introduction to o Chatbot, Architecture of a Chatbot. NLP in the cloud, NL Interface, How to Build a Chatbot, Transformative user experience of chatbots, Designing Elements of a chatbot, Best practices for chatbot development. NLP components. NLP wrapper to chatbots. Audiobots and Musicbots.

**List of Experiment(s):**

1. Building a Chatbot using IBM Watson visual studio
2. Building a Chatbot using Pandora bots
3. Build a virtual assistant for Wikipedia using Wolfram Alpha and Python

**UNIT 10** **2 Hours**

Smart Applications: Smart Manufacturing, Smart Agriculture, Smart Healthcare, Smart Education, Smart Grids, Smart Transportation and Autonomous Vehicles, Smart Homes, Smart Cities

**List of Experiment(s):**

1. Build a smart application specific to the domain of the student.

**Textbooks:**

1. Tom Markiewicz& Josh Zheng, Getting started with Artificial intelligence, Published by O'Reilly Media,20l7
2. Stuart J. Russell and Peter Norvig, Artificial Intelligence A Modern Approach.

**References:**

1. Aurtlien Giron. Hands on Machine Learning with Scikit-Learn and TensorFlow concepts,Tools, and Techniques to Build intelligent Systems , Published by O'Reilly Mcdia,20l 7
2. Build an AI Assistant with wolfram alpha and Wikipedia in python.https://medium .com/@salisuwy/build-an-ai-assistant-with-wolfram-alpha-and-wikipedia-in-python-d9bc8ac838fe.
3. Joseph Howse, Prateek Joshi, Michael Beyeler - Opencv Computer Vision Projects withPython-Publishing (201 6).
4. Curated datasets on kaggle https://www.kaggle.com/datasets.

**Course Outcomes:**

1. Able to grasp the concepts of artificial intelligence, machine learning, natural language processing, image processing
2. Recognize various domains in which Al can be applied
3. Implement the methods in processing an image:
4. Implement simple of chatbots
5. identify smart applications:

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | | 1 | | | | 2 | | | 2 | 3 | 2 | 2 |
| CO2 | 2 | 2 | 2 | | 1 | | | | 2 | | | 2 | 2 | 2 | 2 |
| CO3 | 2 | 3 | 2 | | 1 | | | | 2 | | | 2 | 2 | 2 | 2 |
| CO4 | 2 | 3 | 2 | | 1 | | | | 2 | | | 2 | 3 | 2 | 2 |
| CO5 | 2 | 2 | 2 | | 1 | | | | 2 | | | 2 | 2 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : September 6, 2021**

**ACADEMIC COUNCIL: 21st AC(September 17, 2021)**

**SDG No. & Statement:**

**SDG Justification:**

<table>
<tr><td rowspan="2">EECE1001</td><td rowspan="2">BASIC ELECTRICAL AND ELECTRONICS ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>2</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Co- requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Nil</td></tr>
</table>

**Course Description:**

*This course introduces the fundamental principles and building blocks of electrical and electronics engineering. The first three units cover the electric circuit laws, theorems, and principles of electrical machines. The last two units cover semiconductor devices and their applications.*

**Course Educational Objectives:**

1. To impart the analysis and design aspects of DC networks in electrical and electronic circuits
2. To explain the basic concepts of AC networks used in electrical and electronic circuits.
3. To demonstrate the importance and operating principles of electrical machines (transformers, motors and generators)
4. To impart the knowledge about the characteristics, working principles and applications of semiconductor diodes, Metal Oxide Semiconductor Field Effect Transistors (MOSFETs).
5. To expose basic concepts and applications of Operational Amplifier and configurations.

**UNIT 1** **7 Hours**
DC Circuits: Basic circuit elements and sources, Ohms law, Kirchhoff's laws, series and parallel connection of circuit elements, Node voltage analysis, Mesh current analysis, Superposition, Thevenin's and maximum power transfer theorem.

**UNIT 2** **8 Hours**
AC Circuits: Alternating voltages and currents, AC values, single phase RL, RC, RLC series circuits, power in AC circuits, Power Factor, three phase systems-Star and Delta Connection-Three phase power measurement.

**UNIT 3** **9 Hours**
Electrical Machines: Construction, working principle and application of DC machines, Transformers, single phase and three phase Induction motors, special machines-Stepper motor, Servo motor and BLDC motor.

**UNIT 4** **8 Hours**
Semiconductor Devices: p-n Junction diode - Basic operating principle, current-voltage characteristics, rectifier circuits (half-wave, full-wave, rectifier with filter capacitor), Zener

diode as Voltage Regulator; Metal oxide semiconductor field effect transistor (MOSFET): Operation of NMOS and PMOS FETs, MOSFET as an amplifier and switch.

**UNIT 5** **8 Hours**

Operational Amplifiers: The Ideal Op-amp, The Inverting Configuration, The closed loop gain, Effect of Finite open-loop gain, The Noninverting Configuration, The closed loop gain, Characteristics of Non-Inverting Configuration, Difference amplifiers, A Single Op-amp difference amplifier. Adders, subtractors, integrators, differentiators, filter circuits using Opamps,

**Basic Electrical and Electronics Engineering Laboratory**

**List of Experiments:**

1. Verification of Kirchhoff's Laws.
2. Verification of DC Superposition Theorem.
3. Verification of Thevenin's Theorem.
4. Verification of Maximum power transfer Theorem.
5. Load test on DC generator.
6. Load test on single phase transformer.
7. Measurement of voltage, current and power factor of single phase RL, RC series circuits.
8. Measurement of voltage, current and power factor of single phase RLC series circuit.
9. Measurement of power in a three phase circuit.
10. Current Voltage Characteristics of a p-n Junction Diode/LED.
11. Diode Rectifier Circuits.
12. Voltage Regulation with Zener Diodes.
13. Design of a MOSTFET amplifier and MOSFET inverter/NOR gate
14. Inverting and Non-inverting Amplifier Design with Op-amps.
15. Simulation experiments using PSPICE
    a) Diode and Transistor Circuit Analysis.
    b) MOSFET Amplifier design.
    c) Inverting and Noninverting Amplifier Design with Op-amps.

**Textbooks:**

1. D. P. Kothari, I. J. Nagrath, Basic Electrical and Electronics Engineering, 1/e, McGraw Hill Education (India) Private Limited, 2017.
2. B. L. Theraja, Fundamentals of Electrical Engineering and Electronics, 1/e, S. Chand Publishing, New Delhi, 2006.
3. Adel S. Sedra and Kenneth C. Smith, Microelectronic Circuits 6/e, Oxford University Press, 2014.

**References:**

1. S.K. Bhattacharya, Basic Electrical and Electronics Engineering, Pearson Education,

2011.
2. Dharma Raj Cheruku, B T Krishna, Electronic Devices and Circuits, 2/e, Pearson Education, 2008.
3. R. K. Rajput, Basic Electrical and Electronics Engineering, University Science Press, New Delhi, 2012.

**Course Outcomes:**

After completion of this course, the student will be able to

1. predict and analyse the behaviour of an electrical circuit (L3).
2. analyse the performance quantities such as losses, efficiency and identify applications of DC machines (L4).
3. explain the use of transformers in transmission and distribution of electric power and other applications (L2).
4. demonstrate the operation and applications of various electronic devices (L2).
5. construct Inverting and Noninverting configurations of Op-amp (L3).

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | | | | |
| CO2 | | | | | | | | | | | | | | | |
| CO3 | | | | | | | | | | | | | | | |
| CO4 | | | | | | | | | | | | | | | |
| CO5 | | | | | | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**
**SDG3: Good Health and Well Being:** Understanding the fundamentals of electrical and electronics systems can help in designing systems, to promote good health and well being

**SDG5: Gender Equality:** Acquiring the interdisciplinary knowledge help overcome the gender barriers in workplace

**SDG8: Descent Work and Economic:** The learners of this course can get descent work and earn financial benefits and they can work in interdisciplinary areas

**SDG12: Responsible Consumption and Production:** Use of right and energy efficient electric and electronic components and devices results in reasonable consumption and production
**SDG Justification:**

| HSMCH102 | UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | Nil | | | | | | |
| **Co- requisite** | Nil | | | | | | |
| **Preferable exposure** | Nil | | | | | | |

**Course Description:**

*During the Induction Program, students would get an initial exposure to human values through Universal Human Values – I. This exposure is to be augmented by this compulsory full semester foundation course.*

**Course Educational Objectives:**

The objective of the course is fourfold:

1. Development of a holistic perspective based on self- exploration about themselves (human being), family, society, and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society, and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

**COURSE TOPICS:** The course has 28 lectures and 14 practice sessions in 5 modules:

**UNIT 1 Course Introduction - Need, Basic Guidelines, Content and Process for Value Education**

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I.
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration.
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

**UNIT 2 Understanding Harmony in the Human Being - Harmony in Myself!**

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
4. Understanding the characteristics and activities of 'I' and harmony in 'I'.
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available tome. Identifying from one's own life.
Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

**UNIT 3 Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship**

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

**UNIT 4 Understanding Harmony in the Nature and Existence - Whole existence as Coexistence**

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and self-regulation in nature.
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.

4. Holistic perception of harmony at all levels of existence.
5. Include practice sessions to discuss human being as cause of imbalance in nature (film “Home” can be used), pollution, depletion of resources and role of technology etc.

**UNIT 5 Implications of the above Holistic Understanding of Harmony on Professional Ethics**

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order:
    a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
    b. At the level of society: as mutually enriching institutions and organizations
7. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

**Text Books:**

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

**References:**

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)

13. Gandhi - Romain Rolland (English)

Lectures hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them. Tutorial hours are to be used for practice sessions.

While analysing and discussing the topic, the faculty mentor’s role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one’s own self and do self- observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up “ordinary” situations rather than” extra-ordinary” situations.

Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials)would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

**This course is to be taught by faculty from every teaching department, including HSS faculty.**

**Teacher preparation with a minimum exposure to at least one 8- day FDP on Universal Human Values is deemed essential.**

**ASSESSMENT:**
This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation.

**Example:**
Assessment by faculty mentor: 10 marks
Self-assessment: 10 marks
Assessment by peers: 10 marks
Socially relevant project/Group Activities/Assignments: 20 marks Semester End Examination:

50 marks
The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

**Course Outcomes:**
By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

This is only an introductory foundational input. It would be desirable to follow it up by

a. faculty-student or mentor-mentee programs throughout their time with the institution
b. Higher level courses on human values in every aspect of living. E.g. as a professional

<table>
<tr><td rowspan="2">INTN2333</td><td rowspan="2">INTERNSHIP 1</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Completion of minimum of four semesters</td></tr>
<tr><td>Co- requisite</td><td colspan="7"></td></tr>
<tr><td>Preferable exposure</td><td colspan="7"></td></tr>
</table>

**Course Educational Objectives:**

1. The course is designed to expose the students to expected industry skills and industry environment and to take up onsite assignment as trainees or interns.

**Contents:** **1 Week**

**One week** of work at industry site. Supervised by an expert at the industry.

**Mode of Evaluation:** Internship Report, Presentation and Project Review

**Course Outcomes:**

At the end of this internship the student should be able to:

1. Have an exposure to industrial practices and to work in teams
2. identify skill set required to participate activity in real-time projects relevant to the industry
3. Understand the impact of engineering solutions in a global, economic, environmental and societal context
4. formulate technical background required to participate in Internship 2

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

| INTN3444 | INTERNSHIP 2 | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 0 | 1 | 3 |
| **Pre-requisite** | Completion of minimum of six semesters | | | | | | |
| **Co- requisite** | | | | | | | |
| **Preferable exposure** | | | | | | | |

**Course Educational Objectives:**

1. The course is designed to expose the students to industry environment and to take up onsite assignment as trainees or interns.

**Contents:** **1 Week**

**Four weeks** of work at industry site. Supervised by an expert at the industry

**Mode of Evaluation:** Internship Report, Presentation and Project Review

**Course Outcomes:**

At the end of this internship the student should be able to:

1. Have an exposure to industrial practices and to work in teams
2. Communicate effectively
3. Understand the impact of engineering solutions in a global, economic, environmental and societal context
4. Develop the ability to engage in research and to involve in life-long learning
5. Comprehend contemporary issues
6. Engage in establishing his/her digital footprint

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

| MATH1001 | SINGLE VARIABLE CALCULUS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 | 0 | 2 |
| Pre-requisite | NIL | | | | | | |
| Co- requisite | NIL | | | | | | |
| Preferable exposure | NIL | | | | | | |

**Course Description:**

*This course is designed to impart knowledge on differentiation and integration of function, emphasizing their inter-relationship and applications to engineering.*

**Course Educational Objectives:**

1. To familiarize the students in the concepts the derivatives and its underlying concepts like limits and continuity.
2. To explain the concept of derivative and calculation of extreme values of extreme values of various functions.
3. To impart knowledge on integration for the computation of areas, arc lengths.
4. To demonstrate various techniques of integrations.

**UNIT 1 Limits and continuity of single and several variables 6 Hours**

Limit of a Function and Limit Laws, The Precise Definition of a Limit, One-Sided Limits, Continuity (Without proofs). Functions of Several Variables, Limits and Continuity in Higher Dimensions (Without proofs)

**UNIT 2 Derivatives and applications 7 Hours**

The Derivative as a Function, Differentiation Rules, The Chain Rule, Extreme Values of Functions on Closed Intervals, Monotonic Functions (Without proofs)

**UNIT 3 Integrals and applications 7 Hours**

The Definite Integral, The Fundamental Theorem of Calculus, Indefinite Integrals and the Substitution Method, Definite Integral Substitutions and the Area between Curves, Arc Length (Without proofs)

**UNIT 4 Techniques of integration 6 Hours**

Using basic Integration Formulas, Integration by Parts, Trigonometric Integrals, Trigonometric Substitutions, Integration of Rational Functions by Partial Fractions (Without proofs)

**Textbooks:**

1. Joel Hass, Christopher Heil, Maurice D. Weir, Thomas' Calculus, Fourteenth edition, Pearson Addison Wesley (2018).

**References:**

1. Erwin Kreyszig, Advanced Engineering Mathematics,10/e, John Wiley & Sons, 2018.
2. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015.
4. Hyghes-Hallett, Gleason, McCallum et al. Single Variable Calculus (6th Edn) John Wiley and Sons New York, 2013.


**Course Outcomes:**

At the end of the course, the student will be able to

- determine limit, one sided limit, continuity of single and several variable functions.
- solve problems in a range of mathematical applications using differentiation
- solve problems in a range of mathematical applications using integration
- apply the fundamental theorem of calculus.
- evaluate integrals using various techniques.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 26-04-2021 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4

Ensure inclusion and equitable quality education and promote lifelong opportunities for all

**SDG Justification:**

Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

| MATH1011 | SEVERAL VARIABLE CALCULUS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 | 0 | 2 |
| **Pre-requisite** | **MATH1001** | | | | | | |
| **Co- requisite** | **NIL** | | | | | | |
| **Preferable exposure** | **Engineering and Science** | | | | | | |

**Course Description:**

*This course is designed to impart knowledge on calculus of functions of more variables which are useful in modelling and analyzing physical phenomena involving continuous change of variables or parameters and have applications across all branches of engineering.*

**Course Educational Objectives:**

1. To teach basic concepts of partial derivatives.
2. To explain the evaluation of double integrals and its applications.
3. To demonstrate the evaluation and applications of triple integrals.
4. To acquaint the knowledge of line and surface integrals and applications.

**UNIT 1 Partial derivatives and applications 7 Hours**

Partial Derivatives of a Function of Two Variables and More Than Two Variables, Second-order Partial derivatives, The Chain Rule for Functions of Two and Three variables, Extreme Values and Saddle Points, Lagrange Multipliers, Taylor's Formula for Two Variables (Without proofs)

**UNIT 2 Double integrals 6 Hours**

Double and iterated Integrals over Rectangles, Double Integrals over General Regions, Area by Double Integration: Area of bounded region in a plane, Double Integrals in Polar Form. (Without proofs)

**UNIT 3 Triple integrals 5 Hours**

Triple Integrals in Rectangular Coordinates: Triple Integrals, Volume of a Region in Space, Finding limits of integration, Triple Integrals in Cylindrical and Spherical Coordinates. (Without proofs)

**UNIT 4 Integrals and Vector fields 8 Hours**

Vector Fields and Line Integrals: Line Integrals of Vector Fields, Line Integrals with Respect to dx, dy, or dz, Work Done by a Force over a Curve in Space, Green's Theorem in the Plane: Tangential form, Using Green's Theorem to Evaluate the Line Integral and Verification, Surface Integrals: Surface Integrals of Vector Fields, Stokes' Theorem (Without proofs)

**Textbooks:**

1. Joel Hass, Christopher Heil, Maurice D. Weir, Thomas' Calculus, Fourteenth edition,

Pearson Addison Wesley (2018).

**References:**

1. Erwin Kreyszig, Advanced Engineering Mathematics,10/e, John Wiley & Sons, 2018.
2. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.
3. Hyghes-Hallett, Gleason, McCallum et al. Multivariable Variable Calculus (6th Edn) John Wiley and Sons New York, 2013.
4. James Stewart. Multivariate Calculus, Concepts and Contexts. (3rd Edn) Thomson/Brooks/Cole, Canada, 2005.

**Course Outcomes:**

At the end of the course, the student will be able to

- utilize functions of several variables in optimization.
- employ the tools of calculus for calculating the areas.
- calculate volumes using multiple integrals.
- determine the work done using vector calculus
- determine the rate of flow of a fluid using vector calculus

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4

Ensure inclusion and equitable quality education and promote lifelong opportunities for all

**SDG Justification:**

Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

<table>
<tr><td rowspan="2">MATH2371</td><td rowspan="2">DIFFERENCE EQUATIONS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Co- requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Engineering and Science</td></tr>
</table>

**Course Description:**

*Difference equations is the study of equation which involves the difference of a discrete function. In this course, the student can form a difference equation, solving linear higher order difference equations using analytical techniques, simultaneous linear difference equations and also find the solution of linear higher order difference equations and simultaneous difference equations using Z-transforms.*

**Course Educational Objectives:**

1. Student is able to know how to find the order of a difference equation and complementary function of a difference equation.
2. Student is able to know how to find the particular solution of a difference equation and also find the solutions of simultaneous linear difference equations.
3. Student is able to know how to find Z-transforms a discrete function using properties and using to basic theorems.
4. Student is able to know how to find the inverse Z-transforms a function and also using convolution theorem.
5. Student is able to know how to find the solution of a difference equation using Z-transforms

**UNIT 1 Difference equations - I 5 Hours**

Introduction, definition of order, and solution of difference equation, formation of difference equations, linear difference equations, complementary function, rule for finding complementary function.

**UNIT 2 Difference equations-II 5 Hours**

Particular integrals, Rule for finding particular integrals, simultaneous linear difference equations.

**UNIT 3 Z-transforms 5 Hours**

Introduction, Definition, some standard Z-transforms, linear property, damping rule, Shifting $U_n$ to the **right and to the left, Multiplication by n, two basic theorems.**

**UNIT 4 Inverse Z-transforms 5 Hours**

Convergence of Z-transforms, evaluation of inverse Z-transforms, properties, convolution theorem.

**UNIT 5 Applications of Z-transforms 5 Hours**

Solving difference equations and simultaneous linear difference equations with constant coefficients by Z-transforms.

**Textbooks:**

1. "Higher Engineering Mathematics" by B.S. Grewal published by Khanna Publishers

**References:**

1. Advanced Engineering mathematics by Irvin Kreyszig

**Course Outcomes:**

1. Able to find the order of a difference equation and complementary function of a difference equation.
2. Able to find the particular solution of a difference equation and also find the solutions of simultaneous linear difference equations.
3. Able to find Z-transforms a discrete function using properties and using to basic theorems.
4. Able to find the inverse Z-transforms a function and also using convolution theorem.
5. Able to find the solution of a difference equation using Z-transforms

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4

Ensure inclusive and equitable quality education and promote lifelong opportunities for all

**SDG Justification:**

Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

<table>
<tr><td rowspan="2">MATH1031</td><td rowspan="2">DIFFERENTIAL EQUATIONS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Co- requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Engineering and Science</td></tr>
</table>

**Course Description:**

*This course is designed to impact the knowledge on ordinary, partial differential equations and their applications.*

**Course Educational Objectives:**

6. To familiarize the students with the basic concepts of ordinary differential equations.
7. To demonstrate the evaluation and applications of first order differential equations.
8. To explain the evaluations of linear homogeneous and non-homogeneous differential equations.
9. To familiarize the students with the basic concepts of partial differential equations.
10. To explain the concepts of first order partial differential equations.
11. To demonstrate the evaluation of differential equations using math software's

**UNIT 1 First Order Ordinary Differential Equations 5 Hours**

Order and Degree of an Ordinary Differential Equation (ODE), ODE's of first order and first degree, Variable separable method, Linear Equations, Bernoulli's Equations.

**UNIT 2 Linear Ordinary Differential Equations of High Order 6 Hours**

Definitions, Complete Solution, Operator D, Complimentary function, Inverse operator, Rules for finding particular integral ($e^{ax}$, sinbx/cosbx, $x^m$& $e^{ax}v(x)$)

**UNIT 3 Applications of Linear Ordinary Differential Equations of Higher Order 5 Hours**

Method of Variation of Parameters, Simple Harmonic Motion, Oscillations of a Spring

**UNIT 4 Introduction to Partial Differential Equations 5 Hours**

Introduction, Formation of Partial Differential Equation(PDE), Solutions of a PDE, Equations solvable by direct integration, Linear equations of the first order.

**UNIT 5 Partial Differential Equations of Second Order 5 Hours**

Homogeneous linear equations with constant coefficients, Rules for finding the complementary function and particular integral, Working procedure to solve the equations.

**Textbooks:**

1. Simmons, G.F., Differential Equations with Applications and Historical Notes, Second Edition, McGraw-Hill, Inc., 1991.
2. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.

**References:**

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984
2. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.
3. Erwin Kreyszig, Advanced Engineering Mathematics,10/e, John Wiley & Sons, 2018.

**Course Outcomes:**

1. Form and find the solution of an ordinary differential equation.
2. Apply the concept of differential equations to solve real world problems.
3. Evaluate linear homogeneous and non homogeneous differential equations
4. Form and find the solution of a partial differential equations of first order.
5. Evaluate second order partial differential equations and solution of differential equations using computational tool.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4
Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

**SDG Justification:**
Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

| MATH2281 | NUMERICAL TECHNIQUES | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 | 0 | 2 |
| **Pre-requisite** | **NIL** | | | | | | |
| **Co- requisite** | **NIL** | | | | | | |
| **Preferable exposure** | **Engineering and Science** | | | | | | |

**Course Description:**

*This course is designed to enhance problem solving skills of engineering students using a powerful problem-solving tool namely numerical Techniques. The tool is capable of handling large systems of equations, nonlinearities and complicated geometries that are common in engineering practice but often impossible to solve analytically.*

**Course Educational Objectives:**

1. To familiarize the students with numerical solutions of nonlinear and systems of linear equations.
2. To get exposed to finite differences and interpolation.
3. To demonstrate the numerical differentiation and integration.
4. To explain the numerical solutions of ordinary differential equations

**UNIT 1 Solution of algebraic and transcendental equations 6 Hours**

Regula-falsi method and Newton- Raphson method. **Solution of linear system of equations**-Iterative methods: Gauss Jacobi method, Gauss Seidel method, and finding the eigenvalues of a matrix by Power method.

**UNIT 2 Interpolation 5 Hours**

Difference operators (shifting, delta, del) and difference tables, Newton's forward and backward interpolation formulae, Divided difference formula, and Lagrange's interpolation formula.

**UNIT 3 Numerical Differentiation and Numerical Integration 5 Hours**

**Numerical Differentiation**: Derivatives using forward, and backward difference formulae.
**Numerical Integration**: Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rules.

**UNIT 4 Numerical solutions of ordinary differential equations - 1 5 Hours**

Picard's method, Taylor's series method, Euler's method, and Modified Euler's method

**UNIT 5 Numerical solutions of ordinary differential equations - 2 5 Hours**

Runge-Kutta method (second and fourth order), Predictor-Corrector methods-Adams-Bashforth and Milne's methods.

**Text Books:**

1. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2018.

**References:**

1. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 5/e, New Age International(P) Limited, 2007.
2. S.S. Sastry, Introductory methods of Numerical Analysis,4/e,PHI Learning Publications,2009.
3. H.C Saxena, Finite Differences and Numerical Analysis, Chand and Company Pvt. Ltd., New Delhi.

**Course Outcomes:**

At the end of the course, the student will be able to

1. analyze how root finding techniques can be used to solve practical engineering problems.
2. apply various interpolation techniques to solve practical problems .
3. apply numerical differentiation and integration whenever and wherever routine methods are not applicable .
4. solve differential equations using various numerical methods .
5. know the strengths and weaknesses of the various methods and be able to decide which ones are appropriate for a particular problem

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4

Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

**SDG Justification:**

Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

| MATH1021 | TRANSFORM TECHNIQUES | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 | 0 | 2 |
| **Pre-requisite** | **MATH1031** | | | | | | |
| **Co- requisite** | **NIL** | | | | | | |
| **Preferable exposure** | **Engineering and Science** | | | | | | |

**Course Description:**

*This course is designed to impact the knowledge on (Laplace, Fourier) transforms and applications of these transforms on differential equations.*

**Course Educational Objectives:**

1. To introduce and explain the concepts of Laplace transforms and properties.
2. To demonstrate the evaluation of Laplace transforms of special functions and additional properties.
3. To impart knowledge on obtaining Fourier series
4. To introduce and explain the concepts of Fourier transforms and properties.
5. To explain the evaluation of Fourier transforms of various function and then applications to boundary value problem.
6. To demonstrate and understand the transform techniques using available software

**UNIT 1 Laplace transforms 5 Hours**

Introduction, transforms of elementary functions, properties of Laplace transforms, transforms of derivatives, transforms of Integrals, Multiplication by t^n, Division by t.

**UNIT 2 Applications of Laplace transforms 5 Hours**

Evaluation of integrals by Laplace transforms, Inverse transforms, Solution of Differential equations.

**UNIT 3 Fourier Series 6 Hours**

Introduction, Conditions for a Fourier expansion, Functions having points of discontinuity, Change of interval.

**UNIT 4 Half-Range Fourier Series 3 Hours**

Even and odd functions, Half range sine series, and Half range cosine series.

**UNIT 5 Fourier transforms 7 Hours**

Introduction, Fourier sine & cosine integrals, Fourier transforms, Properties of Fourier transforms-linear, change of scale & shifting property.

**Text Books:**


1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2018.
2. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.


**References:**


1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002.
2. George B. Thomas, Maurice D. Weir and Joel R. Hass, Thomas' Calculus, 13/e, Pearson Publishers, 2014.
3. Glyn James, Advanced Modern Engineering Mathematics, 4/e, Pearson Publishers, 2011.


**Course Outcomes:**

At the end of the course students will be able to

1. find Laplace transform of a function along with properties.
2. evaluate the Laplace transform of special functions.
3. apply the Laplace transform for solving differential equations (continuous systems)
4. evaluate the Fourier transform of a function along with properties and solve boundary value problems by Fourier transforms.
5. evaluate the engineering problems using transform techniques with the help of advanced math software

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4

Ensure inclusive and equitable quality education and promote lifelong opportunities for all

**SDG Justification:**

Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

| MATH2381 | OPERATIONS RESEARCH | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 | 0 | 2 |
| **Pre-requisite** | **NIL** | | | | | | |
| **Co- requisite** | **NIL** | | | | | | |
| **Preferable exposure** | **Engineering and Science** | | | | | | |

**Course Description:**

*Operations Research (OR), also known as management science, has become an indispensable tool in scientific management. Operations Research focuses on developing and analyzing strategic and tactical levels to aid in decision-making and decision-making on the operational level. The essential tools of OR are algorithms, procedures that create and improve solutions to a point at which optimal or, at least, satisfactory solutions have been found.*

**Course Educational Objectives:**

This course is designed to:

1. introduce the fundamentals of Operations Research to the students at the undergraduate level
2. solve different types of optimization problems of various categories and applying modern methodologies in the area of optimization
3. help students to develop a deep understanding of the classical and numerical optimization techniques and problem-solving capabilities

**UNIT 1 Linear Programming 4 Hours**

Formulation of LPP, convex sets and their properties, slack and surplus variables, Basic solution, Basic feasible solution, non-degenerate and degenerate basic feasible solutions, optimal solution, General, Standard, and Canonical form of LPP.

**UNIT 2 Simplex Method 8 Hours**

Simplex method, Degeneracy in LPP, Artificial variables techniques-Two Phase method, Big M-method.

**UNIT 3 Duality 5 Hours**

Duality in linear programming, primal-dual relationships, weak duality theorem, strong duality theorem, and dual simplex method.

**UNIT 4 Integer Programming 4 Hours**

Gomory’s cutting plane method, Branch and Bound method for solving integer linear programming problems

**UNIT 5** **Sensitivity Analysis** **5 Hours**

Introduction to sensitivity analysis, variations in the price vector, variations in the requirement vector, addition of a new decision variable to the existing problem.

**Textbooks:**

1. Operations Research by S.D.Sarma, Kedarnath, Ramnath and company, 15th edition, 2008.
2. Operations Research An Introduction by Hamdy A. Taha, 8th edition, Pearson, 2007.

**References:**

1. Linear Programming by R K Gupta, Krishna Prakashan Mandir, 13th edition 2014.
2. Operations Research Theory and Applications by J K Sharma, 4th edition, Macmillan Publishers India Ltd, 2009

**Course Outcomes:**

On successful completion of this course, students will be able to:

1. understand the linear programming problem, its formation, and basic definitions of solutions
2. understand the simplex method, which is a very efficient algorithm to solve a linear programming problem
3. understand the dual primal relationship, properties of duality, and the dual simplex algorithm
4. find integer solutions to LPP by cutting plane methods
5. find variations in price and requirement vectors and retaining optimality

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4

Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

**SDG Justification:**

Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

| MATH2301 | COMPLEX VARIABLES | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 | 0 | 2 |
| **Pre-requisite** | **NIL** | | | | | | |
| **Co- requisite** | **NIL** | | | | | | |
| **Preferable exposure** | **Engineering and Science** | | | | | | |

**Course Description:**

*This course is designed to familiarize the students with complex analysis, nature of a series, evaluation of integrals using Cauchy's theorem.*

**Course Educational Objectives:**

- To explain the concept of complex functions and analytic functions.
- To explain the concept of conformal mapping.
- To explain the concept of Cauchy's theorem and residue theorem.
- To explain the convergence of series such as Taylor's and Laurent.
- To explain the concept of Cauchy's theorem and residue theorem.

**UNIT 1 Functions of a Complex variable 6 Hours**

Limit and continuity, Differentiation, Analytic functions, Cauchy-Riemann equations, harmonic functions, finding harmonic conjugates- applications to flow problems.

**UNIT 2 5 Hours**

Geometrical representation of f(z) – Some standard transformations – Bilinear transformation - Conformal mappings. Special conformal transformations ( $w = z^2$ , $w= z+1/z$ , $w = e^z$ , $w= \cosh z$)

**UNIT 3 Complex Integration 5 Hours**

Integration of complex functions - Cauchy's theorem - Cauchy's integral formula.

**UNIT 4 Series representation of analytic functions 5 Hours**

convergent series of analytic functions, Laurent 's and Taylor series, zeros and singularities of an analytic function

**UNIT 5 Calculus of residues 5 Hours**

Residue -Cauchy Residue theorem – Calculation of residues (All theorems without proof).

**Text Books:**

1. B.S.Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publishers, New Delhi, 2012.

**References:**

1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics Narosa Publishing House, New Delhi, 2014.
2. N. P. Bali and Manish Goyal, A Text Book of Engineering Mathematics, $8^{th}$ Edition, Lakshmi Publications, New Delhi, 2012.

**Course Outcomes:**

1. Make use of differentiation and integration of complex functions in engineering problems.
2. Concept of conformal mappings .
3. Use Cauchy's theorem and Cauchy's integral formula to evaluate the line integrals
4. Apply Taylor's and Laurent's series to expand complex functions and know about the convergence region .
5. Evaluation of integrals using Residue theorem.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4
Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

**SDG Justification:**
Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

<table>
<tr><td rowspan="2">MATH1041</td><td rowspan="2">DISCRETE MATHEMATICS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Co- requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Engineering and Science</td></tr>
</table>

**Course Description:**

*Discrete Mathematics introduces students to the mathematics of networks, social choice, and decision making. This course provides students with a hands-on exploration of the relevancy of mathematics in the real world. This course reflects the rigor taught in many entry-level mathematics courses.*

**Course Educational Objectives:**

1. To introduce basics of mathematical logical operators and connectives
2. To impart knowledge on normal forms and rules of inference.
3. To impart knowledge on partially ordered and total ordered sets.
4. To familiarize closed form solution of linear recurrence relations by various methods.
5. To impart knowledge on basic concepts of algebraic structures.
6. To write program structures, and understand when programming is most applicable

**UNIT 1** **Logic Operators and Connectives** **5 Hours**

Negation, conjunction, disjunction, conditional and bi-conditional, well formed formulae, tautologies, equivalence of formulae, duality, tautological implications.

**UNIT 2** **Mathematical logic** **5 Hours**

Conjunctive and disjunctive normal forms- principal disjunctive and conjunctive normal forms, Rules of inference for propositional calculus (Rule P, Rule T and CP rule).

**UNIT 3** **Sets and Relations** **5 Hours**

Basic concepts of set theory, Power set, relations, properties of binary relations in a set, Equivalence relations, composition of binary relations, Partial ordering, Partially ordered set.Hasse diagram.

**UNIT 4** **Recurrence relations** **5 Hours**

Recurrence relations, solving linear recurrence relations by characteristic roots method, system of recurrence relations.

**UNIT 5** **Algebraic Structures** **6 Hours**

Algebraic Structures-Semi group, Monoid, Groups, subgroups, cosets (definition and examples) Lagrange's theorem on finite groups

**Text Books:**

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill, 1997.
2. Kenneth H. Rosen, Discrete Mathematics and Applications, Seventh edition, Tata McGrawHill,2012.

**References:**

1. Bhishma Rao, Mathematical Foundations of Computer Science, SciTech Publications (India) Pvt Ltd.
2. Discrete Mathematical Structures,Sixth edition-Kolman,Busby,Ross

**Course Outcomes:**

Upon successful completion of this course the student should be able to

1. Check the validity of a statement formula
2. analyze the concepts in set theory and relations
3. find a general solution of recurrence equation
4. build the algebraic structures and apply Lagrange's theorem on finite groups
5. Convert problem solving strategies to procedural algorithms

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4
Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

**SDG Justification:**
Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

| MATH1051 | Graph Theory | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 | 0 | 2 |
| **Pre-requisite** | **NIL** | | | | | | |
| **Co- requisite** | **NIL** | | | | | | |
| **Preferable exposure** | **Engineering and Science** | | | | | | |

**Course Description:**

*This course introduces basic concepts in Graph Theory, including properties and characterization of graph/trees and graph theoretic algorithms, which are widely used in Mathematical modelling and has got applications across Computer Science and other branches in Engineering.*

**Course Educational Objectives:**

1. To introduce basics of group theory and its applications
2. To impart knowledge on basic concepts of paths and circuits
3. To impart knowledge on Trees, spanning trees, shortest spanning trees
4. To familiarize in the matrix representation of graphs
5. To transform scientific problems into generic computational models

**UNIT 1 Basics of graphs 5 Hours**

Finite and Infinite Graphs, Incidence and Degree, Isolated Vertex, Pendant Vertex, and Null Graph, complete graph, Bi-partite and complete Bi-partite graphs.

**UNIT 2 Matrix representation of graphs 5 Hours**

Adjacency Matrix, Incidence Matrix, Path Matrix (Definition and examples)

**UNIT 3 Paths and circuits 6 Hours**

Paths, and Circuits, Connected Graphs, Disconnected Graphs, and Components, Euler Graphs, Hamiltonian graphs (Definition, examples and without proofs)

**UNIT 4 Trees 5 Hours**

Trees and their properties, spanning trees, minimal spanning trees, Kruskal's algorithm for finding a minimal spanning tree.

**UNIT 5 Applications of Trees and Fundamental circuits 5 Hours**

Preorder, in order and post order traversals, Prefix and Postfix notations of an arithmetic expression, parsing trees.

**Textbooks:**

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill, 1997.

2. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India, 2006.

**References:**

1. Bhishma Rao, Mathematical Foundations of Computer Science, SciTech Publications (India) Pvt Ltd.
2. Kenneth H. Rosen, Discrete Mathematics and Applications, Seventh edition, Tata McGrawHill,2012.

**Course Outcomes:**

Upon successful completion of this course the student should be able to

1. analyse the concepts in graph theory
2. apply graph theory concepts in core subjects such as data structures and network theory effectively
3. Identify different types of paths
4. Construct minimum spanning tree using some algorithms and identify tree traversals
5. Solve the graphical problems which are accessed in available software

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4

Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

**SDG Justification:**

Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

| MATH2311 | NUMBER THEORY | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 | 0 | 2 |
| Pre-requisite | NIL | | | | | | |
| Co- requisite | NIL | | | | | | |
| Preferable exposure | Engineering and Science | | | | | | |

**Course Description:**

*This course is designed to explain the basics and applications of number theory for the students of Computer Science. The core courses of these branches encounter with concepts like prime factorization, modular arithmetic, and quadratic reciprocities in number theory. The first unit of the course provide a strong platform for such encounters and the other units focuses on applications of number theory.*

**Course Educational Objectives:**

1. To teach basic concepts of number theory focusing on Computational aspects.
2. To teach the concepts of factorization of integers.
3. To teach Format's theorem and quadratic residues.
4. To explain Chines remainder theorem and Euclidean algorithm.
5. To explain polynomial arithmetic.

**UNIT 1** **Basic Concepts in Number Theory** **5 Hours**

Topics in elementary number theory, Divisibility, Greatest Common Divisor, Euclidean Algorithm

**UNIT 2** **5 Hours**

Fundamental theorem of Arithmetic, Congruences, Properties of congruences, Linear congruences

**UNIT 3** **5 Hours**

Fermat's theorem, Fermat's little theorem, Wilson's theorem

**UNIT 4** **5 Hours**

Chinese remainder theorem, The functions $\tau \; and \; \sigma$, Euler Phi-function, Euler's theorem, Some properties of phi function

**UNIT 5** **5 Hours**

The order of integer modulo n, Primitive roots for prime, Composite number having primitive roots

**Textbooks:**

1. Elementary Number Theory | 7th Edition by David Burton, Mc Graw Hill Education

**References:**

1. Basic Number Theory by S.B. Malik,S. Chand publishers

**Course Outcomes:**

Upon successful completion of this course the student should be able to

1. Apply concepts of number theory focusing on Computational aspects.
2. Analyze concepts of factorization of integers.
3. Explain Fermat's theorem and quadratic residues.
4. Analyse Chines remainder theorem and Euclidean algorithm.
5. Analyse the concept of polynomial arithmetic.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4
Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

**SDG Justification:**
Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

<table>
<tr><td rowspan="2">MATH2291</td><td rowspan="2">LINEAR ALGEBRA</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Co- requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Engineering and Science</td></tr>
</table>

**Course Description:**

*This course is designed to gain knowledge in the concepts of Linear Algebra focusing on basics of matrices, vector spaces and singular value decomposition to understand the basic concepts of Linear Algebra in the applications of image processing and machine learning.*

**Course Educational Objectives:**

1. To familiarize with theory of matrices and tools for solving system of linear equations
2. To impart knowledge on Eigen values and Eigen vectors.
3. To teach basic concepts of vector spaces and their properties.
4. To explain the concepts of inner product spaces.
5. To familiarize with concept of singular value decomposition and its applications

**UNIT 1** **Fundamentals of Matrices** **5 Hours**

Introduction to Matrices and Rank of a matrix, Echelon form, solving system of linear equations.

**UNIT 2** **Eigen values and Eigen vectors** **5 Hours**

Eigen values and Eigen vectors, positive definite matrices, Linear dependence, and Linear independence.

**UNIT 3** **Vector Spaces** **6 Hours**

Vector space, linear combination of vectors, linear span, basis and dimension, linear Transformation.

**UNIT 4** **Inner Product Spaces** **5 Hours**

Inner Product Spaces, examples of inner product spaces, norm and length of a vector cauchy-schwarz's inequality.

**UNIT 5** **Singular value decomposition** **5 Hours**

Singular values, computing singular value decomposition and Introduction to principal component analysis.

**Textbooks:**

1. Higher Engineering Mathematics, B. S. Grewal.
2. Linear Algebra, Schaum's Outline,4$^{th}$ edition, Seymour Lipchutz,Marc Lipson

**References:**


1. Advanced Engineering Mathematics, 7th Edition, Peter V. O'Neil.
2. Advanced Engineering Mathematics, 2nd Edition, Michael. D. Greenberg.
3. Introduction to linear algebra, 5th Edition, Gilbert Strang.
4. Applied Mathematics (Vol. I & II), by P. N. Wartikar& J. N. Wartikar.
5. Digital Image Processing, R C Gonzalez and R E Woods.


**Course Outcomes:**

At the end of the course the student will be able to

- solve the system of linear equations
- calculate Eigen values and Eigen vectors
- find the basis
- learn Singular value decomposition
- learn principal Component analysis

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4

Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

**SDG Justification:**

Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems.

<table>
<tr><td rowspan="2">MATH2341</td><td rowspan="2">PROBABILITY THEORY AND RANDOM VARIABLES</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Co- requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Engineering and Science</td></tr>
</table>

**Course Description:**

*To expose the students to the basics of probability theory and random processes essential for modelling and quantifying uncertainties and noise in systems*

**Course Educational Objectives:**

- To know about various random life length models and their uses in finding the reliability of different electronic devices.
- To learn about basic properties and characteristics of various random processes with reference to signal and trunk processes.

**UNIT 1 Probability 5 Hours**

Axioms of probability theory. Probability spaces. Joint and conditional probabilities. Bayes' Theorem- Independent events.

**UNIT 2 Random Variable 5 Hours**

Random variables and random vectors. Distributions and densities. Independent random variables. Functions of one and two random variables.

**UNIT 3 Multiple Random Variables 6 Hours**

Vector random variables, joint distribution and density functions, properties, conditional distribution and density, statistical independence, distribution and density of a sum of random variables, central limit theorem.

**UNIT 4 Expected Value of a Function of Random Variables 6 Hours**

Joint moments about the origin, joint central moments, jointly Gaussian random variables - two random variables case, N random variable case.

**UNIT 5 Random Process 6 Hours**

Temporal characteristics - the random process concept, stationarity and statistical independence, correlation functions, Gaussian random processes, Poisson random process.

**Textbooks:**

1. Peyton Z. Peebles, Probability, Random Variables and Random Signal Principles, 4/e, Tata McGraw Hill, 2002.
2. Athanasios Papoulis, S. Unnikrishnan Pillai, Probability, Random Variables and Stochastic Processes, 4/e, Tata McGraw Hill, 2002.

**References:**

1. Simon Haykin, Communication Systems, 4/e, Wiley Student Edition, 2006.
2. Henry Stark, John W. Woods, Probability and Random Processes with Application to Signal Processing, 3/e, Pearson Education, 2002.

**Course Outcomes:**

Upon successful completion of this course, the student should be able to

1. Analyze the outcomes of random experiments and develop the concept of random variables and obtain probabilities through them
2. define single random variables in terms of their PDF and CDF, and calculate moments such as the mean and variance
3. explore the random experiments specified by multiple random variables and study the Distribution of them
4. apply the fundamentals of probability theory and random processes to practical engineering problems
5. identify and interpret the key parameters that underlie the random nature of the problems

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4

Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

**SDG Justification:**

Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

<table>
<tr><td rowspan="2">MATH2321</td><td rowspan="2">RANDOM PROCESSES</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Co- requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Engineering and Science</td></tr>
</table>

**Course Description:**

*This course is designed to impart knowledge on random processes needed in applications such as signal processing, digital communications, speech processing, data modelling, etc.*

**Course Educational Objectives:**

1. To familiarize the students in the concepts of probability and random variables.
2. To study Random Processes, its types, distribution, and density functions.
3. To study Gaussian and Poisson processes.
4. To apply random process to signal processing in communication systems.
5. To apply skills in analysing random phenomena which occur in Electrical and Electronics Engineering applications.

**UNIT 1** **Random Processes** **6 Hours**

Temporal characteristics - the random processes concept, Classification of random processes, stationarity and statistical independence. Time averages and Ergodicity.

**UNIT 2** **Correlation and Covariance functions** **5 Hours**

Auto correlation, Cross correlation, Properties. Covariance functions. Gaussian random processes, Poisson random processes

**UNIT 3** **Density functions** **5 Hours**

Probability density and joint probability density functions, Properties.

**UNIT 4** **Spectral densities functions - I** **5 Hours**

Spectral characteristics, the power density spectrum: Properties, relationship between power density spectrum and autocorrelation function.

**UNIT 5** **Spectral densities functions-II** **5 Hours**

Cross-power density spectrum, Properties, relationship between cross power spectrum and cross-correlation function.

**Textbooks:**

1. Peyton Z. Peebles, Probability, Random Variables and Random Signal Principles, 4/e, Tata McGraw Hill, 2002.

**References:**

1. Athanasios Papoulis, S. Unnikrishnan Pillai, Probability, Random Variables and Stochastic Processes, 4/e, Tata McGraw Hill, 2002.
2. Simon Haykin, Communication Systems, 4/e, Wiley Student Edition, 2006.
3. Henry Stark, John W. Woods, Probability and Random Processes with Application to Signal Processing, 3/e, Pearson Education, 2002.

**Course Outcomes:**

At the end of the course, the student will be able to:

- solve the problems on multiple random variables, joint distribution and independence
- solve the problems Gaussian and Poisson processes
- understand the concept of random processes
- determine covariance and spectral density of stationary random processes
- characterize the random signals in communication systems with their autocorrelation and power spectral density functions

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4
Ensure inclusive and equitable quality education and promote lifelong opportunities for all.
**SDG Justification:**
Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

<table>
<tr><td rowspan="2">MATH2351</td><td rowspan="2">OPTIMIZATION METHODS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Co- requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Engineering and Science</td></tr>
</table>

**Course Description:**

*Optimization is the art of finding the best result under given conditions. In this fast-expanding world, an engineer has to use many Optimization methods, as it is the most significant in decision-making, design, manufacturing, maintenance, planning, and scheduling.*

**Course Educational Objectives:**

This course is designed to:

- introduce various optimization methods for solving real-world problems
- find optimal solutions to transportation, assignment, and sequencing problems
- know project planning and scheduling
- study the network analysis techniques through CPM and PERT

**UNIT 1 Transportation Problem 6 Hours**

Introduction and LP formulation of Transportation Problem, feasible solution, basic feasible solution, finding Initial basic feasible solutions by North West corner rule, Least-cost entry method, Vogel's approximation method, Transportation Algorithm (MODI Method) to find an optimal solution.

**UNIT 2 Assignment Problems 5 Hours**

Introduction to Assignment Problem, Mathematical formulation, Hungarian Method for finding optimal solution, unbalanced assignment problem, Travelling Salesman Problem.

**UNIT 3 Sequencing Problem 4 Hours**

Introduction, Basic terminology, Algorithms to obtain optimal solutions for sequencing problems with $n$ jobs and two machines and $n$ jobs and $k$ machines.

**UNIT 4 Network Analysis in Project planning 4 Hours**

Project, Project Planning, Project Scheduling, Project Controlling, Work breakdown structure, Network Techniques, terms used in network-activity, event, path, network, dummy activity, looping, Fulkerson's rule, network diagram, and activity on node diagram.

**UNIT 5 PERT and CPM 7 Hours**

Critical path method (CPM), Measure of activity, Critical path analysis, the four floats, subcritical and supercritical activities, slack, Programme evaluation and review technique (PERT), time estimates, frequency distribution curve for PERT

**Text Books:**

1. Operations Research by S.D.Sarma, Kedarnath, Ramnath and company, 15th edition, 2008.
2. Operations Research An Introduction by Hamdy A. Taha, 8th edition, Pearson, 2007.

**References:**

1. Linear Programming by R K Gupta, Krishna Prakashan Mandir, 13th edition 2014.
2. Operations Research Theory and Applications by J K Sharma, 4th edition, Macmillan Publishers India Ltd, 2009

**Course Outcomes:**

On successful completion of this course, students will be able to:

1. apply MODI method for finding optimal transportation cost
2. apply Hungarian Method for solving assignment problems and finding an optimal route to the salesman
3. understand the process of finding optimal sequencing for processing jobs on machines
4. understand the network terminology and construction
5. apply CPM and PERT techniques for project management

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4

Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

**SDG Justification:**

Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

<table>
<tr><td rowspan="2">MATH2331</td><td rowspan="2">COMPUTATIONAL METHODS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Co- requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Engineering and Science</td></tr>
</table>

**Course Description:**

*This course is designed for Aerospace Engineering undergraduate students. It is designed for the students for the basic understanding of techniques for numerical solution of algebraic equations, differentiation, integration used to solve aerospace engineering application problems.*

**Course Educational Objectives:**

1. Develop the mathematical skills in the areas of numerical methods.
2. Focus on the theory and applications of numerical methods in many engineering subjects which require solutions of linear systems, finding eigenvalues, eigenvectors, Interpolation, and applications, solving ODEs, PDEs.
3. Help in the foundation of computational mathematics for postgraduate courses, specialized studies, and research.
4. Train in developing the codes for implementing the numerical methods using any programming languages.
5. Formulate a mathematical model for a given engineering problem

**UNIT 1 Mathematical Modeling of Engineering Problems 5 Hours**

**Approximations**: Accuracy and precision, round-off and truncation errors, error problem with example problems. **Roots of Equations:** Formulations of linear and non-linear algebraic equations, solution with bisection, Newton-Raphson and Secant methods. Application to practical problems. **Algebraic Equations**: Formulation of linear algebraic equations from engineering problems, solution of these problems by Gauss elimination method, pitfalls of elimination and techniques for improving the solutions, Gauss Seidel iteration for solving sparse equations by avoiding storage of zero coefficients in matrix, convergence of iteration methods. LU decomposition methods for symmetric (Chelosky) matrices.

**UNIT 2 Eigenvalues and Eigenvectors Problems 5 Hours**

Formulation of equations to column, truss, spring-mass and friction problems. Solutions for the largest and smallest eigenvalues and corresponding eigenvectors. **Interpolation Methods:** Polynomial interpolation, Lagrange interpolation polynomials with equi- spaced data. **Regression or Curve Fitting:** Linear regression by least squares method.

**UNIT 3** **Initial Value Problems** **6 Hours**

Ordinary differential equations, Euler, Heun's and Ralston methods. Runge- Kutta method of 2nd and 4th order, application to vibration and heat transfer problems. **Boundary Value Problems:** Linear and nonlinear ordinary differential equations, boundary value problems over semi-infinite domain, solution of nonlinear equations by finite difference method.

**UNIT 4** **6 Hours**

**Laplace Equations**: Finite difference discretization of computational domain, different types of boundary conditions, solution to elliptic equations. **Parabolic Transient Diffusion Equations:** Explicit and implicit formulation, Crank Nicolson Method.

**UNIT 5** **Numerical Integration** **6 Hours**

Trapezoidal, Simpson's 1/3 and 3/8 rule and Gauss quadrature method.

**List of Computational Exercises:**

1. Determine the real root for a given polynomial equation by (i) Bisection, (ii) Newton-Raphson until the approximate error falls below 0.5%.
2. Solve the system of simultaneous linear equations by
   i. Naïve -Gauss elimination
   ii. Gaussian elimination with partial pivoting
   iii. Gauss -Seidel method.
   iv. LU decomposition
3. Implement power method to find Eigenvalues and Eigenvectors for Spring mass system
4. Solve the parabolic partial differential equations by using explicit, implicit and semi-implicit methods
5. Solve the elliptic partial differential equations by finite difference techniques.
6. Finding the integral for a second-order polynomial using Gauss quadrature formula.
7. Solve numerical differentiation problems using Runge-Kutta $2^{nd}$ and $4^{th}$ order methods.
8. Find the integral by numerical methods such as Trapezoidal and Simpson's rule.

**Textbooks:**

1. S.P. Venkateshan, P. Swaminathan, Computational Methods in Engineering, 1/e, Ane Publisher, 2014.
2. S.C. Chapra, R.P. Canale, Numerical Methods for Engineers, 6/e, Tata McGraw-Hill, 2012.

**References:**

1. S.K. Gupta, Numerical Methods for Engineers, 1/e, New Age International, 2005

**Course Outcomes:**

At the end of the course, the student will be able to:

1. Demonstrate understanding of common numerical methods and how they are used to

obtain approximate solutions to otherwise intractable mathematical problems.
2. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
3. Analyse and evaluate the accuracy of common numerical methods.
4. Implement numerical methods using any programming language (matlab, scilab, python…)
5. Write efficient, well-documented code and present numerical results in an informative way.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4
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**SDG Justification:**
Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

<table>
<tr><td rowspan="2">MATH1061</td><td rowspan="2">Introduction to Mathematics - I</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Co- requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Engineering and Science</td></tr>
</table>

**Course Description:**

*This course is designed to introduce the mathematics required for basic physics, engineering mathematics, and introductory engineering courses.*

**Course Educational Objectives:**

- To explain the concepts of Trigonometry.
- To explain the basic concepts of differentiation and differential equations
- To teach the evaluation of definite and indefinite integrals.
- To explain the basic concepts of differential equations, multivariable and vector calculus

**UNIT 1 : Representations , Co-ordinate systems and Trigonometry 3 Hours**

Representations for Scalars, Vectors, Matrices and Tensors. Coordinate systems: cartesian and polar coordinate systems.
Trigonometry: Trigonometric functions, Periodicity, Trigonometric Ratio of Compound angles, multiple and sub multiple angles, transformations, brief introduction of inverse trigonometric, hyperbolic and inverse hyperbolic functions.

**UNIT 2 Differential Calculus 3 Hours**

**Limits and Continuity:** Definition of right hand limit, left hand limit, standard limits

(without proofs)**,** definition of continuity and simple illustrations.
**Differentiation:** Introduction, definition, differentiation of a function at a point and on an interval, derivative of a function, differentiation of sum, difference, product and quotient of functions, differentiation of algebraic, exponential, logarithmic functions, composite, implicit, parametric, hyperbolic, inverse hyperbolic functions, derivatives of first and second order.

**UNIT 3 Integration 8 Hours**

**Indefinite Integrals:** Integration as the inverse process of differentiation, standard forms, properties of integrals, integration by the method of substitution covering algebraic, trigonometric, exponential functions, integration by parts, logarithmic functions, inverse trigonometric functions.
**Definite Integrals:** Definition of a definite integral and its properties (without proof)

**UNIT 4** **Introduction to differential equations , Multivariable calculus, and Vector Calculus** **8 Hours**

Differential Equations : Order and degree of a ordinary differential equations, Formation of ordinary differential equations

Multivariable Calculus : Limits and continuity of functions of two or more variables, Partial derivates, Total derivates(without problems)

Vector Calculus : Gradient, Divergence and Curl (with simple problems), Introduction to line, surface and volume integrals (without problems) illustrated with Stokes, Gauss, and Green's theorems (Only statements).

**Textbooks:**

1. Text book for Intermediate Mathematics, Board of Intermediate Education, AP, Volumes IA, IB & IIA, 2018.
2. NCERT class XI and XII (part 1) Mathematics text books.
3. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.

**References:**

1. V. Venkateswara Rao, N. Krishna Murthy, B.V.S.Sharma, Intermediate Mathematics, S.Chand & Company Ltd., Volume I & II.
2. Chandrika Prasad, A first Course in Mathematics.
3. Text book for Intermediate Mathematics, Deepti Publications.

**Course Outcomes:**

After the completion of the course the student should be able to

- solve problems involving trigonometric functions
- understand the principles of differential calculus
- evaluate integration using various techniques
- understand the basic concepts of ordinary differential equations,
- understand the basic concepts of multivariable and vector calculus

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

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**SDG Justification:**
Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

| MATH1071 | INTRODUCTION TO MATHEMATICS - II | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 | 0 | 2 |
| Pre-requisite | NIL | | | | | | |
| Co- requisite | NIL | | | | | | |
| Preferable exposure | Engineering and Science | | | | | | |

**Course Description:**

*This course is designed to introduce the mathematics required for basic physics, engineering mathematics, and introductory engineering courses.*

**Course Educational Objectives:**

1. To describe the basic concepts of matrices
2. To introduce complex numbers and their properties.
3. To teach the techniques based on partial fractions
4. To explain the concepts of straight lines and circles
5. To impart knowledge on solid geometry.
6. To demonstrate the solution of a problem using computational

**UNIT 1 Matrices 6Hours**

Matrices, determinants, definition, types of matrices, algebra of matrices, properties of determinants of 2 X 2, 3 X 3 matrices, inverse of a matrix, solving simultaneous linear equations in two and three variables using matrix inverse method, Cramer's rule and Gauss Jordan method. Eigenvalues and Eigenvector of matrices.

**UNIT 2 Complex Numbers 6 Hours**

Complex number as an ordered pair of real numbers, representation of z (a, b) in the form (a + ib) conjugate complex numbers, modulus and amplitude of a complex number, geometrical representation of a complex number, Argand diagram.

**UNIT 3 Partial Fractions 6 Hours**

Introduction, resolving g(x) into partial fractions when g(x) contains non repeated linear factors, repeated linear factors, repeated and non-repeated irreducible quadratic factors.

**UNIT 4 Co-ordinate Geometry 6 Hours**

**Straight lines:** General equation of a straight line,line passing through the point of intersection of two given lines, angle between two intersecting lines, condition for perpendicularity and parallelism, length of the perpendicular from a point to a straight line, distance between two parallel lines (without proofs).

**Circles**: Equation of a circle, centre and radius, equation of a circle through three non collinear points, parametric equations of a circle.

**Unit V Solid Geometry 6 hours**

**Solid Geometry**: Equation of a plane, Intersection of two planes, Equation of a sphere in spherical and cartesian coordinates, Intersection of a plane and a sphere.

**Textbooks:**

1. Textbook for Intermediate Mathematics, Board of Intermediate Education, AP, Volumes IB, IIA & IIB, 2018.
2. NCERT class XI and XII (part 1 & 2) Mathematics text books.

**References:**

1. V. Venkateswara Rao, N. Krishna Murthy, B.V.S. Sharma, Intermediate Mathematics, S. Chand & Company Ltd., Volume I & II.
2. Chandrika Prasad, A first Course in Mathematics.
3. Text book for Intermediate Mathematics, Deepti Publications.

**Course Outcomes:**

After the completion of the course the student should be able to

1. describe the properties of matrices
2. describe the properties of complex numbers
3. find a fractional function and resolve it into partial fractions
4. illustrate straight-line and circle properties and describe different regions in different co-ordinate systems
5. illustrate the procedure to solve a problem using math software

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4

Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

**SDG Justification:**

Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

| MATH2361 | PROBABILITY AND STATISTICS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | **NIL** | | | | | | |
| **Co- requisite** | **NIL** | | | | | | |
| **Preferable exposure** | **Engineering and Science** | | | | | | |

**Course Description:**

*Probability theory is important when it comes to evaluating statistics. This course treats the most common discrete and continuous distributions, showing how they use in decision and estimation problems, and constructs computer algorithms for generating observations from the various distributions.*

**Course Educational Objectives:**

1. To familiarize the students with the foundations of probability and statistical methods
2. To impart concepts in probability and statistical methods in engineering applications.

**UNIT 1 Data Science and Probability 10 Hours**

**Data Science:** Statistics introduction, Population vs Sample, collection of data, primary and secondary data, types of variables: dependent and independent Categorical and Continuous variables, data visualization, Measures of central tendency, Measures of dispersion (variance).

**Probability**: Probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem (without proof).

**UNIT 2 Random Variable and Probability Distributions 8 Hours**

Random variables (discrete and continuous), probability density functions, probability distribution - Binomial, Poisson and normal distribution-their properties (mathematical expectation and variance).

**UNIT 3 Correlation, Regression and Estimation 8 Hours**

Correlation, correlation coefficient, rank correlation, regression, lines of regression, regression coefficients, principle of least squares and curve fitting (straight Line, parabola and exponential curves). **Estimation:** Parameter, statistic, sampling distribution, point estimation, properties of estimators, interval estimation.

**UNIT 4 Testing of Hypothesis and Large Sample Tests 8 Hours**

Formulation of null hypothesis, alternative hypothesis, the critical region, two types of errors, level of significance, and power of the test. Large Sample Tests: Test for single proportion, difference of proportions, test for single mean and difference of means. Confidence interval for parameters in one sample and two sample problems

**UNIT 5** **Small Sample Tests** **6 Hours**

Student t-distribution (test for single mean, two means and paired t-test), testing of equality of variances (F-test), $\chi2$ - test for goodness of fit, $\chi2$ - test for independence of attributes.

**Textbooks:**

1. Miller and Freunds, Probability and Statistics for Engineers,7/e, Pearson, 2008.
2. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.

**References:**

1. S. Ross, A First Course in Probability, Pearson Education India, 2002.
2. W. Feller, An Introduction to Probability Theory and its Applications, 1/e, Wiley, 1968.

**Course Outcomes:**

Upon successful completion of this course, the student should be able to

1. classify the concepts of data science and its importance
2. apply discrete and continuous probability distributions
3. explain the association of characteristics through correlation and regression tools
4. identify the components of a classical hypothesis test
5. infer the statistical inferential methods based on small and large sampling tests

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:** 4

Ensure inclusive and equitable quality education and promote lifelong opportunities for all.

**SDG Justification:**

Learning of various mathematical techniques will lead to knowledge of applications in Engineering problems

<table>
<tr><td rowspan="2">MECH1011</td><td rowspan="2">ENGINEERING VISUALIZATION AND PRODUCT REALIZATION</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Co- requisite</td><td colspan="7">3D Printing</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Fusion 360 Additional Modules</td></tr>
</table>

**Course Description:**

*This course introduces basic engineering drawing concepts such as projections, sectional views, and utility of drafting and modelling packages. The course imparts the knowledge of modelling and assembling of components using CAD software. The course also includes preparation of 3D models using 3D printing. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

1. To create awareness of engineering drawing as relevant to industry standards.
2. To improve visualization abilities essential for successful engineering design.
3. To impart 2D sketching and 3D modeling using the relevant software.
4. To teach assembly drawing and simulation of motion between mating components.
5. To introduce basic 3D printing software for preparing the products for printing.

**List of experiments:**

1. Manual Drawing: Introduction to Engineering graphics: Principles of Engineering Graphics and their significance, conventions in drawing lettering, BIS Conventions, Dimensioning, Sectional Views
2. Free hand sketching, Free hand sketching of isometric & orthographic views and interpretation of drawings.
3. Computer Aided Drafting, Introduction to CAD software: Basic draw and Modify commands in 2d
4. Introduction to 2D and 3D modelling using CAD packages
5. Assembly drawings, Assembly of individual 3D components, animation of motion
6. Coordinating multiple moving parts under joint constraints.
7. 3D printing, Introduction to 3D printing software, slicing.
8. Grading and rendering of simple geometries using software.

**List of Projects:**

Any one project among the following can be opted by the student and submitted:IC Engine Model (3D printed mini model)

- Belt Drive for a bike
- Four Wheel Drivable
- ATV Robot
- Toy making
- Carrom board
- Chess board and pieces model toy train,
- Avengers
- Building Bridges dams etc.,
- Wind Turbine Model etc
- Design of Radar and 3D Printing of Radar
- Models' Programmable logic Controllers –PLC
- Arduino Board Design and 3D Printing of Enclosures for Arduino Boards
- Design of mini mother boards

**Text Books:**

1. N D Bhatt, 'Engineering Drawing',53,Charotar Publishers, Gujarat India,2019,9789380358963
2. Lydia Sloan Cline,'Fusion 360 for Makers: Design Your Own Digital Models for 3D Printing and CNC Fabrication – Import, 5 June 2018 ',1,Make Comm**UNIT** y LLC,USA,2018,9781680456509

**References:**

1. Randy Shih,'Parametric Modeling with Autodesk Fusion 360 ',(Spring 2021 Edition),SDC Publications,Squibb Road Mission, KS,2021,1630574376, 9781630574376

**Online Resources:**

1. Introduction-to-parametric-modeling. 14, 2021, 1:27 p.m., https://www.ascented.com/courseware/product/autodesk-fusion-360--introduction-to-parametric-modeling
2. PP Song et al.,,'https://www.researchgate.net/publication/325189986_Research_and_Application_of_Autodesk_Fusion360_in_Industrial_Design', 2018,8

**Course Outcomes:**

1. Prepare drawings as per international standards.
2. Utilize Engineering visualization as Language of Engineers.
3. Sketch 2D models using CAD software
4. Sketch 3D models using CAD package.
5. Develop model for printing simple objects using 3D printer

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | 1 | 1 | 2 | | | | | | | 3 | 1 | 1 |
| CO2 | 3 | 3 | | 2 | 1 | 3 | 1 | | 2 | 1 | 1 | | 2 | 2 | 1 |
| CO3 | 2 | 3 | | 3 | 1 | 2 | | | 2 | 1 | 2 | | 3 | 2 | 1 |
| CO4 | 2 | 3 | | 3 | 1 | 3 | | | | | | | 3 | 2 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | | 2 | | 3 | 3 | 1 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**
**SDG 4** - ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.
**SDG-9** engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation***.***
**SDG Justification:**
**SDG 4**-The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.
**SDG 9**-The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| MECH1041 | TECHNOLOGY EXPLORATION & PRODUCT ENGINEERING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 0 | 0 | 2 |
| **Pre-requisite** | None | | | | | | |
| **Co-Requisite** | Engineering Visualization and Product Realization | | | | | | |
| **Preferable Exposure** | Power tools and Basic Electronics | | | | | | |

**Course Description:**

*This is a fundamental engineering course that introduces the incoming students to hands-on product development experience using a combination of Mechanical Engineering and IoT concepts, programming with application of EVPR concepts and exposure to project planning.*

**Course Educational Objectives:**

- Inculcate creativity, critical thinking and problem-solving skills with hands-on approach to all incoming freshmen.
- Emphasise product development using systems engineering approach.
- Impart multidisciplinary project-based skills with a combination of IoT, Programming, Simulation, Mechanisms and Machining.
- Involve Ideation to develop a variety of solutions to a problem statement rather than performing a standard job/experiment.
- Project planning and management to deliver the assigned project within the timeline.

SYLLABUS

- Manufacturing economics
- Evaluation of manufacturing strategies
- OBHS (Operational Behaviour, health, safety in hazardous environment)
- Power tools operations and safety – Angle grinder (Cutting, Grinding and Polishing), Driller and Jigsaw.
- Basics of Microprocessors and Microcontrollers
- General Introduction to Arduino, Node MCU, and Raspberry Pi.
- Basics of Electronics: General Introduction to the usage of Breadboard, Digital Multimeter, General Connections, Usage of Resistors, Capacitors, LEDs.
- Basics of Arduino & Node MCU coding – Libraries, board & port selection, baud rate, Basics of Troubleshooting, Cloud Interfacing etc.
- Usage and Applications of Basic Sensors: Ultrasonic, Voltage/Current, Temp/Humidity, Gas, IR
- Basics of Electromagnetism – Permanent Magnet DC Motor (PMDC), Brushless DC Motor (BLDC), Stepper and Servo Motors.
- Basics of Drawing/Circuit Simulation - Line diagram, Tinker CAD, Multisim, PROTEUS

- Basics of Mechanisms - Linear motion, Cam mechanism, Belt drive, gears
- Demonstration of Carpentry, Tin smithy, Fitting, Welding and Injection Moulding.
- Problem identification and understanding the needs of the users
- Project management and planning.

**Project**: All students must work in teams to complete a product/prototype of a given problem statement with the topics covered in the class.

**Textbooks:**

1. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, Internet of Things, Wiley India, 2019
2. Simon Monk, Programming Arduino: Getting Started with Sketches, Mc Graw Hill Publications, 2011

**References:**

1. Essaid, a. (2019). 507 Mechanical Movements: Mechanisms and How They Work (Dover Science Books). (n.p.): Independently Published.

**Course Outcomes**

At the end of the course, the student will be able to:

1. Perform basic mechanical operations with power tools.
2. Understand and apply IoT concepts to drive mechanical components.
3. Apply multidisciplinary skills to solve practical engineering problems.
4. Conceptualize and work towards the creation of physical products.
5. Think along the lines of innovation and entrepreneurship.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | 1 | | | 3 | 2 | 1 | 1 |
| **CO2** | 3 | 3 | 3 | | 1 | | | | | | | 2 | 1 | 1 | 1 |
| **CO3** | 2 | 3 | 3 | 1 | 1 | 1 | | | 3 | 2 | 3 | 1 | 2 | 1 | 1 |
| **CO4** | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | | 2 | 1 | 1 |
| **CO5** | | | | | | | | | | | | | 2 | 1 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 21-04-2023** **ACADEMIC COUNCIL: 19-06-2023**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH1001</td><td rowspan="2">DESIGN THINKING</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Co- requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Nil</td></tr>
</table>

**Course Pre-requisite(s): Engineering Visualization and Product Realization**

**Course Description:**

*Design is a realization of a concept or idea into a configuration, drawing or product. Design Thinking is the cognitive and practical process by which design concepts are developed by designers. Innovation is a new idea or a new concept. Product development is the creation of a new or different product that offers new benefits to the end-user. This course introduces design thinking in product innovation.*

**Course Educational Objectives:**

1. To familiarize the product design process
2. To introduce the basics of design thinking
3. To bring awareness on idea generation
4. To familiarize the role of design thinking in services design

| **Topic** | **Type** |
|---|---|
| Each member of the group has to ask (vocally) the group members different questions about a product that they would like to design. Write down the questions and answers and submit as a word or pdf document. | Exercise |
| Each member of the group must ask (vocally) the group members questions about the product chosen in the previous experiment. This helps to gain indepth insights as well as new findings and information in order to grasp the problem or situation holistically or simply to find relevant questions for an interview. Write down the questions and answers and submit as a word or pdf document | Exercise |
| Identify relevant factors of influence that constitute the basis for a new or improved product or offer; then analyze it in a targeted manner.<br>➢ Make sure that you are sufficiently creative in the analysis process, because the focus is on technical "details".<br>➢ Boost the efficiency of the analysis process by avoiding empty runs.<br>➢ Make use of a standardized procedure in order to examine the problem and solution space again with the help of data. | Exercise |
| ➢ Do research, talk with people, and have empathy to formulate profound stories.<br>➢ Summarize the results from the "understand" and "observe" phases and discuss with the team.<br>➢ Highlight unexpected results and generate new perspectives. | Exercise |

| | |
|---|---|
| ➢ In general, share insights, ideas, and results (solutions) with others.<br>➢ Explore untapped market opportunities.<br>➢ Provide differentiated and new offers based on the user needs.<br>➢ Adapt a strategy to new market needs by understanding the competitive edge.<br>➢ Establish the right vision for the design challenge or a road map for stepby-step implementation and control mechanisms. | Exercise |
| ➢ Find out at an early stage whether the basic need is satisfied and the product attracts interest on the market.<br>➢ Find out through iterative testing whether the user need is met with a minimally functional product and how the product should be enhanced.<br>➢ Find out through user feedback how much demand there is for the product before developing further details and features.<br>➢ Minimize the risk of investing in a solution for which there is little demand on the market, thus saving time, money, and energy. | Exercise |
| ➢ Perform a true A/B test or several variants of a prototype in the form of a multi-variants test or as split testing.<br>➢ Do a quantitative evaluation.<br>➢ Carry out a qualitative survey and evaluate the number and content of feedbacks.<br>➢ Compare individual variants of a function or a prototype (e.g. buttons, visuals, arrangement). | Exercise |
| ➢ Collect and appraise experiences made in the project in a structured manner.<br>➢ Learn from experience and make use of it in the next project.<br>➢ Facilitate a positive attitude toward mistakes and appreciate progress.<br>➢ Identify and document the findings; make them applicable and usable. | Exercise |
| Case Studies: Example : Software Prototyping, Additive Manufacturing; Design of Arduino Boards for various applications etc | Exercise |

**Text Books:**

1. Pahl, Beitz, Feldhusen, Grote,'Engineering Design: a systematic approach',3rd,Springer Science & Business Media,London,2007,978-1846283185
2. Christoph Meinel,Larry Leifer,Hasso Plattner,'Design Thinking Understand – Improve – Apply',1st,Springer,Berlin, Heidelberg,2011,978-3-642-13756-3

**References:**

1. Marc Stickdorn, Jakob Schneider,'This is Service Design Thinking: Basics, Tools, Cases',1st,WILEY,United States,2012,978-1-118-15630-8

**Course Outcomes:**

1. Innovate new methods in product development
2. 2 Apply Design Thinking in developing the new designs

3. Select ideas from ideation methods in new product development
4. Use Design Thinking in developing software products
5. Apply principles of Design Thinking in service design

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | 1 | 1 | 2 | | | | | | | 3 | 1 | 1 |
| CO2 | 3 | 3 | | 2 | 1 | 3 | 1 | | 2 | 1 | 1 | | 2 | 2 | 1 |
| CO3 | 2 | 3 | | 3 | 1 | 2 | | | 2 | 1 | 2 | | 3 | 2 | 1 |
| CO4 | 2 | 3 | | 3 | 1 | 3 | | | | | | | 3 | 2 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | | 2 | | 3 | 3 | 1 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS: 29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**
***SDG 9***
The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.
**SDG Justification:**
The course involves design aspects

<table>
<tr><td rowspan="2">PHYS1001</td><td rowspan="2">PHYSICS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>2</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Co- requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">NIL</td></tr>
</table>

**Course Description:**

*This course is designed with fundamentals of electromagnetism and properties of materials for advanced courses in their respective engineering branches. It introduces electromagnetic theory with relevant mathematical tools, optical fibres and their propagation characteristics, properties of dielectric and magnetic materials. It also introduces principles of semiconductors and some widely used semiconductor devices for various applications.*

**Course Educational Objectives:**

1. To introduce mathematical principles to estimate forces, fields and waves.
2. To familiarize students with electromagnetics in modern communication systems.
3. To impart knowledge concerning the electrical behaviour of dielectric materials.
4. To demonstrate the properties of magnets.
5. To introduce semiconductor physics and devices.

**UNIT 1 Basics of Electromagnetics 9 Hours**

Electrostatic field: Coulomb’s law and Gauss ‘law, derivation of Coulombs law from Gauss’ law, applications of Gauss’ law (line charge, thin sheet of charge and solid charged sphere), Gauss’ law of electrostatics in dielectric medium, divergence and curl of electric fields, electric potential, relation between potential and force, Poisson’s and Laplace equations. Magnetostatic field: Biot–Savarts’ law, divergence and curl of magnetic fields, Faraday’s and Ampere’s laws in integral and differential form, displacement current, continuity equation, Maxwell’s equations.

**UNIT 2 Fiber Optics 7 Hours**

Introduction, advantages of optical fibers, principle and structure, acceptance angle, numerical aperture, modes of propagation, classification of fibers, fiber optic communication, importance of V-number, fiber optic sensors (Temperature, displacement and force), applications.

**UNIT 3 Dielectric, Magnetic and superconducting Materials 10 Hours**

Dielectric materials: Introduction, electric polarization, dielectric polarizability, susceptibility and dielectric constant, types of polarizations (qualitative treatment only). Magnetic materials: Introduction, magnetic dipole moment, magnetization, magnetic susceptibility and permeability, origin of permanent magnetic moment, classification of magnetic materials, Weiss theory of ferromagnetism (qualitative), domain theory, hysteresis, soft and hard magnetic materials.

Superconductivity: definition –Meissner effect –type I & II superconductors –BCS theory (qualitative) –high temperature superconductors –Josephson effects applications.

**UNIT 4** **Semiconductor Physics** **8 Hours**

Introduction, origin of energy band, intrinsic and extrinsic semiconductors, mechanism of conduction in intrinsic semiconductors, generation and recombination, carrier concentration in intrinsic semiconductors, variation of intrinsic carrier concentration with temperature, n-type and p-type semiconductors, carrier concentration in n-type and p- type semiconductors, Drift and diffusion currents in semiconductors.

**UNIT 5** **Semiconductor Devices** **8 Hours**

Zener Diode, Tunnel diode, Hall effect and its applications, magnetoresistance, p-n junction layer formation and V-I characteristics, direct and indirect band gap semiconductors, construction and working of photodiode, LED, solar cell.

**PHYSICS LABORATORY**

**List of Experiments**

1. To determine the magnetic field along the axis of a circular coil carrying current.
2. To determine the numerical aperture of a given optical fiber and hence to find its acceptance angle
3. To determine magnetic susceptibility by Quincke's tube method
4. To determine the Hall coefficient using Hall effect experiment
5. To determine the resistivity of semiconductor by Four probe method
6. To determine the energy gap of a semiconductor.
7. To study the characteristics of PN Junction diode.
8. To study magnetic hysteresis loop (B-H curve).
9. To determine the dielectric constant of a substance by resonance method.
10. To determine hysteresis loss by CRO.
11. To study the characteristics of Photodiode
12. To study the characteristics of Solar Cell
13. To study the characteristics of Zener diode
14. To study the resonance of LCR circuit

**Text Books:**

1. David J.Griffiths, "Introduction to Electrodynamics", 4/e, Pearson Education, 2014.
2. Charles Kittel, "Introduction to Solid State Physics", Wiley Publications, 2011.
3. M. N. Avadhanulu, P.G. Kshirsagar, "A Text book of Engineering Physics", 11/e, S. Chand Publications, 2019.

**References:**

1. Principles of Physics, 10ed, ISV, Jearl Walker, David Halliday, Robert Resnick, Wiley India.
2. Gerd Keiser, "Optical Fiber Communications", 4/e, Tata Mc Graw Hill, 2008.
3. S.O.Pillai, "Solid StatePhysics", 8/e, New Age International, 2018.

4. S.M. Sze, “Semiconductor Devices-Physics and Technology” , Wiley, 2008.

**Journal(s):**

1. https://aapt.scitation.org/doi/abs/10.1119/1.3317450
2. https://aapt.scitation.org/doi/full/10.1119/1.5144798
3. https://aapt.scitation.org/doi/abs/10.1119/1.1511591

**Course Outcomes:**

1. Apply mathematical principles to estimate magnetic and electric forces, fields and waves
2. Use the principles of EM waves and Maxwell equations to understand communication systems
3. Apply basic properties of dielectric, magnetic and superconducting materials in electromagnetics
4. Understand physics of semiconducting materials
5. Use working principles of semiconducting devices in electronic circuits

**Text Book:**

1. S. Balasubramanian, M.N. Srinivasan “A Text book of Practical Physics”- S Chand Publishers,2017

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | | | | | | | 1 | | | 1 | 1 | | |
| CO2 | 1 | 1 | | | | | | | 1 | | | 1 | 1 | | |
| CO3 | 1 | 1 | | | | | | | 1 | | | 1 | 1 | | |
| CO4 | 1 | 1 | | | | | | | 1 | | | 1 | 1 | | |
| CO5 | 1 | 1 | | | | | | | 1 | | | 1 | 1 | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

| PHYS1011 | MECHANICS AND PROPERTIES OF MATTER | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 0 | 0 | 4 |
| **Pre-requisite** | **NIL** | | | | | | |
| **Co- requisite** | **NIL** | | | | | | |
| **Preferable exposure** | **NIL** | | | | | | |

**Course Description:**

*This course is designed for students of Aerospace, Civil and Mechanical Engineering. It introduces fundamentals of elasticity and thermal properties – the essentials for understanding the behaviour of materials. Mechanics of solids is taught to acquaint them with the behaviour of rigid objects. An introduction to sensors will be useful for all the branches as an application of modern technology.*

**Course Educational Objectives:**

1. To acquaint the basic concepts of sound waves and principles in acoustic design.
2. To introduce the concepts of elasticity, strain hardening and failure in materials and impart the relation between stress and strain.
3. To impart the phenomenon of heat transfer so as to understand a wide variety of practical engineering problems.
4. To demonstrate the use of Newton's laws of motion for understanding the mechanics of a particle.
5. To explain the working principle and construction of different types of sensors.

**UNIT 1 Mechanics 10 Hours**

Basic laws of vectors and scalars; Rotational frames; Conservative and non-conservative forces; F = - grad V; Central forces; Elliptical, parabolic and hyperbolic orbits; Noninertial frames of reference; Centripetal acceleration; Harmonic oscillator; Damped harmonic motion; Forced oscillations and resonance. Degrees of freedom.

**UNIT 2 Elasticity 8 Hours**

Concepts of elasticity and plasticity, stress and strain, Hooke's law, different moduli of elasticity, Poisson's ratio, strain energy, stress-strain diagram, elastic behavior of a material, factors affecting elasticity, relation between different moduli of elasticity, determination of elastic moduli.

**UNIT 3 Thermal Properties 10 Hours**

Transfer of heat energy; Thermal expansion of solids and liquids; Expansion joints - bimetallic strips; Thermal conduction, convection and radiation and their fundamental laws; Heat conductions in solids; Thermal conductivity - Forbe's and Lee's disc method: theory and experiment; Applications (qualitative only): heat exchangers, refrigerators, ovens and solar water heaters.

**UNIT 4 Acoustics 8 Hours**

Characteristics of sound waves; Weber-Fechner Law; Absorption coefficient, determination of absorption coefficient; Reverberation time; Sabine's formula, derivation of Sabine's formula using growth and decay method; Intensity of sound; Acoustics of buildings, Acoustic requirements of a good auditorium.

**UNIT 5 Sensors 9 Hours**

Sensors (qualitative description only); Different types of sensors and applications; Strain and pressure sensors- Piezoelectric, magnetostrictive sensors; Fibre optic methods of pressure sensing; Temperature sensor - bimetallic strip, pyroelectric detectors; Hall-effect sensor; Smoke and fire detectors.

**Text Books:**

1. D.Kleppner and Robert Kolenkow"An Introduction to Mechanics- II" Cambridge University Press,2015.
2. M.N. Avadhanulu & T.V.S. Arun Murthy, S Chand A Textbook of Engineering Physics, Volume-I 2018.
3. Ian R Sinclair, Sensor and Transducers 3/e,Elsevier (Newnes), 2001.

**References:**

1. M K Varma, "Introduction to Mechanics"-Universities Press, 2015
2. Prithwiraj Purkait, Budhaditya Biswas and Chiranjib Koley, Chapter 11 Sensors and Transducers, Electrical and Electronics Measurements and Instrumentation, 1/e., McGraw Hill Education (India) Private Limited, 2013.

**Course Outcomes:**

After completion of this course, the student will be able to

1. describe the fundamental principles of acoustics with emphasis on physical mechanisms, law and relationships
2. apply the concepts of strain, internal force, stress and equilibrium to deformation of solids
3. explain the fundamental theory for the analysis of heat transfer processess in solids and liquids and to apply basic principles of heat transfer in design of refrigerators and heaters
4. estimate forces and moments in mechanical systems using scalar and vector techniques
5. outline the basic principle and operation of different types of sensors

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | | | | | | | 1 | | | 1 | | 1 | 1 | |
| CO2 | 1 | 1 | | | | | | 1 | | | 1 | | 1 | 1 | |
| CO3 | 1 | 1 | | | | | | 1 | | | 1 | | 1 | 1 | |
| CO4 | 1 | 1 | | | | | | 1 | | | 1 | | 1 | 1 | |
| CO5 | 1 | | | | | 1 | | 1 | | | 1 | | 1 | 1 | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

<table>
<tr><td rowspan="2">PHYS1021</td><td rowspan="2">PRINCIPLES OF QUANTUM MECHANICS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Co- requisite</td><td colspan="7">NIL</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">NIL</td></tr>
</table>

**Course Description:**

*This course is designed with principles of Quantum mechanics for advanced courses in their respective engineering branches. It introduces Quantum mechanics with relevant mathematical tools and provides a basis for further study of quantum mechanics. It also introduces basics of Qubits for Quantum computing applications.*

**Course Educational Objectives:**

1. To introduce the basic principles of quantum mechanics.
2. To introduce wave equation and significance of wave function.
3. To teach solving the Schrödinger's equation for spinless particles moving in one-dimensional potential.
4. To develop an understanding of concepts of angular momentum.
5. To introduce Dirac bra-ket formalism and the concept of QUBITs.

**UNIT 1 Introduction to Quantum Physics 10 Hours**

Introduction, Classical Mechanics vs Quantum Mechanics, Planck's quantum theory (qualitative), Photo-electric effect. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them, Wave-particle duality, Heisenberg uncertainty principle: ground state energy of hydrogen atom.

**UNIT 2 Properties of Matter Waves 8 Hours**

Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities, and normalization.

**UNIT 3 Quantum Tunneling 8 Hours**

One dimensional infinitely rigid box-energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical tunnelling in one dimensional rectangular potential barrier, 1D linear harmonic oscillator (no derivation required, only eigen function, eigen values and zero-point energy).

**UNIT 4 Quantum Properties of Electrons 9 Hours**

Electron angular momentum, angular momentum operator, Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect, Stark Effect, Gyromagnetic Ratio and Bohr

Magneton (qualitative)

**UNIT 5** **Qubits for Quantum Computing** **10 Hours**

Introduction to Dirac Bra-Ket notation, Introduction to Pauli spin matrices, Quantum Superposition, Interference, Quantum Measurement, Decoherence, Entanglement, Bloch sphere, Qubits, and multiple qubits, Qubits Vs classical bits, representation of a qubit probability.

**Textbooks:**

1. Quantum Mechanics, G. Aruldhas, 2ndEdn. 2002, PHI Learning of India.
2. Quantum Mechanics, Satya Prakash, 2016, Pragati Prakashan.
3. Quantum Computing for Everyone, Chris Bernhardt, 2019, The MIT Press,

**References:**

1. Introduction to Quantum Mechanics, D.J. Griffith, 2ndEd. 2005, Pearson Education.
2. Quantum Computing: An Applied Approach, Jack D. Hidary, 2019,

**Journal(s):**

1. https://aapt.scitation.org/doi/full/10.1119/1.4897588
2. https://aapt.scitation.org/doi/full/10.1119/1.3639154

**Websites**

1. https://www.intechopen.com/online-first/73811
2. https://www.quantum-inspire.com/kbase/what-is-a-qubit/

**Course Outcomes:**

At the end of this course, the students will be able to:

1. Explain the basic principles of quantum mechanics.
2. Interpret wave equation and significance of wave function.
3. Solve the Schrödinger's equation for spinless particles moving in one-dimensional potential.
4. Understand of concepts of angular momentum and spin.
5. Apply Dirac bra-ket formalism to the concept of QUBITs.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | | | | | | | 1 | | | 2 | 1 | | |
| CO2 | 1 | 1 | | | | | | | 1 | | | 2 | 1 | | |
| CO3 | 1 | 1 | | | | | | | 1 | | | 2 | 1 | | |
| CO4 | 1 | 1 | | | | | | | 1 | | | 2 | 1 | | |
| CO5 | 2 | 2 | | | | | | | 2 | | | 2 | 2 | 1 | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

| PHYS1241 | PHYSICS OF OPTOELECTRONIC DEVICES | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 0 | 0 | 4 |
| Pre-requisite | NIL | | | | | | |
| Co- requisite | NIL | | | | | | |
| Preferable exposure | NIL | | | | | | |

**Course Description:**

*This course is designed with fundamentals of electromagnetism and properties of materials for advanced courses in their respective engineering branches. It introduces electromagnetic theory with relevant mathematical tools, optical fibres and their propagation characteristics, properties of dielectric and magnetic materials. It also introduces principles of semiconductors, and some widely used semiconductor devices for various applications.*

**Course Educational Objectives:**

1. To introduce nature light and its properties.
2. To familiarize students with different semiconductors and its energy band gaps.
3. To introduce semiconductor physics and devices.
4. To impart knowledge about the semiconducting optical devices.
5. To demonstrate the properties of different semiconducting optical devices.

**UNIT 1 Elements of light 8 Hours**

Nature of light, Light sources, Black body, Colour temperature, Units of light, Radio metric and photometric units, Light propagation in media and waveguides, Electro-optic effects. Overview of luminescence: Photoluminescence, Cathodoluminescence, Electroluminescence, Injection-luminescence.

**UNIT 2 Semiconductor Materials 10 Hours**

Free electron theory of metals, Density of states in 1D, 2D, and 3D, Bloch's theorem for particles in a periodic potential, Energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect bandgaps, Types of electronic materials: metals, semiconductors, and insulators, Occupation probability, Fermi level, Effective mass.

**UNIT 3 Principles of Lasers 10 Hours**

Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission; Einstein coefficients, Population inversion, Transition rates (Fermi's golden rule), Optical loss and gain; semiconducting diode laser, applications of semiconductor Lasers.

**UNIT 4 Solar cells and Photovoltaic devices 9 Hours**

Charge carrier generation and recombination, p-n junction model and depletion capacitance, Photovoltaic effect, Physics of Solar Cells, Principle of solar energy conversion,

Conversion efficiency, Type of solar cells in use: Dye Sensitized Solar Cells, Thin film solar cells, Perovskite Solar cell.

**UNIT 5 Semiconductor devices 8 Hours**

Radiative recombination devices: Light-emitting diodes (LED), Organic Light Emitting Diodes (OLED) and its types, Photoelectric devices: Photodiodes. Photo conducting devices: Photodetectors and photoconductors, Photoresistors, Photo transistors.

**Textbooks:**


1. Jasprit Singh, Optoelectronics – An Introduction to materials and devices; McGraw Hill,1996.
2. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition 2019
3. Maurice Quillec, Materials for Optoelectronics; Springer Science, 1996.
4. S. C. Gupta, Optoelectronic Devices and Systems; Prentice Hall India, 2005.
5. P. Bhattacharya, Semiconductor optoelectronic devices; Prentice Hall India, 2006.


**References:**


1. Pyshkin, Ballato, Optoelectronics - Advanced Materials and Devices; InTech, 2013.
2. Manijeh Razeghi, Optoelectronic materials and device concepts; SPIE, 1991
3. Sun and Dalton, Introduction to Organic Electronic and Optoelectronic Materials and Devices; CRC Press, 2008.
4. J. Palais, Introduction to optical electronics; Prentice Hall, 1988.
5. Jasprit Singh, Semiconductor optoelectronics; McGraw-Hill, 1995.


**Course Outcomes:**

After completion of this unit, the student will be able to

1. Outline the properties of semiconductors
2. explain the occupation probability and Fermi level variation in different electronic materials
3. Know about the interaction of light with materials and its optical properties
4. Explain the conduction mechanism in semiconducting and optical devices.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | | | | | | | 1 | | | 1 | 1 | | |
| CO2 | 2 | 1 | | | | | | | 1 | | | 2 | 1 | | |
| CO3 | 1 | 1 | | | | | | | 1 | | | 2 | 1 | | |
| CO4 | 2 | 1 | | | | | 1 | | 1 | | | 2 | 1 | | 1 |
| CO5 | 2 | 1 | | | | | 1 | | 1 | | | 2 | 1 | | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

| PHYS1041 | MECHANICS AND MODERN PHYSICS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|

| | | 3 | 1 | 0 | 0 | 0 | 4 |
|---|---|---|---|---|---|---|---|
| **Pre-requisite** | **NIL** | | | | | | |
| **Co- requisite** | **NIL** | | | | | | |
| **Preferable exposure** | **NIL** | | | | | | |

**Course Description:**

*This course designed for students of Biotechnology to impart principles of Newtonian mechanics will help the students in understanding the oscillatory behavior of materials. It also introduces fundamentals of quantum mechanics – the essentials for understanding the behavior of properties of materials. Fundamentals of optics and electromagnetism in understanding the use in spectroscopy. An introduction to sensors will be useful for all the branches as an application of modern technology.*

**Course Educational Objectives:**

1. To impart knowledge on damped and forced oscillations.
2. To familiarize students with the concepts of quantum mechanics
3. To impart knowledge concerning the wave properties of electromagnetic waves
4. To familiarize the students about the Maxwell's equations and its propagation
5. To outline the principles and working of few common sensing devices

**UNIT 1 Fundamentals of Dynamics and Oscillations 10 Hours**

Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations.
Galilean invariance. Review of Newton's Laws of Motion.
Oscillations: SHM, Simple Harmonic Oscillations. Differential equation of SHM and its solution. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor

**UNIT 2 Modern Physics (Quantum Physics) 8 Hours**

Introduction, matter waves and its properties, Davisson-Germer experiment, GP Thomson experiment, Heisenberg's uncertainty principle, Schrodinger's time independent wave equation, physical significance of wave function, particle in a one-dimensional infinite well, rectangular potential barrier (transmission coefficient), band theory of solids (qualitative), distinction between metals, insulators and semiconductors, introduction to Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstien statistics.

**UNIT 3 Optics 10 Hours**

Interference: Introduction, interference in thin films due to reflected light: interference in parallel-sided film and wedge-shaped film, Newton's rings. Diffraction: Introduction; Fraunhofer diffraction at single slit (qualitative only), diffraction due to N-slits (diffraction grating) (qualitative only), determination of wavelength of light with a plane transmission grating.

Polarisation: Introduction; Double refraction –double refraction in calcite crystal, negative and positive crystals, Nicol's prism, Retarders (quarter and half¬wave plates).

**UNIT 4 Maxwell`s equations and Electromagnetic wave propagation 8 Hours**

Maxwell's equations (both differential and integral forms) and its physical significance, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization of EM waves.

**UNIT 5 Sensors 9 Hours**

Sensors (qualitative description only); Different types of sensors and applications; Strain and pressure sensors -Piezoelectric, magnetostrictive sensors, ultrasonic sensors; Fibre optic methods of pressure sensing; Temperature sensor -bimetallic strip, pyroelectric detectors; Hall-effect sensor; Smoke and fire detectors

**Textbooks:**

1. Mechanics, D.S. Mathur, S.Chand and Company Limited, 2000.
2. A Text Book of Optics, 25/e, Brij Lal, M N Avadhanulu & N Subrahmanyam, 2012, S. Chand Publishing.
3. Ian R Sinclair, Sensor and Transducers 3rd eds, 2001, Elsevier (Newnes)
4. David J. Griffiths, "Introduction to Electrodynamics"-4/e, Pearson Education,2014
5. M.N. Avadhanulu, P.G. Kshirsagar, A Textbook of Engineering Physics, S.Chand, 2014.

**References:**

1. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
2. Prithwiraj Purkait, Budhaditya Biswas and Chiranjib Koley, Chapter 11 Sensors and Transducers, Electrical and Electronics Measurements and Instrumentation, 1st eds., 2013 McGraw Hill Education (India) Private Limited.
3. Elements of Properties of Matter, D. S. Mathur, S. Chand Publishing

**Journal(s):**

1. https://aapt.scitation.org/doi/abs/10.1119/1.3317450
2. https://aapt.scitation.org/doi/full/10.1119/1.3639154

**Course Outcomes:**

At the end of this course, the students will be able to:

1. Understand the concept of damped and forced oscillations.
2. Understand concepts of quantum mechanics
3. Understand interference, diffraction and polarization of light waves
4. Know about the maxwell's equations and its propagation
5. Use principles and working of few common sensing devices

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 1 | | | | 1 | 1 | | | | |
| CO2 | | | | | | 1 | | | | 1 | 1 | | | | |
| CO3 | | | | | | 1 | | | | 1 | 1 | | | | |
| CO4 | | | | | | 1 | | | | 1 | 1 | | | | |
| CO5 | | | | | | 1 | | | | 1 | 1 | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

| PROJ2999 | CAPSTONE PROJECT – INTRODUCTION | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 0 | 2 | 2 |
| **Pre-requisite** | **NIL** | | | | | | |
| **Co- requisite** | **NIL** | | | | | | |
| **Preferable exposure** | **NIL** | | | | | | |

**Course Educational Objectives:**

1. To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

**Course Logistics**

Capstone Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.

1. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
2. Can be individual work or a group project, with a maximum of 3 students.
3. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.
4. Carried out inside or outside the university, in any relevant industry or research institution.
5. Publications in the peer reviewed journals / International Conferences will be an added advantage

**Mode of Evaluation:** Periodic reviews, Presentation, Final oral viva, Poster submission

**Course Outcomes:**

At the end of the course the student will be able to

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing
5. Synthesis the results and arrive at scientific conclusions / products / solution
6. Document the results in the form of technical report / presentation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

<table>
<tr><td rowspan="2">PROJ3999</td><td rowspan="2">CAPSTONE PROJECT – FINAL</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>6</td><td>6</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">PROJ2999</td></tr>
<tr><td>Co- requisite</td><td colspan="7"></td></tr>
<tr><td>Preferable exposure</td><td colspan="7"></td></tr>
</table>

**Course Educational Objectives:**

1. To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

**Course Logistics:**
Capstone Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.

1. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
2. Can be individual work or a group project, with a maximum of 3 students.
3. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.
4. Carried out inside or outside the university, in any relevant industry or research institution.
5. Publications in the peer reviewed journals / International Conferences will be an added advantage

**Mode of Evaluation:** Periodic reviews, Presentation, Final oral viva, Poster submission

**Course Outcomes:**

At the end of the course the student will be able to
1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing
5. Synthesis the results and arrive at scientific conclusions / products / solution
6. Document the results in the form of technical report / presentation

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

| PROJ2888 | PROJECT EXHIBITION 1 | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 0 | 1 | 1 |
| **Pre-requisite** | | | | | | | |
| **Co- requisite** | | | | | | | |
| **Preferable exposure** | | | | | | | |

**Course Educational Objectives:**

To provide platform for the student to exhibit their project work to

1. Excite interested students in continuing/initiating in the work of interest
2. Attract startups/industry to commercialize the project work
3. acquire comments on improving the quality of the work from other students/academicians/industry

**Mode of Evaluation:** Poster submission, Viva-Voce Examination

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

| PROJ3888 | PROJECT EXHIBITION 2 | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 0 | 1 | 1 |
| **Pre-requisite** | PROJ2888 | | | | | | |
| **Co- requisite** | | | | | | | |
| **Preferable exposure** | | | | | | | |

**Course Educational Objectives:**

To provide platform for the student to exhibit their project work to

- Excite interested students in continuing/initiating in the work of interest
- Attract startups/industry to commercialize the project work
- acquire comments on improving the quality of the work from other students/academicians/industry

**Mode of Evaluation:** Poster submission, Viva-Voce Examination

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

<table>
<tr><td rowspan="2">VIVA3555</td><td rowspan="2">COMPREHENSIVE EXAMINATION</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Completion of minimum of six semesters</td></tr>
<tr><td>Co- requisite</td><td colspan="7"></td></tr>
<tr><td>Preferable exposure</td><td colspan="7"></td></tr>
</table>

**Course Educational Objectives:**

1. Designed to test the students on the Aerospace Engineering concepts, and tools, and the process of identifying and solving engineering problems.

**UNIT 1 Engineering Mechanics**

Free-body diagrams and equilibrium; friction and its applications including rolling friction, belt-pulley, brakes, clutches, screw jack, wedge, vehicles, etc.; trusses and frames; virtual work; kinematics and dynamics of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations; Lagrange's equation.

**UNIT 2 Mechanics of Materials**

Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; concept of shear centre; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength

**UNIT 3 Thermodynamics**

Thermodynamic systems and processes; properties of pure substances, behaviour of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations

**UNIT 4 Fluid Mechanics**

Fluid properties; fluid statics, forces on submerged bodies, stability of floating bodies; control volume analysis of mass, momentum, and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings; basics of compressible fluid flow.

**UNIT 5 Machining and Machine Tool Operations**

Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, jigs and fixtures; abrasive machining processes; NC/CNC machines and CNC programming

**Mode of Evaluation:** 12 Quizzes with Multiple Choice Questions. Best 10 quizzes are considered for computing 100M. Student shall score atleast 80% in atleast 8 quizzes to be considered for grading

**Course Outcomes:**

The students will be able to

1. Apply knowledge of mathematics, science, and engineering
2. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health care and safety, manufacturability, and sustainability

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

| BTEN1001 | INTRODUCTION TO BIOTECHNOLOGY-I | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 | 0 | 2 |
| **Pre-requisite** | Nil | | | | | | |
| **Co- requisite** | Nil | | | | | | |
| **Preferable exposure** | Nil | | | | | | |

**Course Description:**

This course introduces the student to the basics of biology such as classification, cell structure, biomolecular structure, metabolism, function

**Course Educational Objectives:**

- Introduce the cellular basis of life.
- Provide the basis for classification of living organisms.
- Describe the important biomolecules
- Describe the applications of biomaterials
- Describe the different metabolic pathways

**UNIT 1** **6 hours**

Introduction to Biology, Cellular basis of life, differences between prokaryotes and eukaryotes. Classification based on carbon and energy sources, Tools of molecular taxonomy

**UNIT 2** **8 hours**

Biomolecules, structure and functions of proteins, nucleic acids, lipids and sugars. Structure and function of hemoglobin, antibodies and enzymes. Industrial applications of enzymes

**UNIT 3** **10 hours**

Bioenergetics, Respiration: Glycolysis and TCA cycle, Electron transport chain and oxidative phosphorylation. Anaerobic respiration and Fermentation and its industrial applications Mechanism of photosynthesis, Light and dark reactions

**UNIT 4** **12 hours**

Genetics: Mendel's laws of inheritance. Gene interactions- Epistasis, Incomplete & Codominance, Multiple alleles, Additive, complementation, Pleiotropism. Linkage, Crossing over. Gene mapping. Cell cycle and regulation. Mitosis and Meiosis

**UNIT 5** **14 hours**

Human physiology – Membrane transport- Active and passive. Cell signaling and communication. Neurons – structure, function and types. Synapse-types, neurotransmitters, transmission of nerve impulse. Neuromuscular junctions. Muscle- structure, function and types.

**Textbooks:**

1. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, “Biology: A global approach”, Pearson Education Ltd, 2018.
2. Arthur T Johnson, Biology for Engineers, CRC press, 2011

**References**

1. Alberts et. al. The molecular biology of the cell, 6/e, Garland Science, 2014
2. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, “Outlines of Biochemistry”, John Wiley and Sons, 2009.
3. John Enderle and Joseph Bronzino Introduction to Biomedical Engineering, 3/e, 2012.

**Course Outcomes:**

After the completion of the course the student should be able to

1. Explain classification of living organisms.
2. Explain cell as the basis of life
3. Explain the importance of various biomolecules
4. Summarize application of enzymes and fermentation in industry.
5. Analyze metabolic pathways

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | 2 | | | 3 | | | |
| CO2 | | | | | | | | | | | 2 | | 3 | | | |
| CO3 | | 2 | 2 | | | | | | | 1 | | | 2 | | | |
| CO4 | 3 | | | | | | | | | 3 | | | | 3 | | |
| CO5 | | 3 | | | | 1 | | | | 3 | 1 | 1 | | | 3 | |

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

<table>
<tr><td rowspan="2">BTEN1021</td><td rowspan="2">INTRODUCTION TO BIOTECHNOLOGY-II</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Co- requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Nil</td></tr>
</table>

**Course Description:**

This course introduces the student to the Applications of Biotechnology in plant , animal and industrial development

**Course Educational Objectives:**

1. Describe the concept of Central Dogma of Molecular Biology
2. Describe the transfer of genetic information.
3. Introduce recombinant DNA technology
4. Introduce the techniques used for modification of living organisms

**UNIT 1** 10 hours

Biotechnology: Concept, scope and importance. Origin of life-theories. Structure of bacterial, plant and animal cells-functions of cell organelles. Significance of biomolecules in biological systems

**UNIT 2** 12 hours

The central dogma of molecular biology. Concepts of genetic engineering, Restriction endonucleases, cloning vectors, methods of gene transfer. Polymerase Chain Reaction. Introduction to bioinformatics and biological databases

**UNIT 3** 12 hours

Biotechnology for Plant improvement: Strategies for engineering stress tolerance, transgenic plants. Micropropagation of novel varieties. Production of secondary metabolites and their importance. Molecular pharming.

**UNIT 4** 12 hours

Biotechnology for improvement of animals: Applications in animal husbandry, medicine and animal husbandry. Transgenic animals. Gene therapy and genetic counselling. Bioethics.

**UNIT 5** 14 hours

Industrial and Microbial Biotechnology: Overview of industrial fermentation process and products. Fermentation technology for production of Penicillin. Introduction to patents. Biotech industry in India and abroad.

**Textbooks:**

1. J.M. Walker and R. Rapley, Molecular Biology and Biotechnology, 5/e, Royal society of chemistry, 2009.
2. W. Godbey, An Introduction to Biotechnology, The Science, Technology nd Medical Applications, 1/e, Woodhead Publishing, 2014.

**References**

1. P.K. Gupta, Elements of Biotechnology, 2/e, Rastogi Publications, 2014.
2. B. Albert's, A. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts and P.Walter, Molecular Biology of the Cell, 6/e, Garland Publishers, 2014.
3. H. Lodish, A. Berk, C. A. Kaiser, M. Krieger, A. Bretscher, H. Ploegh, Amon and M. P. Scott, Molecular Cell biology, 7/e, W.H Freeman and Company, 2014.

**Course Outcomes:**

After the completion of the course the student should be able to

1. Explain the scope and importance of biotechnology
2. Understand the application of biotechnology in transgenic plant development.
3. Understand the role of biotechnogy in animal husbandry and livestock improvement
4. Explain the potential of biotechnology in industry in strain improvement

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | | | | | | | | | 2 | | | 3 | | | |
| CO2 | | 2 | | | | | | | | | 2 | | 3 | | | |
| CO3 | | | 3 | | | | | | | 1 | | | 2 | | | |
| CO4 | 3 | | | | | | | | | 3 | | | | 3 | | |
| CO5 | | 3 | | | | 1 | | | | 3 | 1 | 1 | | | 3 | |

**APPROVED IN:**

**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

| FINA1031 | PRINCIPLES AND PRACTICE OF BANKING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | Nil | | | | | | |
| **Co- requisite** | Nil | | | | | | |
| **Preferable exposure** | Nil | | | | | | |

**Course Description:**

*The significance of the banking sector in India has been continuously upward for several decades. The sector is playing a role of a catalyst in the development of the economy. The Banks started playing a critical role in the social development process and became a partner in Government's welfare schemes and policies. Principles of and Practices of Banking course explores the fundamental principles and practices of banking and credit in India. It helps students to understand basics of banking and regulation to recent developments in Banking technology*

**Course Educational Objectives:**

1. To understand the Indian financial system, role of commercial Banks, RBI in India and the regulations of Indian Banks.
2. To comprehend the banking Principles
3. To give the student adequate exposure to banking practice.
4. To acquaint and apply innovations in the banking sector.
5. To give an overall exposure to banking Principles and Practice.

**UNIT 1 Banking System and Structure 9 Hours**

Banking system and structure in India: Evolution of Indian Banks-Types of banks; Commercial Banks, Cooperative Banks, Role of RBI; Banking Regulation, Constitution, Objectives, Functions of RBI, Tools of Monetary control; Regulatory Restrictions on Lending. Types of Banking- Retail, Wholesale and International Banking.

**UNIT 2 Risk management and Basel Accords 9 Hours**

Introduction to Risk Management and Basel I, II &III Accords. Role and functions of CIBIL. Fair practices code for debt collection. Principles of Lending: Cardinal Principles, Non-fund-based limits, Credit appraisal Techniques. Cash management services and its importance.

**UNIT 3 Functional Banks 9 Hours**

Banker Customer Relationship: Types, Different Deposit Products & Services, Services to customers and Investors; PMLA Act; KYC Norms; Banker as lender: Types of loans, Overdraft facilities, Discounting of bills, Financing book Debts and supply bills- Charging of Security bills- pledge, mortgage

**UNIT 4 Customer Protection 9 Hours**

COPRA Act and its operational aspects; Banking Ombudsman Scheme; Role and duties Paying and collecting Banks; Banker Protection under Negotiable Instrument Act- Endorsement, Forged Instruments- Bouncing of Cheques and their implications; Operational aspects of opening and maintaining accounts of various types of account holders. Ancillary Services: Remittances & Safe Deposit lockers, Govt Business, EBT

**UNIT 5 Banking Technology 9 Hours**

Computer Systems: LAN,WAN, UPS, Core banking, Data warehousing, Data Mining. Digital Banking: ATMs, Electronic Kiosks-CDK, BNA, PBP; Cards – Types, Networks, Wallets; PPI. Electronic Banking – Internet & Mobile Banking. Trends In Communication Networks for Banking: EFT System, SWIFT, RTGS, NEFT, Automated Clearing System. Digital Payment Systems – NPCI

**Textbooks:**

1. Principles and Practices of Banking, IIFB, 5thEditionn 2021
2. Principles And Practices Of Banking (Paperback, N S TOOR & ARUNDEEP TOOR) 14th Edition

**References:**

1. Shekhar&Shekhar (2010),Banking Theory and Practice, New Delhi: Vikas Publishing House.
2. P.K. Srivastav(2011),Banking Theory and Practice, NewDelhi:Vikas Publishing House.
3. Sundaram& P.N. Varshney (2010), Banking Theory, Law and Practice, New Delhi:S.Chand& Co.
4. Padmalatha Suresh and Justin Paul (2013),Management of Banking and Financial Services, New Delhi: Pearson Education.

**Journal(s):**

1. GITAM Journal of Management, Visakhapatnam.
2. The Journal of Banking Studies, Mumbai.

**Website(s):**

1. https://www.icai.org/

**Course Outcomes:**

1. Student acquires knowledge about theoretical aspects of banking and
2. Student acquires knowledge about relationship between banker and customer
3. Student learns about the practicalities of banking and the latest trends in banking.
4. Students develops skills about legal aspects and negotiable instruments.
5. Student enhance knowledge about latest banking trends and technology.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 0 | 0 | 0 | 0 | 0 | | | | | | | 3 | 1 | 0 |
| CO2 | 1 | 2 | 0 | 1 | 0 | 0 | | | | | | | 2 | 1 | 1 |
| CO3 | 2 | 2 | 3 | 2 | 1 | 0 | | | | | | | 0 | 1 | 1 |
| CO4 | 1 | 2 | 3 | 2 | 1 | 2 | | | | | | | 2 | 0 | 1 |
| CO5 | 0 | 0 | 0 | 0 | 1 | 1 | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

<table>
<tr><td rowspan="2">HRMG1021</td><td rowspan="2">HUMAN RESOURCE MANAGEMENT</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Co- requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Nil</td></tr>
</table>

**Course Description:**

*Success in today's competitive business environment is increasingly a function of effective management of its resources, particularly human resources, which are the most valuable assets of an organization. The efficiency and quality of service of an organization depend on its employee's enthusiasm and satisfaction with their jobs, which are directly related to their sense of being treated fairly. To become a successful manager, it is imperative to understand human sensitivities and factors that motivate individuals. Human Resource Management course provides the basic tools required as an HR professional in an organization*

**Course Educational Objectives:**

1. To Understand the fundamentals, evolution, function & challenges of HRM
2. To Explore the role of HRM in procurement, development of human resources
3. To Analyze the basic factors in designing the compensation and collective bargaining
4. To Evaluate safety and health and establish effective separation practices.

**UNIT 1 Introduction 10 Hours**

Introduction: Nature, scope and significance of HRM - Evolution of HRM – Recent trends in HRM – Functions of HRM – Challenges of HR managers.)

**UNIT 2 Procurement 10 Hours**

Procurement: Human Resource Planning – HR Forecasting methods - Job analysis and Job design – Recruitment - Selection – Induction.

**UNIT 3 Development 10 Hours**

Development: Identification of training needs - designing the training program – Methods of training – Difference between Training & Development.

**UNIT 4 Compensation and Integration 10 Hours**

Compensation and Integration: Introduction - Basic factors in determining pay rates – Basic, Supplementary and Executive Remuneration – types of employee benefits and services - Quality of work-life – Collective Bargaining.

**UNIT 5 Separation and maintaining 10 Hours**

Separation and Maintaining: Communication and Counseling - Safety and Health – Internal mobility - Retirement and Retirement benefits..

**Textbooks:**

1. Gary Dessler & Biju Varkkey, "Human Resource Management," Pearson, New Delhi, 16th edition.
2. George W Bohlander, Scott A Snell, "Principles of Human Resource Management," Cengage Learning, 2017.16th edition.
3. Aswathappa, K., Human Resource and Personnel Management: Text & Cases, TMGH
4. Subba Rao, P., Personnel and Human Resource Management (Text & Cases), Himalaya

**References:**

1. Edwin B Flippo, "Personnel Management," Tata McGraw Hill Publishing, New Delhi, 1984
2. John H. Bernardin, "Human Resource Management - An Experiential Approach," Tata McGraw Hill, New Delhi, 2013
3. Mirza, Saiyadain, "Human Resource Management," Tata McGraw Hill, New Delhi, 2013
4. Gary Dessler & Biju Varkkey, "Human Resource Management," Pearson, New Delhi, 2015 14th edition.

**Journal(s):**

- Harvard Business Review, Harvard Business School Publication USA
- People Matters Online Magazine
- Human Capital Magazine
- Vikalpa, Indian Institute of Management, Ahmedabad

**Course Outcomes:**

On successful completion of this course, students will be able to:

- Understanding the concept of HRM and its importance.
- Describe the process of workflow analysis and identify why it is essential to HRM.
- Understand the concepts of Training and Development
- List various factors determining pay rates.
- Analyze the role of the supervisor in employee safety and minimize accidents at the workplace.

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | 2 | 1 | 0 | 2 | | | | | | 3 | 1 | 0 |
| CO2 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | | | | | | 2 | 1 | 1 |
| CO3 | 2 | 1 | 2 | 2 | 1 | 0 | 1 | | | | | | 0 | 1 | 1 |
| CO4 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | | | | | | 2 | 0 | 1 |
| CO5 | 0 | 0 | 2 | 3 | 0 | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

SDG No. & Statement: 8 Decent Work and Economic Growth

SDG Justification: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

<table>
<tr><td rowspan="2">MKTG3011</td><td rowspan="2">SALES AND DISTRIBUTION MANAGEMENT</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Co- requisite</td><td colspan="7">Nil</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Nil</td></tr>
</table>

**Course Description:**

*Sales Management focuses on the sales techniques and the management of the sales force. The success of any sales and marketing department lies in the effectiveness of the Sales Force. The goal of the Sales Management course is to examine the elements of an effective sales force as a key component of the organization's total marketing effort. A successful Sales Manager needs to understand the fundamentals of the sales process, the relationship between sales and marketing, sales force structure and issues in recruiting, selecting, training, motivating, compensating and retaining sales people.*

**Course Educational Objectives:**

1. To understand the planning and staffing needs in professional sales
2. To learn how to manage and motivate a professional sales team as a Sales manager
3. To analyse the key success factors for sales executive performance.

**UNIT 1**

Introduction to Sales Management - Evolution of Sales Management, importance of Sales Management, types of Selling, difference between Selling and Marketing, Modern Day Sales Activities, Selling Skills, Selling Strategies, Selling Process.

**UNIT 2**

Sales Planning and Budgeting: Sales planning process, sales forecasting methods, sales budgeting process, methods used for deciding sales budget, types of quotas and quota setting procedure, reasons for establishing or revising sales territories, routing and scheduling sales persons, market cost analysis.

**UNIT 3**

Sales Force Management: Recruitment and selection of the sales force, training the sales force, sales force motivation, sales force compensation, sales force control and evaluation.

**UNIT 4**

Introduction to Distribution Management -Definition, need for Distribution Channels, designing the Marketing Channels, Motivating and Evaluating Channel Members, Capturing the Customer requirements

**UNIT 5**

Managing Distribution Channels - Managing Channel Information Systems, reasons for Channel Conflicts, Managing Conflict, Managing, Ethical issues in Sales and Distribution Management

**Textbooks:**

1. Krishna K Havaldar, Vasnt M Cavale, Sales and Distribution Management, 2nd edition, Tata Mcgraw Hill, 2011.

**References:**


1. Tapan K. Panda &Sunil Sahadev (2011), Sales and Distribution Management 2nd edition Oxford Press.
2. S.L. Gupta, M.K.Rampal (2009) Cases in Sales and Distribution Management, Himalaya Publication house.
3. K.Sridhara Bhat (2011) Sales and Distribution Management, 1st, Himalaya Publication house.
4. S.A.Chunawalla (2012) Sales and Distribution Management, 3rd edition, Himalaya Publication house.
5. Dinesh kumar (2012) Marketing Channels ,Oxford Press.
6. Richard R Still, Edward W Cundiff, Norman &A P Govoni(2011) Sales and Distribution Management, 5th edition, Pearson Publications.
7. Spiro Stanton & Rich (2010) Management of Sales Force, 13th edition, Tata McGraw Hill.
8. Prof. M.V. Kulkarni (2010) Sales and Distribution Management, Everest Publishing House.
9. Anne T Coughlan etal (2011), Marketing Channels, 7th edition, Pearson education.
10. Mark W Johnston, Greg W Marshall (2009), Sales Force Management, 9th edition, Tata McGraw Hill.
11. Dr.S.L.Guptha (2010), Sales and Distribution Management, 2nd edition, Excel books.
12. PingaliVenugopal (2012) Sales and Distribution Management, Sage Publications


**Journal(s):**

- Indian Journal of Marketing & Journal of Advertising Research
- GITAM Journal of Management, GITAM Institute of Management, GITAM Deemed to be university, Visakahapatnam
- Harvard Business Review, Harvard Business School Publication Co. USA
- Vikalpa, Indian Institute of Management, Ahmedabad

**Course Outcomes:**

On successful completion of this course, students will be able to:

1. Students would be able to understand the planning and staffing needs in professional sales.
2. Students would learn how to manage and motivate a professional sales team, as a sales manager.
3. Students would be able to analyze the key success factors for sales executive performance.
4. Students would learn how to manage and motivate distribution channel members.
5. Students can manage distribution channels and manage conflicts

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | 2 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 0 |
| CO2 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 1 |
| CO3 | 2 | 1 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| CO4 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 1 |
| CO5 | 0 | 0 | 2 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**
**BOS : 26-04-2021** **ACADEMIC COUNCIL: 17-09-2021**

**SDG No. & Statement:**

**SDG Justification:**

# Programme Core

| MECH2001 | ENGINEERING MECHANICS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 1 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | NONE | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | Intermediate Mathematics and physics | | | | | | |

**Course Description:**
*This course introduces the principles required to solve engineering mechanics problems. Concepts will be applied in this course from previous courses you have taken in basic mathematics and physics. It addresses the modelling and analysis of static and dynamic equilibrium problems with an emphasis on real-world engineering applications and problem solving. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To Explain the conditions for mechanical equilibrium of the systems subjected to forces and moments.
- To Compute geometric properties such as centroid and moment of inertia of various plane sections.
- To Explain kinematics of particles and rigid bodies.
- To Analyze the rigid bodies under dynamic conditions.
- To Expose the concepts of work-energy, conservation of energy and momentum to rigid bodies.

**UNIT 1 Introduction to Engineering Mechanics 8 hours**

**Introduction to Engineering Mechanics:** Units, Significance of Engineering Mechanics, Composition and resolution of forces, parallelogram law, principle of transmissibility, types of force systems - concurrent and non-concurrent, coplanar forces, resultant of coplanar force systems, couple, moment of a force, Varignon's theorem, concept of free body diagrams, concept of equilibrium of coplanar force systems.

**UNIT 2 Friction and Analysis of Structures & Analysis of Structures 8 hours**

**Friction and Analysis of Structures Friction**: Laws of friction, types of friction, equilibrium of force systems involving frictional forces, wedge friction. Free body diagrams involving frictional forces.

**Analysis of Structures:** Introduction to plane trusses, analysis of plane trusses by method of joints and method of sections.

**UNIT 3 Properties of Surfaces and Moment of Inertia 8 hours**

**Properties of Surfaces:** Centroid and center of gravity, derivation of centroids from first moment of area, centroids of composite areas, Theorems of Pappus

**Moment of Inertia**: Area moment of inertia of plane and composite shapes, parallel axis theorem, perpendicular axis theorem, polar moment of inertia, radius of gyration.

**UNIT 4 Kinematics 8 hours**

**Kinematics:** Kinematics of particles – Rectilinear motion of particles, curvilinear motion of particles, use of rectangular coordinates, tangential and normal coordinates, radius of curvature, projectile motion, Kinematics of rigid bodies in translation, rotation of a rigid body about a fixed axis.

**UNIT 5 Kinetics and Ideal systems 8 hours**

**Kinetics and Ideal systems: Kinetics:** Principles of dynamics - Newton's Laws of motion, D'Alembert's principle in rectilinear translation, principle of work and energy.

**Ideal Systems**: Principle of conservation of energy, concept of power, conservation of linear momentum, principle of momentum and impulse, impact - types of impact.

**Textbooks:**

1. N.H. Dubey, Engineering Mechanics: Statics and Dynamics, Tata McGraw Hill, 2014.
2. S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati, Engineering Mechanics (in SI **UNIT** s), 5/e, McGraw Hill, 2013.
3. Irving Shames, G.K.M. Rao, Engineering Mechanics: Statics and Dynamics, 4/e, Pearson, 2009.

**References:**


1. Basudeb Bhattacharya, Engineering Mechanics, 2/e, Oxford University Press (India),
   2015.
2. K.L. Kumar, Veenu Kumar, Engineering Mechanics, 4/e, Tata McGraw Hill, 2010
3. S.S. Bhavikatti, Engineering Mechanics, 4/e, New Age International, 2008


**Course Outcomes:**

1. Apply equilibrium concepts on mechanical systems
2. Analyze the forces and moments on the mechanical systems
3. Calculate the physical properties of rigid bodies in engineering systems.
4. Understand the role of friction in engineering practices
5. Analyze various static and dynamic engineering mechanical systems and understand the mechanics and identify the drawbacks/problems.

**CO-PO Mapping:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | | | | | | | | | 1 | 2 | 2 |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 3 | 2 | | 2 | | | | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 1 | 1 | | | | | | | | | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 2 | | | | | | | | | | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | | 2 | 2 | | 3 | | | | 3 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.
SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.
SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| | | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| **MECH2011** | **THERMODYNAMICS** | **3** | **0** | **0** | **0** | **0** | **3** |
| **Pre-requisite** | Mathematics & Calculus, Engineering Physics. | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**
*This course focuses on the basics of Thermodynamics, various Laws of Thermodynamics such as First law of Thermodynamics, Second Law of Thermodynamics, Zeroth law of Thermodynamics, and Entropy, availability and irreversibility, basics of pure substance and steam calculations, and the thermodynamic relations, gas power cycles, and basics of refrigeration and air-conditioning. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities*

**Course Educational Objectives:**
- To understand the concepts of heat, work, energy, and different laws of thermodynamics
- To familiarize the basic understanding of entropy, availability, and its application to open and closed systems.
- To impart the concepts of Thermodynamic relations, Properties of pure substance and steam calculations.
- To introduce the concepts of gas power cycles.
- To familiarize refrigeration and air conditions concepts and understand the working principles.

**UNIT 1 Introduction and Basic Laws of Thermodynamics 8 hours**

**Introduction:** Basic concepts of thermodynamics, Zeroth law of thermodynamics.
**First law of Thermodynamics:** Joule's experiment - first law of thermodynamics, corollaries- PMM-1, first law applied to non-flow and flow process- limitations of first law of thermodynamics.
**Second Law of Thermodynamics:** Kelvin - Planck statement and Clausius statement and their equivalence, corollaries - PMM-2, reversibility and irreversibility, cause of irreversibility - Carnot cycle, heat engine, heat pump and refrigerator, Carnot theorem, Carnot efficiency

**UNIT 2 Entropy and Availability 8 hours**

Entropy: Clausius inequality -Concept of Entropy- entropy equation for different processes and systems
Availability and Irreversibility: Definition of exergy and energy, expressions for availability and irreversibility. Availability in steady flow, non-flow processes, irreversibility

**UNIT 3 Thermodynamic relations and Properties of pure substance 8 hours**

Thermodynamic Relations: Maxwell relations, TdS equations, difference in heat capacities, ratio of heat capacities, Energy equation, Joule Thompson coefficient, Clausius-Clapeyron equation.
Properties of Pure substance: Pure Substances, P-V-T surfaces, T-s and h-s diagram, Mollier chart, dryness fraction, property tables, analysis of steam undergoing various thermodynamic processes using Mollier chart– steam calorimetry.
Vapour Power Cycles: simple Rankine cycle, concepts of regeneration and reheat, analysis of Rankine Cycle.

**UNIT 4 Gas Power cycles 8 hours**

Gas Power Cycles: Otto, Diesel and dual cycles, Brayton cycle, Sterling Cycle, Atkinson Cycle, Ericsson Cycle, Lenoir Cycle, representation on P-V and T -S diagrams - description and efficiencies, mean effective pressures. Comparison of Otto, Diesel, and dual cycle

**UNIT 5 Refrigeration, Psychrometry, and Airconditioning 8 hours**

Refrigeration: Bell-Coleman cycle-vapor compression cycle, effect of vapor condition on COP of VCR, vapor Absorption cycle, properties of common refrigerants Principles of Psychrometry and Air Conditioning: Psychometric terms, psychometric processes and air conditioning systems.

**Textbooks:**

1. P.K. Nag, Engineering Thermodynamics,5/e, Tata McGraw Hill,2013
2. Yunus A. Cengel, Michael. Boles, Thermodynamics,7/e, Tata McGrawHill,2011.

**References:**


1. J.B. JonesandG. A. Hawkins, IntroductiontoThermodynamics,2/e, John Wiley & Sons, 2012.
2. Moran, Michael J. and Howard N. Shapiro, Fundamentals of Engineering Thermodynamics, 3/e, Wiley,2015
3. Claus Borgnakke Richard E. Sonntag, Fundamentals Thermodynamics,7/e, Wiley, 2009
4. R. K. Rajput, S. Chand Co., Thermal Engineering,6/e, Laxmi publications,2010.


**Course Outcomes:**

1. student will demonstrate basic understanding and knowledge of thermodynamic properties and different laws of thermodynamics.
2. student will describe basic knowledge of entropy, availability, and its application to open and closed systems.
3. student will explain basic understanding of Thermodynamic relation and steam based analysis.
4. student will demonstrate the knowledge of gas power cycles and their analysis.
5. student will explain the basic understanding of Refrigeration and Air conditioning principles.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | | | | | | | 2 | | 3 | 3 | 1 |
| **CO2** | | 3 | | | 1 | | | | | | 2 | | 3 | 3 | 0 |
| **CO3** | 2 | | | 1 | 2 | 1 | | | | | | | 3 | 3 | 0 |
| **CO4** | 3 | 2 | 1 | 2 | 2 | 3 | | | | | 2 | | 3 | 3 | 1 |
| **CO5** | 3 | 2 | 1 | 2 | 2 | 3 | | | | | 2 | | 3 | 3 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.
SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.
SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH2021</td><td rowspan="2">MATERIAL SCIENCE AND ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>2</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Prerequisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*The focus of the course is on crystal structures of metals. The course addresses both theoretical and practical aspects of materials engineering. It imparts knowledge on the microstructure, mechanical properties and heat treatment methods of ferrous and nonferrous metals and alloys. This course also gives an insight into the properties and applications of ceramics, polymers, composites, and nanomaterials.*

**Course Educational Objectives:**

- To teach the principles of physical metallurgy, i.e., crystallography of metals, constitution of alloys and construction of phase diagrams.
- To explain the methods to change the properties of steels through various heat treatment processes.
- To explain the properties and applications of commercially important steels and cast irons with their engineering constraints.
- To explain the properties and applications of important nonferrous metals/alloys.
- To familiarize students with the structure, properties and applications of ceramics, polymers, composite materials, and nanomaterials.

**UNIT 1 Crystal Structure of Metals 8 hours**

Crystal Structures: Unit cells, Metallic crystal structures. Imperfection in solids: Point, Line and Volume imperfections.
Constitution of Alloys: Necessity of Alloying, substitutional and interstitial solid solutions, Intermediate alloy phases.
Phase diagrams: Phase rule, methods of construction of phase diagrams, lever rule. Eutectic, peritectic, peritectoid and mono tactic reactions.

**UNIT 2 Heat treatment of steels 8 hours**

Iron – Iron carbide diagram: Study of Iron - Iron carbide diagram and microstructural aspects of ferrite, cementite, austenite, ledeburite and pearlite.
Heat Treatment of Steels: Annealing, normalizing, hardening, and tempering. Isothermal transformation diagrams for steels and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties. Austempering martempering. Case hardening: Carburizing, nitriding, cyaniding, carbo-nitriding, flame, and induction hardening.

**UNIT 3 Steels and cast irons 8 hours**

Steels: Plain carbon steels, use and limitations of plain carbon steels. Classification of alloys steels. Microstructure, properties, and applications of alloy steels - stainless steels and tool steels.
Cast Irons: Microstructure, properties and applications of white cast iron, malleable cast iron, grey cast iron and nodular cast irons.

**UNIT 4 Non-ferrous Metals and Alloys 8 hours**

Non-ferrous Metals and Alloys: Microstructure, properties and applications of copper and its alloys, aluminum, and its alloys. Study of Al-Cu phase diagram, precipitation hardening. Microstructure, properties and applications of titanium and its alloys.

**UNIT 5 Ceramics, Polymers and Composites 8 hours**

Ceramics, Polymers and Composites: Structure, properties and applications of ceramics, polymers, and composites. Introduction to super alloys and nanomaterials.

The focus of the course is on crystal structures of metals. The course addresses both theoretical and practical aspects of materials engineering. It imparts knowledge on the microstructure, mechanical properties and heat treatment methods of ferrous and nonferrous metals and alloys. This course also gives an insight into the properties and applications of ceramics, polymers, composites, and nanomaterials.

**Course Educational Objectives:**

- To teach the principles of physical metallurgy, i.e. crystallography of metals, constitution of alloys and construction of phase diagrams.

- Toexplainthemethodstochangethepropertiesofsteelsthroughvariousheattreatmentprocesses.
- Toexplainthepropertiesandapplicationsofcommerciallyimportantsteelsandcastironswiththeir engineering constraints.
- Toexplainthepropertiesandapplicationsofimportantnonferrousmetals/alloys.
- To familiarize students with the structure, properties and applications of ceramics, polymers, composite materials and nanomaterials.

**List of Experiments:**

1. Preparation and study of crystal structure models of simple cubic, body centered cubic, face centered cubic and hexagonal close packed structures.
2. Preparation and study of microstructure of pure metals like iron, copper, and aluminum
3. Preparation and study of microstructure of mild steels, low carbon steels and high carbon steels
4. Preparation and study of microstructures of white, malleable, grey, and nodular cast irons
5. Preparation and study of microstructures of aluminum alloys
6. Preparation and study of microstructures of copper alloys
7. Preparation and study of microstructures of annealed, normalized, and hardened steels.
8. Preparation and study of microstructures of welds.
9. To find out the hardness of annealed, normalized, and hardened steels.
10. To find out the microstructure and hardness of cold worked specimen
11. To find out the hardness of welded specimen across various zones
12. To find the corrosion potentials of different metals and alloys

**Textbooks:**

1. S.H.Avner, IntroductiontoPhysicalMetallurgy,2/e,TataMcGrawHill,1997.
2. R. Balasubramaniam, Callister’s, Material Science and Engineering, 2/e, Wiley India, 2014.

**References:**

1. Y.Lakhtin, Engineering Physical Metallurgy, University Press of the Pacific,2000.
2. V.Raghavan, Material Science andEngineering,5/e, Prentice HallofIndia,2004.
3. L.H.VanVlack,ElementsofMaterialScienceandEngineering,6/e,PearsonEducation,2008.

**Course Outcomes:**

1. Explain the crystallography of metals, constitution of alloys and can construct binary phase diagrams. (L2)
2. Select an appropriate heat treatment method to modify the properties of steels. (L3)
3. Select a suitable type of steel, cast iron for a given application. (L3)

4. Choose an appropriate non-ferrous metal/alloy for various applications. (L3)
5. Explain the structure, properties and applications of composite, polymer, ceramic materials, and nanomaterials. (L2)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| **CO2** | 3 | 3 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| **CO3** | 3 | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| **CO4** | 3 | 3 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| **CO5** | 3 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.
SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.
SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH 2031</td><td rowspan="2">COMPUTER AIDED MACHINE DRAWING</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Engineering Visualization and Product Realization</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*This course familiarizes the students to representation of mechanical components such as threads, keys, joints etc. And introduces modeling software to represent assembling and disassembling of mechanical components with emphasis on dimensioning and tolerance. This course acts as a prerequisite to computer aided engineering software to perform structural and thermal analysis on structures.*

**Course Educational Objectives:**

- Introduceconventionalrepresentationsofmaterialsandmachinecomponents.
- Train to use software for 2D and 3D modelling and create of 2D assemblydrawingsfrom3D assemblies
- Expose with thread profiles, riveted, welded and key joints
- Teach solid modelling of machine parts and their sections
- Familiarize with limits, fits and tolerances in mating components

**List of Experiments:**

1. Drawing of thread profiles. Hexagonal and square-Headed bolts and nuts
2. Bolted joint, bolted joint with washer and locknut, stud joint, screw joints
3. Riveted joints: Drawing of rivet, lap joint, butt joint with single strap, single riveted, double riveted double strap joints
4. Keys: Taper key, sunk taper key, round key, saddle key, feather key, woodruff key.
5. Shaft coupling: bushed pin-type flange coupling, universal coupling, Oldham's coupling.
6. Screw Jack Assembly and Lathe Tail Stock Assembly drawings
7. Connecting rod and Knuckle Joint Assembly Drawings
8. Limits fits and tolerances Usage In Production drawing
9. Detailed part drawings of CROSS HEAD AND ECCENTRIC
10. Welded joints: Lap joint and T-joint with fillet, butt joint with conventions

**Textbooks:**

1. N D Bhatt,' Machine Drawing', 50th, Charotar Publishing House, Gujarat, India, 2016, 9789380358895
2. K L Narayana Kannaiah,K, K, K Venkat Reddy, ‘Production Drawing',3rd,New Age

International, New Delhi, India, 2014, 9788122435016

**References:**

1. Cecil Jensen, Jay Helsel and Donald D. Voisinet, Computer Aided Engineering Drawing, Tata McGraw-Hill, 2000
2. K.L. Narayana, Production Drawing, 3/e, new Age International Publishers, 2014

**Course Outcomes:**

1. Demonstratetheconventionalrepresentationsofmaterialandmachinecomponents.
2. Model riveted, welded and key joints using CAD system
3. Create solid models and sectional views of machine components
4. Generate solid models of machine parts and assemble them
5. Translate3Dassembliesinto2Ddrawings

**CO-PO Mapping:**

| | PO1 | PO 2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO1 2 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 0 | 1 |
| **CO2** | 1 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| **CO3** | 1 | 2 | 3 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 1 |
| **CO4** | 1 | 3 | 3 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 1 | 0 |
| **CO5** | 1 | 3 | 3 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.
SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

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| MECH2041 | MANUFACTURING PROCESSES | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 0 | 0 | 4 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | • Modern manufacturing methods • ,Automation in manufacturing | | | | | | |
| **Preferable exposure** | Manufacturing technology | | | | | | |

**Course Description:**

*This course emphasizes the basics of various manufacturing processes so that the student will be able to choose an appropriate manufacturing process for a given application. The course enables the students of mechanical engineering to gain hands on experience and skills necessary to perform traditional manufacturing operations such as moulding, casting and welding. It also introduces the students to modern manufacturing techniques such as development of components and use of power tools. The major objective of this course is to make sure that all the mechanical engineering graduates gain practical exposure to manufacturing methods and various manufacturing tools.*

**Course Educational Objectives:**

- To explain different casting processes, metal forming, rolling and extrusion processes.
- To familiarize with different welding processes and welding defects and forging and sheet metal forming methods.
- To teach various cutting tools, lathe operations and shaping and slotting machine operations.
- To impart various metal cutting processes like milling and grinding.
- To explain the principles of drilling and boring operations

**UNIT 1 Introduction 8 hours**

Importance and selection of manufacturing processes. Casting Processes: Introduction to casting process. Process steps. Pattern: types, materials and allowance.

Cores: Types of cores, core prints. Principles and design of gating system. Various casting defects. Metal Forming: Introduction, nature of plastic deformation, hot and cold working of metals, mechanics of metal forming. Rolling: Principle, types of rolling mill and products, roll passes. Extrusion: Basic extrusion process and its characteristics, hot extrusion and cold extrusion, wire drawing, tube drawing.

**UNIT 2 Forging 8 hours**

Forging: Principle of forging. Types: Smith forging, drop forging, forging hammers, rotary forging, and forging defects. Sheet metal forming: Mechanics of sheet metal working, blanking, piercing, bending, stamping. Metal Joining Processes: Classification of welding processes, types of welds and welded joints, arc welding, weld bead geometry, submerged arc welding, gas tungsten arc welding, gas metal arc welding. Applications, advantages and disadvantages of the above processes. Soldering and brazing: Types and their applications. Welding defects: causes and remedies.

**UNIT 3 Lathe and Lathe Operations 8 hours**

Lathe and Lathe Operations: Principle of working, specifications, types of lathes, operations performed, work holders and tool holders. Taper turning, thread turning attachments for lathes. Turret and capstan lathes - Principle of working, collect chucks, other work holders - tool holding devices. Shaping, Slotting and planning machines - Principles of working - principal parts, specification, classification, operations performed, machining time calculations

**UNIT 4 Milling operations and Milling Machines and Grinding and Grinding Machines 8 hours**

Milling operations and Milling Machines-Principle of working, specifications. Classifications of milling machines, machining operations.
Grinding and grinding machines: Grinding process, types of grinding machines, grinding process parameters, honing, lapping, other finishing processes.

**UNIT 5 Drilling and Drilling Machines and Boring and Boring Machines 8 hours**

Drilling and Drilling Machines: Principle of working, specifications, types, and operations performed. Tool holding devices. Nomenclature of twist drill.
Boring and Boring Machines- Principle of working, specifications, types, and operations performed - tool holding devices - nomenclature of boring tools.

**List of Experiments:**

1. Preparation of a green sand mould using single piece pattern and split pattern
2. Preparation of aluminium alloy specimen by stir casting technique
3. Lap joint, butt joint and T joint using arc welding.
4. Lap Joint Using TIG Welding.
5. Lap Joint Using MIG Welding.
6. Lap joint using resistance spot welding.
7. Job on step turning, taper turning, knurling, thread cutting on lathe machine.
8. Perform drilling, reaming and tapping operations.
9. Job on milling (Groove cutting/Gear cutting).
10. Job on shaping and planning.
11. Job on slotting.
12. Job on cylindrical and surface grinding

**Textbooks:**

1. S. Kalpakjain and S.R. Schmid, Manufacturing Engineering and Technology, 7/e, Pearson, 2018.
2. P.N. Rao, Manufacturing Technology – Volume I, 5/e, McGraw-Hill Education, 2018.
3. P.N. Rao, Manufacturing Technology: Metal Cutting and Machine Tools, (Volume 2), 5/e, Tata McGraw-Hill Education, 2018

**References:**

1. P.C. Sharma, A Textbook of Production Technology, 8/e, S Chand Publishing, 2014.
2. P. Mikell. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and Systems,4/e, John Wiley and Sons Inc, 2010

**Course Outcomes:**

1. Explain the principles of various casting processes, metal forming, rolling and extrusion processes. (L2)
2. Explain forging, sheet metal forming and various metal joining processes. (L2)
3. Explain the basic principles of lathe, shaping, slotting, and planning operations. (L2)
4. Explain the Milling and grinding operations. (L2)
5. Explain drilling and boring operations. (L2)

**CO-PO Mapping:**

| | PO1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 1 | 1 | 0 | 1 |
| **CO2** | 3 | 3 | 3 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 1 | 1 | 0 | 1 |
| **CO3** | 3 | 3 | 3 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 1 | 1 | 0 | 1 |
| **CO4** | 3 | 3 | 3 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 1 | 1 | 0 | 1 |
| **CO5** | 3 | 3 | 3 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 1 | 1 | 0 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.
SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.
SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| MECH2051 | STRENGTH OF MATERIALS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 4 | 0 | 2 | 0 | 0 | 5 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | MECH2081 Advanced Strength of Materials | | | | | | |
| **Preferable exposure** | Basics of material science and Basic engineering applications | | | | | | |

**Course Description:**

*This course helps in understanding the material behavior of solid structures such as beams, shafts, and other members. It covers the design calculations related to safety, reliability and life of structures and other mechanical components and hence central to the whole activity of engineering design*

**Course Educational Objectives:**

- Introduce the concepts of stresses, strains and their relationships.
- Explain shear force and bending moment diagrams and to calculate stresses in beams.
- Impart the concept of biaxial stresses and strains and their application in thin cylinders.
- Teachstressesandstrainsinacircularshaftsubjecttovarioustypesofloads.
- Describe energy methods and theories of failure.

**UNIT 1 Simple Stresses and Strains & Axial Stresses 8 hours**

Simple Stresses and Strains: Introduction to stresses and strains, Stress-Strain Diagram – Application to various materials: Ductile and Brittle, Types of Loads & Stresses (elastic materials) – Axial, Bending, Torsional, Different types of elastic Moduli – Relationship between them.

Axial Stresses: Simple and Compound bars, Taper bars, Thermal stresses in axial bars

**UNIT 2 Bending of Beams & Stresses in Beams 8 hours**

Bending of Beams: Euler beam theory, Types of beams – simply supported, cantilever and overhang beams, Shear force and Bending Moment diagram

Stresses in Beams: Flexural formula, Bending stresses in beams, Shear stresses in beams.

**UNIT 3 Complex stresses & Torsion of Circular Shafts 8 hours**

Complex stresses: Biaxial state of stress with and without shear- principal stresses - Mohr's circle.
Torsion of Circular Shafts: Torsion equation - solid and hollow circular shaft, Torsional rigidity – power transmitted by the shafts.

**UNIT 4 Thin Cylinders & Stresses due to combined loadings 8 hours**

Thin Cylinders: Stresses in thin cylindrical and spherical shells, Volumetric change in thin pressure vessels.
Stresses due to combined loadings: Combined stresses due to axial load, torsion, bending, and shear.

**UNIT 5 Energy Methods & Theories of Failure 8 hours**

Energy Methods: Strain Energy due to Axial Loading, Bending, Torsion and Transverse loading .
Theories of Failure: Yield Criteria for Ductile Materials: Maximum-Shearing-Stress Criterion, Maximum- Distortion-Energy Criterion. Fracture Criteria for Brittle Materials: Maximum-Normal- Stress Criterion, Mohr's Failure Criterion.

**List of Experiments**

1. Preparation of tensile testing samples using ASTM or ASME standards.
2. Metallographic sample preparation (Mounting and Polishing)
3. Study the Stress Strain Characteristics of Metals by using UTM (analysis of Tensile Stress-Strain Data).
4. Compression test using UTM – Applications & comparison with Tensile results
5. Determination of hardness using different hardness testing Machines- Brineless, Micro Vickers, and Rockwell's.

6. Impact Test by using Izod and Charpy Methods.

7. Deflection test on Beams using UTM.

8. Torsion Test on Circular Shafts.

9. Creep and Stress Relaxation tests

10. Fatigue Test – Analysis of results

**Textbooks:**

1. F. P. Beer, E. R. Johnston Jr., J. T. DeWolf, D. F. Mazurek & S. Sanghi, Mechanics of Materials,8/e, McGraw Hill Education (India), 2020.
2. S. S. Rattan, Strength of materials, 3/e, Tata McGraw-Hill, 2016.

**References:**

1. R. C. Hibbeler, Mechanics of Materials (SI Edition), 9/e, Pearson Education, 2018.
2. B. C. Punmia, Ashok K. Jain, Arun K. Jain, Mechanics of Materials, R/e, Laxmi Publications, 2017

**Course Outcomes:**

1. Understand the concepts of stress and strain due to various types of loading. (L2)
2. Draw shear force and bending moment diagrams and calculate stresses in beams. (L3)
3. Determine principal stresses and power transmitted by shafts (L3)
4. Analyse the stresses and strains in thin cylinders and spheres (L4)
5. Evaluate the structural integrity of components using theories of failure (L5)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 1 |
| **CO2** | 3 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 1 |
| **CO3** | 3 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 1 |
| **CO4** | 3 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 1 |
| **CO5** | 3 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 2 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.
SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

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<table>
<tr><td rowspan="2">MECH2061</td><td rowspan="2">APPLIED THERMODYNAMICS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Thermodynamics</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*The course Applied Thermodynamics is the application of the Engineering Thermodynamics. This course mainly focuses on air-standard and vapour cycles where thermodynamic process involving energy conversion takes place in power plants, compressors, turbines or rocket engines, IC engines. The knowledge of this course is essential in solving several practical applications in the power sector*

**Course Educational Objectives:**

- provide fundamental concepts of thermodynamic cycles used in steam power plants, IC engines and gas turbines
- familiarize the performance parameters and combustion process in SI and CI engines
- familiarize concepts of thermodynamic cycles used in steam power plants and gas turbines
- impart knowledge on the working of nozzles, and compressors
- to understand the working of rockets and jet propulsions

| **UNIT 1** | **IC Engines** | **8 hours** |
|---|---|---|

IC Engines: Components, classification and working of IC engines, comparison of two stroke and four stroke engines, comparison of SI and CI Engines, Valve and Port Timing Diagrams, Fuel systems- simple carburettor, Multi point fuel injection, Common rail Direct Injection system, Cooling systems and lubricating systems.
Ignition system - Battery, Magneto, and electronic systems.

| **UNIT 2** | **Performance of IC Engines** | **8 hours** |
|---|---|---|

Performance test - Measurement of Brake power, indicated power, Fuel consumption, Air consumption, Heat balance test, Morse test and Retardation test on IC engine. Combustion process - pre ignition, Knocking and detonation, Fuel requirements, Cetane number and Octane number

**UNIT 3 Nozzles and steam turbines 8 hours**

Nozzles: Type of nozzles, Compressible flow through nozzle- condition for maximum discharge - nozzle efficiency.
Steam Turbines: Impulse and reaction principles, compounding of steam turbines, velocity diagrams Work done and efficiency

**UNIT 4 Air compressors, Dynamic Compressors and Axial Flow Compressors 8 hours**

Air compressors
Reciprocating Compressors: Principle of operation, work required
Rotary Compressor (Positive displacement type): Roots Blower, vane sealed compressor, mechanical details, and principle of working
Dynamic Compressors: Centrifugal compressors: Mechanical details and principle of operation – velocity and pressure variation.
Axial Flow Compressors: Mechanical details and principle of operation

**UNIT 5 Gas Turbines, Rockets and Jet propulsions 8 hours**

Gas Turbines, Rockets and Jet propulsions
Gas turbines: Brayton cycle, Simple gas turbine plant, closed cycle and open cycle for gas turbines, Regeneration, Intercooling and Reheating, condition for maximum pressure ratio and optimum pressure ratio, actual cycle
Jet Propulsion: Criteria of performance, gas turbine engines - working, Ramjet engines, pulsejet engines, simple turbojet engine, simple turbofan engine, simple turboprop engine.
Rocket Propulsion: Rocket engines - rocket engine performance, solid and liquid propellant rockets, comparison of various propulsion systems.

**List of Experiments**

1. Preparation of bio diesel
2. To determine the flash and fire point of biodiesel or any Fuel
3. To Prepare Valve timing diagram 4-stroke diesel engine and Port timing diagram of 2-stroke petrol engine
4. To find the cetane index of bio diesel or neat diesel oil
5. To prepare Heat balance sheet of 4-stroke multi-cylinder diesel engine and estimate the emissions using gas analyser and smoke meter

6. To conduct Morse test on multi cylinder petrol engine
7. To conduct Performance Test of Refrigeration system
8. To conduct Performance of Air conditioning system
9. To conduct Performance of heat pipe
10. To conduct Performance Test of 4-stroke multi-cylinder diesel engine
11. To conduct a test to find the viscosity and viscosity index of any lubricant
12. To study and Determinations of nozzle characteristics
13. Demonstration of fuel cell
14. Emission measurement and analysis of diesel engine
15. Emission measurement and analysis of petrol engine

**Textbooks:**

1. Ganesan V, Internal Combustion Engines, Tata McGraw Hill, 2017
2. M.L. Mathur and F.S. Mehta, Thermal Engineering, Jain brothers,2014
3. R K Rajput, Thermal Engineering, Lakshmi publications
4. P.L. Ballaney, Thermal Engineering, 2/e, Khanna, 2005.

**References:**

1. Cengal Y.A and Boles M.A, Thermodynamics: An Engineering Approach, 5/e,
2. Yahya, S. M., Turbines, Compressors and Fans, 4/e, Tata McGraw Hill, 2010
3. Nag P.K, Engineering Thermodynamics, 4/e, Tata McGraw-Hill, 2008
4. Onkar Singh, Thermal Turbomachines, 3/e, Wiley India, 2014

**Course Outcomes:**

1. Compare thermodynamic relations and air standard cycles. (L2)
2. Explain working of IC engines with combustion process. (L2)
3. Conduct engine test to determine performance characteristics
4. Apply energy balance to design vapour power and gas power cycles. (L3)
5. Apply the principles of jet propulsions and rocketry for different applications. (L3)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | | 3 | | 2 | 1 | 2 | 2 | 1 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | | 3 | | 2 | | 2 | 2 | | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | | 3 | | 2 | | 1 | 2 | | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | | 3 | | 2 | 1 | 3 | 2 | | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 2 | 3 | | 2 | 1 | 1 | 2 | | 3 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

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| MECH3001 | MECHANICS OF MACHINERY | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | Basic engineering applications | | | | | | |

**Course Description:**

*This course provides adequate knowledge on simple mechanisms along with the kinematic analysis. This course also introduces the concepts of gears, vibrations and balancing of rotating and reciprocating masses. These concepts will help the students to analyze and design various mechanisms for different applications. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*.

**Course Educational Objectives:**

- To introduce various mechanisms and their applications
- To explain the importance of degree of freedom
- To familiarize the evaluation of velocity and acceleration in mechanisms
- To explain gear terminology and the analysis of gears and gear trains
- To explain the concept of balancing of rotating and reciprocating masses

**UNIT 1 Simple Mechanisms 8 hours**

Classification of mechanisms – Basic kinematic concepts and definitions – Degrees of freedom, Grashof's law, kinematic inversions of four bar chain, single slider, and double slider crank chains -Mechanical advantage- Transmission angle–steering gear mechanisms- Universal Joint – Simple problems.

**UNIT 2 Velocity and acceleration in Mechanisms 8 hours**

Velocity analysis of simple mechanisms by Instantaneous centre method, relative velocity method (graphical method), Kennedy's theorem. Acceleration analysis of simple mechanisms- Slider crank mechanism, Coriolis component of acceleration, crank and slotted lever mechanism.

**UNIT 3 Gears and Gear trains 8 hours**

Classification of Gears, gear terminology, fundamental law of gearing, Involute and cycloidal gear profiles, spur gear contact ratio and interference/undercutting-helical, bevel, worm, rack & pinion gears, Simple, compound, reverted and epicyclic gear train, Analysis of epicyclic gear train, sun and planet gear train, differentials

**UNIT 4 Balancing of rotating and reciprocating masses 8 hours**

Need for balancing, static, and dynamic balancing, balancing of single mass and several masses in different planes, using graphical methods. Balancing of reciprocating mass, Balancing of locomotives, effects of partial balancing of locomotives

**UNIT 5 Vibrations 8 hours**

Introduction, degree of freedom, types of vibrations, free natural vibrations, degree of freedom, Damped vibrations- under damped, critically damped; and over damped systems, logarithmic decrement, forced vibrations with and without damping in single degree of freedom; Vibration isolation and transmissibility, torsional vibrations- two and three rotor systems

**Textbooks:**

1. S.S. Rattan, Theory of Machines, 4/e, Tata Mc-Graw Hill, 2014
2. G.K. Groover, Mechanical Vibrations, 8/e, Nemchand Bros, 2009

**References:**

1. F. Haidery, Dynamics of Machines, 5/e, NiraliPrakashan, Pune, 2003
2. J.E. Shigley, Theory of Machines and Mechanisms, 4/e, Oxford, 2014
3. P.L. Ballaney, Theory of Machines & Mechanisms, 25/e, Khanna Publishers, Delhi, 2003.
4. Norton, R.L., Design of Machinery - An introduction to Synthesis and Analysis of Mechanisms and Machines,2/e, McGraw Hill, New York, 2000.

**Course Outcomes:**

1. Understand different mechanisms and their inversions
2. Calculate the velocity and acceleration of different links in a mechanism
3. Analyze different gears and gear trains and design the gears for various applications
4. Determine the position and magnitude of masses required for balancing of rotating and reciprocating machines
5. Calculate the natural frequency of vibrating systems

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | | | | | | 2 | | | | 2 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 2 | | | | | 2 | | | | 2 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 2 | | | 2 | | | | 2 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 2 | | 2 | | | 2 | | | 1 | 2 | 1 | 1 |
| CO5 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | | 3 | 2 | | 2 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

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<table>
<tr><td rowspan="2">MECH3011</td><td rowspan="2">FLUID MECHANICS AND MACHINERY</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>4</td><td>0</td><td>2</td><td>0</td><td>0</td><td>5</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Students are expected to know the fundamentals of engineering mechanics, resolving of forces, Statics, Dynamics and flow kinematics.</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*Mechanics of Fluid is a fundamental subject dealt for Mechanical, Electrical, Chemical, Civil and Aeronautical Engineering branches in an interdisciplinary manner. Machineries associated with fluid handling are of utmost importance for the aforesaid Engineers. The characteristic performances of these machines are studied to ascertain the suitability of the same for the specific purpose. The dynamics of fluid deals with all kinds of understanding the intricacies of the subject. The subject deals with various elements that are used in Hydro Electric power plant and ocean power plant. Various equipment's are studied with their performance like Pelton turbine, Francis Turbine, and various other pumps. The purpose of studying this course is to imbibe the basic knowledge on fluid mechanics. This will be useful for Mechanical, civil and electrical engineering students for designing and applying to flow systems. Flow systems are applied for turbines, pumps, pipes etc. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- To impart the knowledge of fluid properties and their behaviour in static and dynamic states
- To acquaint mathematical techniques to fluid flow problems.
- To introduce the concepts of boundary layer
- To evaluate the performance of hydraulic turbines
- To understand the functioning and characteristic curves of pumps

**UNIT 1 Fluid Properties and Fluid Statics 8 hours**

Definition of fluid. Properties of fluid, compressibility, surface tension, vapour pressure, Newton's law of viscosity, Newtonian, and Non-Newtonian fluids. Pressure and its measurement, basic principles of hydrostatic forces on surfaces. Fluid kinematics: Classification of flows-steady and unsteady, uniform, and non-uniform, laminar and turbulent, rotational, and irrational, viscous, and inviscid, internal and external flows, continuity equation, streamline, stream tube, stream function, potential function, vorticity and circulation, vortex motion, free and forced vortices.

**UNIT 2 Fluid Dynamics and Flow through pipes 8 hours**

Fluid Dynamics: Conservation of momentum, conservation of energy, Euler's equation, Bernoulli's equation Measurement of flow- Venturi meter, Orifice meter and Pitot tube. Flow through pipes: Loss of head due to friction in pipes, Darcy-Weisbach equation - friction factor, minor losses. Laminar and turbulent flow through pipes, Hagen-Poiseuille flow.

**UNIT 3 Boundary layer theory and Impact of jets 8 hours**

Concept of boundary layer, boundary layer thicknesses, von-Karman momentum integral method, effect of pressure gradient, Boundary layer separation, Methods to prevent separation. Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.

**UNIT 4 Hydraulic Turbines 8 hours**

Classification of turbines, Heads and efficiencies, impulse and reaction turbines, Pelton wheel, Francis's turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design –draft tube theory- functions and efficiency. Performance of hydraulic turbines: Geometric similarity, unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer.

**UNIT 5 Centrifugal pumps and Reciprocating pumps 8 hours**

Centrifugal pumps: Classification, working, work done – barometric head- losses and efficiencies specific speed- performance characteristic curves, NPSH. Reciprocating pumps: Working, Discharge, slip, indicator diagrams.

**List Of Experiments**

1. measurement of coefficient of discharge using venturi and orifice meter
2. measurement of friction factor
3. measurement of force exerted by the jet on flat, inclined and curved plate
4. performance characteristics of Pelton wheel
5. performance characteristics of Francis turbine
6. performance characteristics of centrifugal pump
7. Estimation of drag and lift coefficient of an aerofoil using wind tunnel

**Textbooks:**

1. S K Som, Gautam Biswas, S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, McGraw Hill Education, 2017

**References:**

1. Y.A. Cengel and J.M. Cimbala, Fluid Mechanics - Fundamentals and Applications, 3/e, Tata McGraw Hill, 2013.

**Course Outcomes:**

1. Interpret the behavior under static and dynamic conditions. (L3)
2. Analyze one dimensional viscous flows using conservation laws for compressible and incompressible flows. (L4)
3. Apply boundary layer flows for laminar and turbulent regimes. (L5)
4. To select and analyze an appropriate turbine with reference to given situation in power
5. plants. (L4)
6. To estimate performance parameters of a given Centrifugal and Reciprocating pump. (L5)

**CO-PO Mapping:**

| | PO 1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO1 2 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | 3 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

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| MECH3021 | MEASUREMENTS AND METROLOGY | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 0 | 0 | 4 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | Measuring instruments | | | | | | |

**Course Description:**

*The objective is to make the students to have knowledge on the various measuring and inspection devices and to provide tolerances during design. This is useful for every engineer who is working in any industry as every industry producing any good should be inspected and then only will be sent out for the release in the market for customers. Course intends to introduce the technological and engineering concepts and study the applications of measuring quantities like force, torque, and temperature. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities***.**

**Course Educational Objectives:**

- To introduce the basic concepts of metrology and measurement methods.
- To demonstrate the importance of metrology in manufacturing.
- To explain the concepts of transducers and its practical applications.
- To expose with various measuring instruments
- To familiarize calibration methods of various measuring instruments.

**UNIT 1 Concept of Measurement 8 hours**

General concept-generalized measurement system, units, and standards, measuring instruments, sensitivity, readability, range of accuracy, precision, static and dynamic response, repeatability, systematic and random errors, correction, calibration, terminology and limits fits and tolerances, hole basis and shaft basis system, interchangeability.

**UNIT 2 Linear measuring instruments 8 hours**

Vernier instruments, micrometres, slip gauges, tool makers microscope. Comparators: Mechanical-Johansson mikrokator, sigma and reed type, pneumatic-solex and differential type and electrical- visual gauging and multi gauging.
Angular measurements: Sine bar, bevel protractor and angle dekkor.

**UNIT 3 Screw thread measurements and Gear Measurement 8 hours**

**Screw thread measurements:** Elements of threads, errors in screw threads, various methods of measuring external and internal screw threads, screw thread gauges and errors in screw threads.
**Gear Measurement:** Gear tooth terminology, measurement of gear elements-runout, lead, pitch backlash, profile and tooth thickness by chordal thickness method, constant chord and base tangent method

**UNIT 4 Surface Roughness and Inspections systems 8 hours**

**Surface Roughness:** Terminology, differences between surface roughness and surface waviness- Numerical assessment of surface finish - CLA, RMS and ten-point height average Value. Methods of measurement of surface finish-Profilometer, Tomlinson surface meter, Taylor Hobson Talysurf.
**Inspections systems:** Classification of automatic inspections systems, co-ordinate- measuring machines, non-contact inspection techniques-machine vision, laser scanning systems.

**UNIT 5 Measurement of Force, Measurement of Torque and Measurement of Temperature 8 hours**

**Measurement of Force:** Direct method - analytical balance, platform balance; elastic members – load cells, cantilever beams and proving rings.
**Measurement of Torque:** Torsion bar dynamometer, servo-controlled dynamometer, and absorption dynamometer.
**Measurement of Temperature:** Pressure thermometers and bimetallic strip thermometers.

**List of experiments:**

1. Calibration of micrometer and dial gauge by using slip gauges.
    a. Measurement of V-groove angle using 2 roller method.
    b. Measurement of angles using angle gauges
2. To determine the gear tooth thickness and height of a given spur gear
3. Measurement of screw thread parameters using tool makers microscope
4. Measurement of roundness and concentricity of a given spigot
5. Measurement of angles using vernier bevel protractor and sine bar
6. Measurement of central distance between two holes by using vernier height gauge
    a. Measurement of straightness using Autocollimator
    b. Measurement of flatness using monochromatic check lite
7. To measure surface roughness parameters of a given specimen

**Textbooks:**

1. Beckwith, Marangoni, Linehard, Mechanical Measurements, 6/e, PHI, 2013.
2. R.K. Jain, Engineering Metrology, 20/e, Khanna Publishers, 2013.

**References:**

1. Mahajan, Engineering Metrology, 2/e, DhanpatRai, 2013.
2. S. Bhaskar, Basic Principles - Measurements and Control Systems, Anuradha Publications, 2014.
3. Anand K Bewoor&Vinay A Kulkarni, Metrology & Measurement, 15/e, McGraw Hill, 2015

**Course Outcomes:**

1. Have knowledge on basic concepts and apply the concepts of limits, fits, tolerances to engineering drawing & design (L4)
2. Demonstrate the concepts of linear and angular measurements to practical applications (L3)
3. Examine geometry of screw threads and gear profiles. (L4)
4. evaluate surface finish and also to inspect various components using non-contact and contact techniques. (L5)
5. Select suitable techniques to measure and evaluate force torque and temperature. (L5)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 1 |
| CO5 | 3 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 2 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

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| MECH3031 | DESIGN OF MACHINE ELEMENTS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 4 | 0 | 0 | 0 | 0 | 4 |
| **Pre-requisite** | MECH2051 Strength of Materials | | | | | | |
| **Co-requisite** | MECH3151 Product Design | | | | | | |
| **Preferable exposure** | Basics of strength of materials, material science. | | | | | | |

**Course Description:**

*This course introduces the design procedures for various mechanical elements. Concepts applied in this course are from previous courses such as Strength of materials and Dynamics of Machinery. The course aims to throw knowledge on design against static and fatigue loadings. The course addresses designing of fasteners, couplings, shafts, and other machine components and limited to strength and rigidity-based designs. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*.

**Course Educational Objectives:**

- To introduces design of machine elements.
- To familiarize with fundamental approaches to failure prevention for static and dynamic loading.
- To explain design procedures for different types of joints.
- To explain the working principle of clutches and brakes and their design procedures.
- To instruct different types of bearings and design procedures.

**UNIT 1 Mechanical Engineering Design 8 hours**

Design process, design considerations, codes, and standards of designation of materials, selection of materials. Design for Static Loads: Modes of failure, design of components subjected to axial, bending, torsional and impact loads, Static theories of failures. Design for Dynamic Loads: Endurance limit, fatigue strength under axial, bending and torsion, stress concentration, notch sensitivity. Types of fluctuating loads, fatigue design for infinite life. Fatigue theories of failure. Soderberg, Goodman and modified Goodman criterion for fatigue failure. Fatigue design under combined stresses.

**UNIT 2** **Bolted, Welded and Riveted Joints** **8 hours**

Bolted Joints: Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening, eccentrically loaded bolted joints, and gasketed joints. **Riveted Joints:** Design of lap, butt and eccentrically loaded joints, failure, and efficiency of riveted joints. **Welded Joints:** Strength of lap and butt welds, eccentrically loaded welded joints. Joints subjected to bending and torsion

**UNIT 3** **Shafts, Keys, And Shaft Couplings** **8 hours**

Power Transmission Shafts: Design of shafts subjected to bending, torsion, and axial loading. Shafts subjected to fluctuating loads using shock factors. Keys: Function, types, design of sunk, saddle, Kennedy, and Woodruff keys. Couplings: Design of flange and bushed pin couplings, universal coupling.

**UNIT 4** **Clutches And Brakes** **8 hours**

Friction Clutches: Torque transmitting capacity of disc and centrifugal clutches. Uniform wear theory and uniform pressure theory. Brakes: Different types of brakes. Concept of self-energizing and self-locking of brake. Band brake, block brakes and disc brakes

**UNIT 5** **Bearings And Gears** **8 hours**

Design of Sliding Contact Bearings: Lubrication modes, bearing modulus, McKee's equations, design of journal bearing. Bearing Failures.Design of Rolling Contact Bearings: Static and dynamic load capacity, Stribeck's Equation, equivalent bearing load, load-life relationships, load factor, selection of bearings from manufacturer’s catalogue. Design of Gears: Spur gears, beam strength, Lewis’s equation, design for dynamic and wear loads.

**Textbooks:**

1. J.E. Shigley, Mechanical Engineering Design, 2/e, Tata McGraw Hill, 1986.
2. V. B. Bhandari, Design of Machine Elements, 3/e, Tata McGraw Hill, 2010.

**References:**


1. R.L. Norton, Machine Design an integrated approach, 5/e, Pearson Education, 2018.
2. R. K. Jain, Machine Design, Khanna Publications, 1988.
3. M. F. Spotts and T. E. Shoup, Design of Machine Elements, 8/e, Prentice Hall (Pearson Education), 2019


**Course Outcomes:**

1. Apply the knowledge in designing of fasteners. [ L3]
2. Use the principles to estimate safety factors of machine members subjected to static and dynamic loads. (L3)
3. Apply basic design procedures of gears [ L2 ]
4. Understand different types of Bearings and designing procedures [ L3 ]
5. Analyze and design different machine components and optimize the design decisions according to the requisites.
6. Design different fasteners subjected to various loads. (L5)

**CO-PO Mapping:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 1 |
| **CO2** | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 |
| **CO3** | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 1 | 0 |
| **CO4** | 3 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 1 | 0 |
| **CO5** | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

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| MECH3041 | HEAT AND MASS TRANSFER | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 0 | 0 | 4 |
| **Pre-requisite** | Thermodynamic | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course focuses on the fundamental concepts and techniques of heat and mass transfer and emphasizes application of mathematical principles in heat transfer. The knowledge of Thermodynamics and Fluid mechanics are prerequisite in understanding the concepts fluid kinematics & boundary layer concepts with respect to heat and mass transfer. Further, this course gives good understanding of industrial related problems as phase change heat transfer and heat exchangers. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To impart the basic laws of conduction, convection and radiation heat transfer and their applications
- To familiarize the convective heat transfer concepts
- To explain basics of radiation heat transfer
- To make conversant with the heat transfer analysis related to thermal systems like heat exchangers, evaporator, and condenser.
- To explain basics of boiling condensation and mass transfer

**UNIT 1** **Introduction** **8 hours**

Introduction: Basic modes of heat transfer- rate equations- generalized heat conduction equation - steady state heat conduction solution for plain and composite slabs – cylinders. Fins: Heat conduction through fins of uniform cross section- fin effectiveness and efficiency. Unsteady State Heat Transfer - Transient heat conduction- lumped system analysis and use of Heisler charts

**UNIT 2 Convection 8 hours**

Convection: Basic concepts of convection–heat transfer coefficient - types of convection – forced convection and free convection. Dimensional analysis in convection External Flow: Concepts of hydrodynamic and thermal boundary layer- use of empirical correlations for flow over plates and cylinders. Fluid friction – heat transfer analogy Internal Flow: Use of empirical relations for convective heat transfer in horizontal pipe flow. Free Convection -development of hydrodynamic and thermal boundary layer along a vertical plate – use of empirical relations for convective heat transfer on plates and cylinders in horizontal and vertical orientation.

**UNIT 3 Radiation 8 hours**

Radiation: Radiation heat transfer – thermal radiation – laws of radiation - Black and Gray bodies – shape factor-radiation exchange between surfaces - Radiation shields - Greenhouse effect.

**UNIT 4 Heat Exchangers 8 hours**

Heat Exchangers: Types of heat exchangers- parallel flow- counter flow- cross flow heat exchangers- overall heat transfer coefficient- LMTD and NTU methods- fouling in heat exchangers.

**UNIT 5 Boiling and Condensation/Mass Transfer 8 hours**

Boiling and Condensation: Different regimes of boiling- nucleate, transition and film boiling – condensation - film wise and dropwise condensation.
Mass Transfer: Conservation laws and constitutive equations - Fick's law of diffusion, isothermal equi-mass - Equimolar diffusion- - diffusion of gases and liquids- mass transfer coefficient.

**List of Experiments**

1. Determine the thermal conductivity of a metal rod
2. Determine the heat transfer coefficient for a vertical cylinder in natural convection
3. Determine the heat transfer coefficient in forced convection of air in a horizontal tube.
4. Determine the heat transfer coefficients on film and drop wise condensation apparatus.
5. Determine the effectiveness of a parallel and counter flow heat exchanger
6. Determine the thermal conductivity by guarded hot plate method
7. Determine the thermal conductivity of a given liquid sample
8. Determine the effectiveness of compact heat exchanger
9. Determine the emissivity of the test plate surface
10. Study the pool boiling phenomenon and different regimes of pool boiling.

**Textbooks:**

1. P.K. Nag, Heat Transfer, 3/e, Tata McGraw-Hill, 2011.
2. F. P. Incropera and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, 6/e, John Wiley, 2007.

**References:**

1. J.P. Holman, Heat Transfer, 9/e, Tata McGraw-Hill,2008.
2. Cengel. A.Yunus, Heat Transfer- A Practical Approach, 4/e, Tata McGraw-Hill, 2007.
3. S.P. Sukhatme, A Textbook of Heat Transfer, Universities Press, 2005
4. Lienhard and Lienhard, A Heat and Mass Transfer, Cambridge Press, 2011.
5. C.P. Kothandaraman and S. Subramanyan, Heat and Mass Transfer databook, New Age Publications, 2014

**Course Outcomes:**

1. Apply the concepts of different modes of heat transfer. (L2)
2. Apply knowledge of conduction heat transfer in the design of insulation of furnaces and pipes. (L3)
3. Analyse free and forced convection phenomena in external and internal flows. (L2)
4. Design of thermal shields using the concepts of black body and non-black body radiation. (L4)
5. Apply the basics of mass transfer for applications in diffusion of gases. (L3)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 1 | 0 | 1 | 0 | 1 | 2 | 0 | 1 | 0 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 3 | 1 | 0 | 1 | 0 | 1 | 2 | 0 | 1 | 0 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 1 | 0 | 1 | 0 | 1 | 2 | 0 | 1 | 0 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 1 | 0 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 1 | 0 | 3 | 3 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH3051</td><td rowspan="2">INTRODUCTION TO CAD, CAM, AND CNC MACHINING</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">Concepts of Machine Design, Concepts of machining operations</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*This course familiarizes you to the foundational knowledge in computer-aided design, manufacture, and the practical use of CNC machines. In this course, we begin with the basics in CAD by learning how to properly sketch and model 3D parts. Before we program any toolpaths, we will explore CNC machining basics to ensure we have the ground level foundational knowledge needed to effectively define toolpaths. Finally, we explore the basics of setting up a CAM program and defining toolpaths to cut simple geometry. This same basic process gets repeated for the design and manufacture of any part and is a critical step in learning and understanding the process. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- Explain the CAD design process as applied to prismatic parts.
- Summarize the workflow of digital manufacturing.
- Demonstrate knowledge and skills in basic CAM software.
- Recall foundational knowledge of practical CNC machining.
- Introduce the standard terminologies, conventions, processes, operations, programming techniques, design and operational characteristics of key hardware components of CNC machines

**UNIT 1 Introduction to CAD 8 hours**

Introduction – Role of Computers in design and manufacture. Fundamentals of CAD: Definition of CAD Tools, Graphics standards, Graphics software: requirements of graphics software, Functional areas of CAD, Efficient use of CAD software. Introduction, Design process, Application of computer for design, creating the manufacturing database, Benefits of CAD, Design workstation, CAD hardware. Introduction to Geometric Modelling: Requirement of geometric modelling, Classification of geometric modeling techniques, comparison, and advantages of Geometric models.

**UNIT 2** **Introduction to CAM** **8 hours**

Introduction to CAM Concepts, Objectives & scope, Nature & Type of manufacturing system, Evolution, Benefits of CAM. Overview on the concepts of Computer Integrated Manufacturing, FMS, and their Impact on manufacturing. Outlines on the concept and component of FMS, FMS: need, objectives, types of FMS lay outs, limitations, and advantages.

**UNIT 3** **Introduction group technology** **8 hours**

Introduction group technology, part families, part classification and coding systems. Benefits of group technology. Concept of CAPP, Different approaches to CAPP systems, application, limitations, and benefits. Basic concepts of Computer Vision and its applications to manufacturing

**UNIT 4** **Introduction to NC and CNC Technology** **8 hours**

Introduction to NC and CNC Technology: Types, Classification, Specification, components, and construction details. NC machine tools: Nomenclature of NC machine axes, Types of NC machine tools, Machining centres, Automatic tool changes (ATC), Turning centres. Machine control Unit& tooling: Functions of MCU, NC actuation systems. Axis designation, NC/CNC tooling. Fundamentals of Part programming, Types of formats, Part Programming for drilling, lathe and milling machine operations, subroutines, do loops, canned Cycles, parametric sub routines.

**UNIT 5** **APT programming** **8 hours**

APT programming: APT language structure, APT geometry: Definition of point, time, vector, circle, plane, patterns, and matrices. APT motion commands: setup commands, point-to-point motion commands, continuous path motion commands. Post processor commands, complication control commands, Macro subroutines, Part programming preparation for typical examples. Extension of Numerical Control such as concepts of direct numerical control (DNC), adaptive control and their advantages.

**List of Experiments**

1. Demonstrate constructional features of CNC and its operation
2. Prepare a part program for simple turning with steps.
3. Prepare a part program for simple turning with tapers.
4. Prepare a part program for turning with circular (concave / convex shape) interpolation codes.
5. Prepare a part program for simple contour milling operation.
6. Prepare a part program for simple contour milling operation.
7. Prepare a part program for simple contour milling operation with (convex / concave) circular interpolation
8. Prepare a part program for drilling holes with same diameter of the hole on a given plate.
9. Prepare a part program for drilling holes with varying diameter of the holes on a given plate.
10. Prepare a part program for drilling holes with varying depth of the holes on a given plate.

**Textbooks:**

1. P.N. Rao, CAD/CAM: Principles and Applications, 3rd edition, McGraw Hill Education, 2017.

**References:**

1. S.R. Deb, Robotics Technology and Flexible Automation, 2nd edition, Tata McGraw-Hill, 1994.
2. Smith Peter, CNC programming handbook, 2nd edition, 2003, Industrial Press Inc.
3. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, Robotics Engineering – An Integrated Approach, 1st edition, Prentice-Hall of India Pvt. Ltd., 2009
4. M.S.F., R.C. Gonzalez and C.S.G. Lee, Robotics Control, Sensing, Vision and Intelligence, McGraw Hill, July 1987

**Course Outcomes:**

1. Students will describe basic concepts of CAD and CAM application and understand CIM wheel
2. Students will prepare CNC programs for manufacturing of different geometries on milling, drilling and lathe machines.
3. Students will classify different components using different techniques of group technology
4. Students will prepare Process planning for different components
5. Students will select layouts of FMS for industrial applications

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | | | 2 | 3 | 2 | 1 | | 2 | | | 3 | 3 | 3 |
| **CO2** | 2 | 1 | | 1 | | 3 | 2 | | | 2 | | | 3 | 3 | 3 |
| **CO3** | 2 | | | | 2 | 2 | | | | 2 | | | 2 | 2 | 2 |
| **CO4** | 2 | 1 | | | 2 | 3 | 2 | 1 | | 2 | | | 3 | 3 | 3 |
| **CO5** | 2 | 1 | | | 2 | 3 | 2 | | | 2 | | | 3 | 3 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

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SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

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| MECH3061 | INDUSTRIAL ENGINEERING AND MANAGEMENT | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 0 | 0 | 4 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*The course is suitable to fit into all functional areas of business in different sections of the economy from manufacturing to the service sector and the process industry and fit into managerial positions in all organizations like Manufacturing, service, IT, Logistics & Apparels. It is helpful to train students to rigorously make use of quantitative techniques in analysing and designing service operations and to train students who will have the passion to engage in improving the service and its delivery. The individual should be creative, inquisitive, analytical, and detail-oriented, and able to work in a team and communicate well, both orally and in writing. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- Understand the basic concepts of management, planning, organizing, and staffing
- Understand the concepts of materials management and quality control
- Understand the concepts of production planning control
- Understand the principles of management
- Learn the acts related to industries

**UNIT 1 Definition of Industrial Engineering 8 hours**

Objectives, work study, method study, method study procedure - various charts, THERBLIGS, work measurement – various methods of work measurements. Factors affecting productivity, strategies for improving productivity.

**UNIT 2 Materials Management 8 hours**

Strategic importance of materials in manufacturing industries, inventory control models, inventory control systems, safety stock, selective Inventory control – ABC, FSN, and VED analysis. Quality Management: Definition of quality, various approaches, concepts of quality assurance systems, statistical quality control, variables & attributes, charts, acceptance sampling, OC curve, introduction to TQM & ISO-9000.

**UNIT 3 Production Planning and Control 8 hours**

Objectives, types of productions, production cycle, product design and development, process planning, forecasting, functions of production control. Plant Layout and Material Handling: Plant layout and location, types of layouts, principles, concept of Unit load, selection of material handling equipment.

**UNIT 4 Industrial Management 8 hours**

Concepts, principles of management, growth of management thought, functions of management, principles of organization, types of organizations.

**UNIT 5 Industrial Relations 8 hours**

Industrial disputes, settlement of industrial disputes, trade unions, industrial dispute act 1947 and factories act 1948. Conflict management in organizations.

**List of Experiments**

1. Method Study for the assembly of a Bolt, a nut and a washer.
2. Time study of electric plug assembly
3. Estimation of standard time using PMTS.
4. Determination of standard time of pin board assembly using centi minute stopwatch
5. Drawing Man-multi machine Multiple activity chart
6. Physiological evaluation of performance testing of individual on Tread Mill/bicycle ergometer
7. Drawing & analyzing Mean and Range Chart for given process.
8. Drawing & analyzing P-chart for given process.

9. Drawing & analyzing C-chart for given process.
10. Showing that sample means from normal universe follow normal distribution
11. Drawing Operation characteristic curve for single sampling attributes plan.
12. Stopwatch time study on drilling machine, lathe machine and CNC machine

**Textbooks:**

1. ILO, Introduction to Work Study, 3/e, Oxford and IBH Publishing, 2008
2. O.P. Khanna, Industrial Engineering and Management, 14/e, Dhanpat Rai Publications, 2011

**References:**

1. Chary, S. N., Production and Operations Management, 4/e, Tata McGraw Hill Publications, 2009
2. M.T. Telsang, Industrial Engineering and Production Management, 2/e, S Chand and Co., 1999.

**Course Outcomes:**

1. Explain the basic concepts of management, planning, organizing and staffing
2. Explain the concepts of materials management and quality control and implement in the industry
3. Explain the concepts of production planning control
4. Explain the principles of management.
5. Explain and utilize various acts related to industries

**CO-PO Mapping:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO2** | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO4** | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 2 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

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# Programme Elective

| MECH3071 | ADVANCES IN WELDING TECHNOLOGY | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | Welding Technology | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*Welding technology traces its history back to the Industrial Revolution in 1750 AD. In 1920, P.O. Nobel of the General Electric Company invented automatic welding which made use of bare electrode wire and direct current. Recent improvements in welding technology include friction, inertia, and laser welding. These recent technologies are now being taught in several institutes for advanced welding programs. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- To impart knowledge on various advanced welding processes so that the students can apply them in engineering industry applications.
- To understand the various parameters and requirements for welding processes.
- To know the comparative merits and demerits of various welding processes.
- To learn about the joint designs adopted in different types of welding techniques.
- To develop the knowledge on the design of welded joints and the quality control of weldments.

| UNIT 1 | Solid State Welding Processes | 9 hours |
|---|---|---|

Fundamental principles, survey of the various pressure welding processes and their applications. Friction, friction stir, explosive, diffusion, and Ultrasonic welding – principles of operation, process characteristics and application.

**UNIT 2** **Electron And Laser Beam Welding** **9 hours**

Heat generation and regulation, equipment details in typical set-up, electron beam welding in different degrees of vacuum, advantages and disadvantages, applications. Laser Welding: Principles of operation, advantages, and limitations, applications.

**UNIT 3** **Electro Slag Welding** **9 hours**

Heat generation, principles of operations, wire and consumable guide techniques, selection of current, voltage and other process variables, nature of fluxes and their choice. Electro-gas welding: Principle and applications. Narrow gap welding, Under Water welding. Rapid Arc Welding, Welding Automation

**UNIT 4** **Plasma Welding** **9 hours**

Special features of plasma arc- transferred and non-transferred arc, keyhole and puddle-in mode of operation, micro low and high current plasma arc welding and their applications, plasma cutting, surfacing and applications.

**UNIT 5** **Testing And Design of Weldment** **9 hours**

Design and quality control of welds. Edge preparation types of joints, welding symbols. Stresses in butt and fillet welds – weld size calculations. Testing – tensile, bend hardness. Impact, notch and fatigue tests. Life assessment of weldments.

**Textbooks:**

1. Nadkarni S.V., "Modern Arc Welding Technology", Oxford IBH Publishers, 1996. 9.

**References:**

1. Schwartz M.M, "Metals Joining Manual", McGraw Hill Book(s), 2001.
2. Tylecote R.F, "The Solid Phase Welding of Metals", Edward Arnold Publishers Ltd, London, 2000.
3. Parmer R.S., "Welding Engineering and Technology", Khanna Publishers, 2002.
4. Carrry B., "Modern Welding Technology", Prentice Hall Pvt Ltd., 2002.
5. Nadkarni S.V., "Modern Arc Welding Technology", Oxford IBH Publishers, 1996.
6. Schwariz, M.M., "Source book on innovative welding processes", American Society for Metals (OHIO), 2004.
7. Christopher Davis, "Laser Welding- Practical Guide". Jaico Publishing House, 2002.

**Course Outcomes:**

1. Apply the knowledge of solid-state welding process for engineering applications (L3).
2. Understand the principles of Heat generation of metal joining process (L2).
3. Understand the fundamental principles of special arc welding process (L2).
4. Understand the knowledge of plasma arc in metal joining and Laser cutting process (L2).
5. Understand the knowledge of design principles in weld joints. Apply the concept of quality control and testing of weldments in industrial environment (L4).

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO2** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

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| MECH3081 | MANUFACTURING OF AUTOMOBILE COMPONENTS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | Manufacturing Process | | | | | | |
| **Co-requisite** | Automobile Engineering | | | | | | |
| **Preferable exposure** | NONE | | | | | | |

**Course Description:**

*The course is designed to introduce the students about the concepts of casting, forging, welding, and coatings processes. The Material selection and Manufacturing methods for manufacturing of component s will be introduced. The concepts of Surface Treatments and welding processes for automobile body components will be covered. The selection of material and manufacturing methods for chassis components and prototype making will be explained. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- To introduce the concepts of casting, forging, welding, and coatings processes.
- To understand the Material selection and Manufacturing methods for transmission system.
- To explain the concepts of Surface Treatments and welding processes for automobile body components
- To describe the Material and manufacturing selection methods for chassis components.
- To understand the various prototype selection of materials and manufacturing methods

**UNIT 1 ENGINE COMPONENTS 9 hours**

Overview - Material selection and Manufacturing methods for the Engine Components. Engine block – Casting – Conventional and expendable pattern. Cylinder head – Casting, machining, and thermal barrier coating. Crank shaft, connecting rod, camshaft – Forging, machining and heat treatment. Piston - Gravity, squeeze, die casting, machining, and finishing. Gudgeon Pin - Machining and Finishing, Valve forging, friction welding, machining, thermal barrier coating, heat treatment and surface improvement. Cylinder Liners, Piston ring - Centrifugal, HPDC, LPDC, machining and finishing. Castings Processes for Oil pan and Carburettors. Push Rods, Rocker Arm, Tappets, Spark Plug – Forging, Machining, Finishing and Heat treatment

| UNIT 2 | Drilling Jigs | 9 hours |
|---|---|---|

Drilling Jigs: design principles, drill bushes, Types of drilling jigs-template, plate type, swinging leaf, channel, box, angle plate, angular post, turnover, pot, universal jigs, Design and development of Jigs for given components.

| UNIT 3 | Fixtures | 9 hours |
|---|---|---|

Fixtures: General principles, lathe, milling, boring, broaching, grinding, planning, and shaping fixtures, simple welding fixtures, design and development of fixtures for given components.

| UNIT 4 | Press Working Terminologies | 9 hours |
|---|---|---|

Press Working Terminologies- Die block, die shoe. Bolster plate, punch holder, guide pins, bushes, strippers, knockouts, presses and press accessories, Computation of capacities and tonnage requirements. Types of dies- progressive, combination and compound dies, clearance, cutting forces, strip layout and strip layout calculations.

| UNIT 5 | Design and Development of Dies | 9 hours |
|---|---|---|

Design and Development of Dies: Design and development of progressive and compound dies for blanking and piercing operations, development of bending, forming, and drawing dies, design considerations in forging, extrusion, casting and plastic dies.

**Textbooks:**

1. P.C. Sharma, A Textbook of Production Engineering, S. Chand & company, 3/e, 1982

**References:**

1. Joshi, P.H., Jigs and Fixtures, 2/e, Tata McGraw-Hill, 2004.
2. Donaldson. C, Tool Design, 3/e, Tata McGraw-Hill, 1986.
3. Kempster, Jigs and Fixtures Design, The English Language Book Society, 1978.

**Course Outcomes:**

1. illustrate the concepts of casting, forging, welding and coatings processes.[L3]
2. explain the various material and suitable manufacturing methods for transmission components. [L4]
3. understand various surface treatments and welding processes for automobile body components. [L2]

4. understand the material and manufacturing selection methods for chassis components [L2]
5. understand the various selection of materials and manufacturing methods prototype of various automobile components [L2]

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO2** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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| MECH3091 | ADDITIVE MANUFACTURING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | 3D Modelling | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | CNC file formats | | | | | | |

**Course Description:**

*Additive manufacturing (AM), broadly known as 3D printing, is transforming how products are designed, produced, and serviced. AM enables on-demand production, without dedicated equipment or tooling, and unlocks digital design tools, giving breakthrough performance and unparalleled flexibility. Across industries, knowledge remains one of the greatest barriers to AM's wider adoption. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- Additive Manufacturing (AM) is an economically viable alternative to conventional manufacturing technologies for producing highly complex parts.
- Select and use the correct CAD formats in the manufacture of a 3D printed parts.
- Understand the operating principles, capabilities and limitations of Additive Manufacturing processes.
- Appreciate the differences and capabilities among liquid, sold and powder based Additive Manufacturing processes.
- Describe the important process parameters for bio-manufacturing and determine the suitable additable technique for bio- manufacturing.
- Impart fundamentals of additive manufacturing processes along with the various file formats, software tools, processes, techniques, and applications.

**UNIT 1 Introduction to Additive Manufacturing (AM) 9 hours**

Introduction to Additive Manufacturing (AM): Overview – History - Need-Classification - Additive Manufacturing Technology in product development- Materials for Additive Manufacturing Technology, Tooling - Applications. Classification of AM processes: Liquid polymer system, discrete particle system - molten material systems - solid sheet system.

**UNIT 2 CAD and Reverse Engineering 9 hours**

CAD and Reverse Engineering: Basic Conceptualization, CAD model preparation – conversion to STL - STL file manipulation - Part Orientation and support generation – Model Slicing –Tool path Generation – Transfer to AM - Machine setup, build, removal and clean up, post processing. Data Processing for Additive Manufacturing Technology - Software's for Additive Manufacturing Technology: MIMICS, MAGICS.

**UNIT 3 Liquid Based and Solid Based Additive Manufacturing Systems 9 hours**

Liquid Based and Solid Based Additive Manufacturing Systems: Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages, and applications - Solid based system – Fused Deposition Modeling - Principle, process, advantages and applications, Laminated Object Manufacturing.

**UNIT 4 Powder Based Additive Manufacturing Systems 9 hours**

Powder Based Additive Manufacturing Systems: Selective Laser Sintering – Principles of SLS process - Process, advantages and applications, Three-Dimensional Printing - Principle, process, advantages, and applications - Laser Engineered Net Shaping (LENS), Electron Beam Melting.

**UNIT 5 Medical And Bio-Additive Manufacturing 9 hours**

Medical And Bio-Additive Manufacturing: Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE) – Case studies.

**Textbooks:**

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2. Gibson, Rosen, Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing. Springer, 2009.
3. Frank W. Liou, Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development, CRC Press, Taylor and Francis Group, 2007.
4. Duc Pham, S.S. Dimov, "Rapid Manufacturing: The Technologies and Applications of

Rapid Prototyping and Rapid Tooling", Springer-Verlag London, 2001.

**References:**


1. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.
2. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
3. Hopkinson, Hague, Dickens, Rapid Manufacturing: An Industrial Revolution for the Digital Age. Wiley, 2005.
4. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.


**Course Outcomes:**

1. Understand the fundamentals of Additive Manufacturing Technologies for engineering applications.
2. Understand the methodology to manufacture the products using SLA and SGC technologies and study their applications, advantages, and case studies.
3. Understand the methodology to manufacture the products using LOM and FDM technologies and study their applications, advantages, and case studies.
4. Understand the methodology to manufacture the products using SLS and 3D Printing technologies and study their applications, advantages, and case studies.
5. Apply professional, ethical, legal, security and social issues in the design of AM processes.

**CO-PO Mapping:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO2** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH3101</td><td rowspan="2">COMPUTER INTEGRATED MANUFACTURING</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Manufacturing Technology</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">NC Part Programming, Material Handling</td></tr>
</table>

**Course Description:**

*This course provides basic knowledge about computer integrated manufacturing, and it deals with grouping technology which is one of the most important technology followed in leading industries. It provides the basic knowledge of Computer aided process planning, Artificial Intelligence, Integrative Manufacturing Planning and Control. CIM combines various technologies like computer-aided design (CAD) and computer-aided manufacturing (CAM) to provide an error-free manufacturing process that reduces manual labour and automates repetitive tasks. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- To introduce the concepts of automation, group technology integrated to Computer aided design and manufacturing.
- To obtain an overview on computer aided process planning
- To impart the knowledge of forecasting, scheduling capacity planning, shop-floor control in manufacturing systems and the concept of JIT manufacturing.
- To impart the basic knowledge of quality control, inspection methods and computer-aided testing
- To classify and summarize the manufacturing systems, and integration of CAQC with CAD/CAM

**UNIT 1 Introduction 10 hours**

Scope of computer integrated manufacturing, product life cycle, production automation. Group technology: Role of group technology in CAD/CAM integration, methods for developing part families, classification and coding, examples of coding systems, facility design using group technology, economics of group technology.

**UNIT 2 Computer Aided Process Planning 9 hours**

Role of Process Planning, Approaches to process planning- manual, variant, generative approach, Implementation techniques, process planning systems – CAM-I'S CAPP system, MI Plan system, criteria for selecting a CAPP system, benefits and advantages of CAPP

**UNIT 3 Integrative Manufacturing Planning and Control 9 hours**

Role of integrative manufacturing in CAD /CAM integration, overview of production control, forecasting, master production schedule, capacity planning, MRP, order release, shop-floor control, quality assurance, planning and control systems, cellular manufacturing, JIT manufacturing philosophy.

**UNIT 4 Computer Aided Quality Control 8 hours**

Terminology in quality control, Automated inspection principles and methods, computer aided inspection, computer aided testing, contact inspection methods, noncontact inspection methods, integration of CAQC with CAD/CAM.

**UNIT 5 Computer Integrated Manufacturing Systems 8 hours**

Types of manufacturing systems, machine
tools and related equipment, material handling systems, computer control systems, FMS.

**Textbooks:**

1. Mikell P. Groover, Automation, Production Systems, and Computer Aided Manufacturing, 2/e., Prentice Hall, 2001
2. Mikell P. Groover, and Zimmers, CAD/CAM: Principles and Applications, 3/e, Tata-McGraw hill, 2010.
3. Dr. Sadhu Singh, Computer Aided Design and Manufacturing, Khanna Publishers

**References:**

1. M.M.M. Sarcar, K. Mallikarjuna Rao, K. Lalit Narayan, Computer Aided Design and Manufacturing, 2/e, Prentice Hall of India, 2008.

**Course Outcomes:**

1. To understand the concepts of Production Automation, Process Planning & Quality control in Computer Integrated Manufacturing Systems
2. To acquire the knowledge on quality control, computer aided testing and inspection methods
3. To analyse the Computer Aided Process Planning &Control, Material handling, and Artificial intelligence in FMS
4. To design and solve the problems of Forecasting, Scheduling, and capacity planning in manufacturing and assembling
5. To integrate computer aided design and computer aided manufacturing protocols to manufacture products

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO2** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH3111</td><td rowspan="2">AUTOMATION IN MANUFACTURING</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">CNC machining</td></tr>
<tr><td>Co-requisite</td><td colspan="7">NONE</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Material Handling</td></tr>
</table>

**Course Description:**

*Automated manufacturing systems operate in the factory on the physical product. They perform operations such as processing, assembly, inspection, and material handling. Manufacturing automation is the use of control systems, such as computers and information technologies for handling different processes and machines in an industry to replace a human being. Students will get exposure to automated manufacturing systems and their importance in the modern automated factory. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- To learn various concepts of automation and work part transport mechanisms
- To study the assembly systems and their applications.
- To understand the importance of handling systems and identification systems.
- To apply the concepts of part families and machine cells into various production systems
- To recognize the importance of automated inspection and to distinguish the various control systems

**UNIT 1** **Manufacturing and Automation-Overview** **10 hours**

Production systems, Automation in production systems, Automation principles and strategies, Reasons for Automation, Manufacturing operations, Functions in Manufacturing, Information processing in Manufacturing plant layout, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers and personal computers. Automation for machining operations.

**UNIT 2** **Assembly Systems and Line Balancing** **10 hours**

Assembly Process-Assembly lines-manual single stations assembly, Manual assembly line, automated assembly system-Line balancing. Automated Assembly Systems – Design for automated assembly-Types of automated assembly systems-Parts feeding devices.

**UNIT 3 Automated Material Handling and storage system 9 hours**

Material Handling and Identification Technologies: Material handling, equipment, Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Functions, material handling equipment-Conveyors, AGVS, Industrial Robots-Anatomy, Robot configurations, work volume-AS/RS. Automatic identification methods, Barcode technology, RFID.

**UNIT 4 Manufacturing Systems and Automated Production Lines 8 hours**

Manufacturing systems: components of a manufacturing system, Single station manufacturing cells, Automated production lines, Applications, Transfer lines.

**UNIT 5 Control Systems** and **Quality Control and Support Systems 8 hours**

**Control Systems**-Process Industries Versus Discrete Manufacturing Industries, Continuous Versus Discrete Control: Continuous Control Systems, Discrete Control Systems, Computer Process Control: Control Requirements, Capabilities of Computer Control, Forms of Computer Process Control

**Quality Control and Support Systems**-Quality in Design and manufacturing, inspection principles and strategies, Automated inspection, contact and non-contact, CMM and machine vision techniques.

**Textbooks:**

1. Milkell P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Kindle Edition, Prentice Hall of India, 2016.

**References:**

1. C. Roy, “Robots and Manufacturing Automation”, Asfahl John Wiley & Sons.
2. Krishna Kant, “Computer Based Industrial Control”, EEE-PHI, 2nd edition, 2010.

**Course Outcomes:**

1. understand various concepts of automation and work part transport mechanisms
2. recognize the importance of handling systems and identification systems.
3. understand various production systems and transfer lines and their applications
4. differentiate various quality control aspects and automatic inspection techniques in automation

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO2** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| MECH3121 | IOT IN MANUFACTURING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | Automation in manufacturing | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | CNC machining | | | | | | |

**Course Description:**

*This course exposes the students on diversity of digital controlled manufacturing processes and information systems developments. It also focuses on use of information technology in manufacturing applications in the organizations. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- To understand the concepts of digital manufacturing system
- To study the importance of organization and management information systems
- To understand the concepts of Information Technology Infrastructure
- To understand the techniques of product life cycle management
- To illustrate the application of digital manufacturing using information technology

**UNIT 1 Introduction to manufacturing systems and digital manufacturing 10 hours**

Introduction to manufacturing systems and approach: Manufacturing organizations, management, and the networked enterprises, Globalization challenges and opportunities, Dimensions of Information systems, Approaches to study information system, Technical and Behavioural approach.
Introduction to Digital Manufacturing: Definition of digital manufacturing, Operation Mode, and Architecture of Digital Manufacturing System.

**UNIT 2 Organizations, management, and the networked enterprise 9 hours**

Information systems in global business today, Global e-business: Use of information systems in manufacturing functions, information system, organizations, and strategy, ethical and social issue in information systems.

**UNIT 3 Information Technology Infrastructure 9 hours**

IT Infrastructure and Emerging Technologies, Foundations of Business Intelligence: Databases and Information Management, Telecommunications, the Internet, and Wireless Technology, Securing Information Systems, Shop floor communications.

**UNIT 4 Product Life Cycle Management 8 hours**

Introduction, Types of Product Data, PLM systems, Features of PLM System, System architecture, Product information models, Functionality of the PLM Systems.

**UNIT 5 Key System Applications 9 hours**

Achieving Operational Excellence and Customer Intimacy: Enterprise Applications, E-Commerce: Digital Markets, Digital Goods, Managing Knowledge, and Collaboration, Enhancing Decision Making.

**Textbooks:**

1. K. Laudon and J. Laudon, Management Information Systems, 14th edition, Pearson Higher Education, 2016, ISBN: 9780136093688.
2. F. Cecelja, Manufacturing Information and Data Systems, 1st edition, Butterworth - Heinemann, 2002, ISBN: 97 81857180312.

**References:**

1. T. O. Boucher and A. Yalçin, Design of Industrial Information Systems, 1st edition, Elsevier, 2006, ISBN: 9780123704924.
2. K. E. Kurbel, Enterprise Resource Planning and Supply Chain Management: Functions, Business Processes and Software for Manufacturing Companies, 1st edition, Springer, 2013, ISBN: 9783662509869.
3. Antti Saaksvuori and AnselmiImmonen, “Product Life cycle Management”, Springer, 2004.
4. M. P. Groover, Automation, Production systems and Computer Integrated manufacturing. 3rd edition, Pearson Education, 2015. ISBN: 978-9332549814.
5. M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1st edition, Morgan Kaufmann, 2010, ISBN-10: 0123748992

**Course Outcomes:**

1. Understand the concepts of Digital manufacturing information system [L1].
2. Understand the information systems in manufacturing functions [L1].
3. Apply knowledge on IT Infrastructure and Emerging Technologies [L3].
4. Analyze the functionality of the PLM Systems [L4].
5. Understand the application of Digital and Smart Manufacturing [L1].

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO2** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

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| MECH3131 | MODERN MANUFACTURING METHODS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | Manufacturing Process | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | CNC machining | | | | | | |

**Course Description:**

*Modern manufacturing is at the heart of industrial production, from raw materials to semi-finished products and finished goods. Over the last decade, several innovative approaches have been developed that enable for more adaptable, energy-efficient, and environmentally friendly production processes. The students will learn about modern manufacturing procedures that are used in today's industry. Modern manufacturing methods concentrate on crucial factors of manufacturing, such as waste reduction, manpower, materials, capacity, and so on. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*

**Course Educational Objectives:**

- An understanding of adaptive control to overcome the adverse effect of rapid changes in the system behavior.
- The Knowledge on manufacturing philosophies to achieve a competitive advantage through cost reduction and efficient service of customer demands.
- An understanding of form, fit and function of a part before expensive tooling is purchased.
- Comprehensive knowledge on material handling system to reduce UNIT cost of the part, reduced manufacturing cycle, reduced delays, and damage.
- Analyze the existing production systems for the purpose of optimization, design verification of new systems, bottlenecks of the project, risks etc.

**UNIT 1 Adaptive Control System 8 hours**

Adaptive Control (AC): Definition of adaptive control, Importance of adaptive control system, comparison of conventional, CNC and AC systems; classification of adaptive control, adaptive control constraint, adaptive optimization, adaptive controlled optimization for machining process

**UNIT 2** **Lean, Agile and JIT** **9 hours**

Lean, Agile and JIT Manufacturing: Introduction to Lean manufacturing, types of wastes in lean manufacturing, comparison lean and agile manufacturing, comparison of lean and agile. JIT Approach: Introduction, definition, elements of JIT, how JIT works, effects of JIT production, plant layout for JIT, product design for JIT, steps in implementation of JIT, benefits of JIT.

**UNIT 3** **Rapid Prototyping** **9 hours**

Rapid Prototyping: Definition, basic steps in rapid prototyping, various techniques in rapid prototyping - Stereolithography, Laminated Object Manufacturing, Selective Laser Sintering, Fused Deposition Modeling, Solid Ground Curing, 3D Printing; applications of rapid prototyping.

**UNIT 4** **Nano Manufacturing** **8 hours**

Introduction, definition, Importance of nanomaterials, Classification of preparation methods, Nanomaterial - synthesis and processing - Mechanical grinding, wet chemical synthesis - Sol-gel process, Gas phase synthesis – Chemical vapour deposition (CVD), characteristics of Nano particles, applications of nanomaterials

**UNIT 5** **Micromachining processes** **8 hours**

Definition, Need and applications of micromachining in engineering industries. Principle of mechanical, thermoelectric, electrochemical, and chemical micromachining processes - Size comparisons in micro manufacturing and micro products. Problems in micro machining.

**Textbooks:**

1. SeropeKalpakjian, Steven Schmid, Manufacturing Engineering and Technology, 7/e, Pearson Education Publications, 2013.
2. David D Bedworth, M R Henderson, Philip M Wolfe, Computer Integrated Design and Manufacturing, McGraw Hill College, 1991.

**References:**

1. Dr. Sadhu Singh, Computer Aided Design and Manufacturing, 5/e, Khanna Publishers, 2014.
2. P.N. Rao, CAD/CAM Principles and Applications, 6/e, Tata Mc Graw Hill, 2006.
3. Jain V. K., Introduction to Micromachining, 2nd edition, Narosa Publishers, New Delhi

2014.

**Course Outcomes:**

Upon completion of the course the students will be able to

1. Demonstrate a basic understanding of adaptive control machining; understand the various manufacturing philosophies, and role and material handling in manufacturing.
2. Analyze the importance of Lean and Agile manufacturing strategies over mass production and can demonstrate the improvement in productivity and quality of the components.
3. Improves the soft skills during development of customized software for manufacturing system simulation.
4. gives a clear insight in prototype development and use of advanced materials for the product development.
5. optimize. Design new systems

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO2** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

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SDG Justification:

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<table>
<tr><td rowspan="2">MECH3141</td><td rowspan="2">SMART MANUFACTURING SYSTEMS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Manufacturing Technology</td></tr>
<tr><td>Co-requisite</td><td colspan="7">NONE</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">NONE</td></tr>
</table>

**Course Description:**

*This course is designed with fundamentals of automation and knowledge based intelligent manufacturing systems and study of algorithms for in group technology. This course provides a general understanding of Group technology and automated process planning, Knowledge Based System for Equipment Selection (KBSES), Knowledge Based Group Technology. The unifying themes of this course are how manufacturing systems work and uses of in intelligent environments. We learn inference engines how it works. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*

**Course Educational Objectives:**

- This course is designed to introduce students to the basics of Machine leaning and learn intelligence and its application manufacturing domain.
- The course introduces knowledge-based systems where students learn about its basics Automated systems, Languages - ES Building Tools or Shells and its application in fault diagnosis, manufacturing, robotics, and CAPP (computer aided process planning).
- The course describes the importance of artificial intelligence in the manufacturing system
- This course combines value creation with strategic development in a manufacturing environment, providing you with the latest manufacturing techniques and processes
- This course is aimed to make the students understand the analysis of a complex problem and various solutions being followed with the help of real time case studies.

**UNIT 1** **Computer Integrated Manufacturing Systems** **8 hours**

**Structure** and functional areas of CIM system- CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems – MAP/TOP, OSI Model, Data Redundancy, Top down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing – System Components, System Architecture and Data Flow, System Operation.

**UNIT 2 Components of Knowledge Based Systems 10 hours**

Basic Components of Knowledge Based Systems, Knowledge Representation, Interference Engine, Knowledge Acquisition. Machine Learning – Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks, Applications in Manufacturing.

**UNIT 3 Automated Process Planning 8 hours**

**Variant** Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning.

**UNIT 4 Knowledge Based System for Equipment Selection (KBSES) 8 hours**

Manufacturing system design, Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KBSES.

**UNIT 5 Group Technology 10 hours**

Models and Algorithms – Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation – Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Knowledge Based Group Technology - Group Technology in Automated Manufacturing System.

**Textbooks:**

1. Intelligent Manufacturing Systems by Andre Kusaic.
2. Artificial Neural Networks by Yagna Narayana
3. Automation, Production Systems and CIM by Groover M.P

**References:**

1. Neural Networks by Wasserman.

**Course Outcomes:**

On completion of this course students should be able to:

1. Comprehend basic concepts of AI, Knowledge based systems and manufacturing systems.
2. Understand the underlying concepts in programming languages PROLOG and LISP used in expert system.
3. Apply expert system for Manufacturing applications in CAD, CAPP, MRP, Adaptive Control, Robotics, Process Control, Fault Diagnosis, Failure Analysis, Process Selection and GT.
4. Link Expert Systems to readily available commercial software such as DBMS, MIS and MDB.
5. Develop the algorithm-based solutions using group technology in Automated Manufacturing Systems.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
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| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

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| MECH3272 | LEAN MANUFACTURING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | NONE | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | Inventory Control | | | | | | |

**Course Description:**

*This course focuses on a systematic strategy to minimize or eliminate waste and increase productivity in manufacturing systems. Waste is defined as anything else that customers do not believe adds value to their lives and for which they are unwilling to pay. The Lean approach starts with creating value for the end consumer, which means delivering the right products on time and at the right price. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- To understand the basics concepts of lean manufacturing
- To familiarize students to design cells in a way that some measure of performance is improved, and plant equipment's overall equipment effectiveness is increased.
- To impart the concepts of JIT.
- To introduce the concepts of Set Up Time Reduction, TQM, 5S, and VSM concepts.
- To familiarize Six Sigma and Pre-Production Planning (3P).

**UNIT 1 Introduction 8 hours**

objectives and principles of lean manufacturing, traditional Vs lean manufacturing, value creation and waste elimination, Introduction to lean manufacturing tools.

**UNIT 2 Cellular Manufacturing and Total Productive Maintenance (TPM) 8 hours**

Cellular Manufacturing – Types of Layouts, Principles of Cell layout, Implementation. **TPM** – Pillars of TPM, Principles and implementation of TPM.

**UNIT 3 JIT 8 hours**

Introduction - elements of JIT - uniform production rate - pull versus push method- Kanban system - small lot size - quick, inexpensive set-up - continuous improvement.

**UNIT 4 Set Up Time Reduction, TQM, 5S, VSM 8 hours**

Set up time reduction – Definition, philosophies, and reduction approaches. TQM – Principles and implementation. 5S Principles and implementation - Value stream mapping - Procedure and principles.

**UNIT 5 Six Sigma and Pre-Production Planning (3P) 8 hours**

Six Sigma – Definition, statistical considerations, variability reduction, Six Sigma implementation, challenges and applications, design of experiments, steps in experimental design. 3P – Introduction, Implementation of 3P Approach, pros and cons of 3P Approach.

**Textbooks:**

1. Design and Analysis of Lean Production Systems, Ronald G. Askin& Jeffrey B. Goldberg, John Wiley & Sons, 2003.
2. Mikell P. Groover (2002) Automation, Production Systems and CIM.
3. Rother M. and Shook J, 1999 Learning to See: Value Stream Mapping to Add Value and Eliminate Muda ‘, Lean Enterprise Institute, Brookline, MA
4. Michael Wader, Lean Tools: A Pocket Guide to Implementing Lean Practices, Productivity and Quality Publishing Pvt Ltd, 2002

**References:**

1. Allan R. Coletta (2017), The Lean 3P Advantage A Practitioner's Guide to the Production, CRC Press.
2. Masaaki Sato, The Toyota Leaders – An Executive Guide, Vertical Inc, New York, 2008.
3. Montgomery DC, Design and Analysis of Experiments, 7th Edition, John Wiley & Sons, NY, 2008. 2. Ross PJ,
4. Taguchi Techniques for Quality Engineering, McGraw-Hill Book Company, NY, 2008.

**Course Outcomes:**

1. The student will demonstrate basic understanding and knowledge of lean manufacturing and its tools.
2. The student will describe basic knowledge of cellular manufacturing and total productive maintenance
3. The student will explain basic understanding of JIT.
4. The student will demonstrate the knowledge of set up time reduction, TQM, 5S, VSM approaches.
5. The student will explain the basic understanding of six sigma and Pre-Production Planning (3P).

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO2** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| MECH3273 | NON-DESTRUCTIVE TESTING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | NONE | | | | | | |
| **Co-requisite** | Welding Technology | | | | | | |
| **Preferable exposure** | Quality control | | | | | | |

**Course Description:**

*This course is very helpful for real time evaluation of both surface and volume defects generated in materials either during manufacturing process or while in service life. A student can get acquainted or trained on certain set of NDT testing Principle and Method those are popularly being practiced by Production Industry. In addition to some basic techniques on NDT, advanced technology in this field can be practiced by the student. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- Explains the concept of detecting defects in material without damaging the structure.
- Understanding special techniques to detect micro-cracks responsible for fatigue failure.
- Learning of detecting volumetric defects within materials by using magnetic and ultrasonic method.
- Understanding certain advanced NDT technique using concept of Eddy current, Thermal Infrared and Acoustic techniques.

**UNIT 1 Introduction to NDT and Discontinuities Origins and Classification 8 hours**

**Introduction to NDT:** Introduction, non-destructive versus destructive tests, conditions for effective non-destructive testing, personnel consideration, certification summary
**Discontinuities Origins and Classification:** Primary production of metals, castings, cracks, welding discontinuities, discontinuities from plastic deformation, corrosion – induced discontinuities, operationally induced discontinuities, fatigue cracking, creep, brittle fracture, geometric discontinuities

**UNIT 2 Penetrant Testing and Magnetic Particle Testing 9 hours**

Penetrant testing: Introduction, theory and principles, penetrant equipment and materials, penetrant procedures, penetrant procedures, techniques and variables, evaluation and disposition, penetrant testing applications. Magnetic Particle Testing: Introduction, theory and principles, equipment and accessories, techniques, variables, evaluation of test results and reporting, applications.

**UNIT 3 Radiography Testing and Radiation Safety and Radiation Safety 9 hours**

**Radiography Testing and Radiation Safety:** Introduction, theory and principles, geometric exposure principles, shadow formation, shadow sharpness, radiographic equipment and accessories, variables, techniques and procedures, radiographic evaluation, applications, compendium of radiographs.

**Radiation Safety:** Special and SI UNITs of radiation, principles of radiation detectors – ionization chamber, proportional counter, G.M. counters, scintillation counters, solid state detectors, biological effect of ionizing radiation, operational limits of exposures, radiation hazards evaluation and control, design of radiography installation and shielding calculations.

**UNIT 4 Ultrasonic Testing 8 hours**

Introduction, theory and principles, equipment for ultrasonic applications, techniques, variables, evaluation of test results, applications, basic instrument calibration, calibration blocks (IIW block, ASTM blocks, distance amplitude block, area amplitude block), cables, 157 connectors, test specimens. Reference reflectors for calibration (side drilled holes, notches, etc.,), inspection calibration, comparison with reference blocks, reference for planned tests (straight beams, angle beam), transmission factors – factors affecting the performance of ultrasonic test.

**UNIT 5 Other NDT Techniques and Thermal Infrared Testing 8 hours**

**Other NDT Techniques:** Eddy current testing; Introduction, theory and principles, alternating current principles, eddy current, test equipment's, eddy current applications and signal display, advantages and limitations

**Thermal Infrared Testing:** Introduction, theory and principles, equipment and accessories, techniques, variables, data storage, applications, advantages and limitations, thermal chalks Acoustic Emission Testing: Introduction, principles of acoustic emission testing, advantages, and limitations of acoustic emission testing.

**Textbooks:**

1. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, 2/e, Tata McGraw Hill, 2011

**References:**

1. C. Hellier, Handbook of Non-Destructive Evaluation, 1/e, McGraw Hill Professional, 2001. 2. B. Raj, T. Jayakumar, and M. Thavasimuthu.

2. Practical Non-Destructive Testing, 3/e, Alpha Science International, 2002.Non-Destructive Examination and Quality Control, 9/e, ASM

**Course Outcomes:**

1. The student will demonstrate basic understanding and knowledge of different types of defects.
2. The student will describe basic knowledge of Penetrant Testing and Magnetic Particle Testing.
3. The student will explain basic understanding of Radiography Testing and Radiation Safety.
4. The student will demonstrate the knowledge of ultrasonic testing.
5. The student will explain the basic understanding of Other NDT Techniques, Thermal Infrared Testing and Acoustic Emission Testing.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO2** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO3** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO4** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| **CO5** | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| Course Code | Course Title | L | T | P | J | S | C |
|---|---|---|---|---|---|---|---|
| 24MECH4141 | **Alloys for Additive Manufacturing** | 3 | 0 | 0 | 0 | 0 | 3 |
| **Course Owner** | Department of Mechanical Engineering | **Syllabus version** | | | | 1.0 | |
| **Course Pre-requisite(s)** | Materials Science, Basic Manufacturing | **Contact hours** | | | | 40 | |
| **Course Co-requisite(s)** | None | **Date Approved** | | | | | |
| **Alternate Exposure** | | | | | | | |

**Course Description**

This course focuses on the alloy materials used in additive manufacturing (AM), examining key techniques such as laser powder bed fusion, laser metal deposition, electron beam melting, and binder jetting. Students will explore essential processing parameters, powder production methods, and common challenges such as defects and process-induced issues. The course includes in-depth analysis of microstructure-property relationships for various alloys, including steels, titanium alloys, nickel superalloys, and aluminum alloys. It also addresses sustainability aspects by evaluating environmental impacts, lifecycle assessments, and eco-design strategies in the context of additive manufacturing.

**Course Objectives:**

1. Understand powder-based additive manufacturing techniques and processing parameters.
2. Analyze the effects of processing on material microstructure and properties.
3. Study the additive manufacturing of steels and titanium alloys.
4. Explore the AM of aluminum and high-entropy alloys.
5. Assess and apply sustainability practices in additive manufacturing.

**Course Outcomes:**

1. Know key powder-based AM techniques and parameters.
2. Analyze processing impacts on material properties.
3. Evaluate the performance of steel and titanium alloys in AM.
4. Assess properties of aluminum and high-entropy alloys in AM.
5. Apply sustainability principles to AM processes.

**UNIT I: Introduction to Powder based additive manufacturing**

Introduction to powder-based additive manufacturing techniques: Introducing 3D printing techniques such as laser powder bed fusion, laser metal deposition, electron beam melting, and binder jetting, identifying their key processing parameters. Introducing most common powder production methods.

Additive manufacturing challenges and applications: Introducing process-induced defects such as cracks, pores, surface roughness, and residual stress.

**Learning outcomes**

At the end of this Unit, the student will be able to

- Identify key powder-based AM techniques and parameters.

- Describe common powder production methods and their impact.
- Recognize common defects like cracks and pores.

**UNIT II: Processing-microstructure-property relationships**

Introducing the general microstructural characteristics of builds in terms of temperature gradients, solidification, and solid-solid phase transformations. How to restore the microstructure and the modelling approaches to predict its development.

**Learning outcomes:**

After completion of this unit, students will be able to

- Explain how processing affects microstructure and properties.
- Use models to predict microstructural changes.
- Analyze effects of temperature gradients and phase transformations.

**UNIT – III: Additive manufacturing of steels and Titanium alloys**

Introducing austenitic, marageing, precipitation hardening stainless, making emphasis on their microstructural hierarchy, strength, ductility, fatigue and wear properties.

Additive manufacturing of titanium alloys: Introducing Ti-6Al-4V, commercially pure titanium, and beta titanium alloys with a focus on their thermal behaviour, mechanical properties, anisotropy, and porosity.

**Learning outcomes:**

After completion of this unit, students will be able to

- Assess microstructure and performance of steels in AM.
- Analyze properties and challenges of titanium alloys in AM.
- Evaluate the additive manufacturing of nickel superalloys.

**UNIT – IV: Additive manufacturing of Aluminium alloys, Nickel based super alloys, and high entropy alloys**

Introducing AlSi10Mg, AlSi12, Scalmalloy, AlSi7Mg and AA6061 alloys with particular attention to their mechanical and fatigue properties. Additive manufacturing of nickel super alloys and high entropy alloys

**Learning outcomes:**

After completion of this unit, students will be able to

- Review mechanical and fatigue properties of aluminum alloys.
- Analyze high-entropy alloys for AM applications.
- Compare properties of various aluminum and high-entropy alloys.

**UNIT – V: Sustainability in Additive Manufacturing**

Introducing the environmental footprints of additive manufacturing in terms of resources required, waste and pollution, and its benefits. The techniques for lifecycle assessment to predict environmental impact before printing; as well as the social impact, life cycle costing and eco-design methodology to conceive new 3D printing processes and alloys.

**Learning outcomes:**

After completion of this unit, students will be able to

- Evaluate the environmental impact of AM processes.
- Apply lifecycle assessment to AM practices.
- Integrate eco-design to enhance AM sustainability.

**Text Books**

1. Manu Srivastava, Sandeep Rathee, Sachin Maheshwari, TK Kundra, Aadditive Manufacturing: Fundamentals and Advancements, Taylor and Francis, 2020
2. Helmi Youssef, Hassan El-Hofy, Mahmoud Ahmed, Fundamentals of Additive Manufacturing Principles, Technologies, and Applications, Taylor and Francis, 2025

**Reference Books**

1. Li Yang, Additive Manufacturing of Metals: Fundamentals and Applications, 1/e, Springer International Publishing, 2017
2. Jing Zhang, Yeon-Gil Jung, Additive Manufacturing: Materials, Processes, Quantifications and Applications, 1/e, Elsevier Butterworth Heinemann, 2018

| **Course Outcome - Programme Outcome Mapping** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcomes:** | **Programme Outcomes** | | | | | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
| 1 | 3 | 3 | 3 | 3 | | 3 | | 2 | 1 | 2 | 2 | 1 | 3 | 3 | 2 |
| 2 | 3 | 3 | 3 | 3 | | 3 | | 2 | | 2 | 2 | | 3 | 3 | 2 |
| 3 | 3 | 3 | 3 | 3 | | 3 | | 2 | | 1 | 2 | | 3 | 3 | 2 |
| 4 | 3 | 3 | 3 | 2 | | 3 | | 2 | 1 | 3 | 2 | | 3 | 3 | 2 |
| 5 | 3 | 3 | 3 | 2 | 2 | 3 | | 2 | 1 | 1 | 2 | | 3 | 3 | 2 |

| MECH3151 | PRODUCT DESIGN | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | MECH2051 Strength of Materials | | | | | | |
| **Co-requisite** | MECH3161 Product life cycle management | | | | | | |
| **Preferable exposure** | NONE | | | | | | |

**Course Description:**

*Product design describes the process of imagining, creating, and iterating products that solve users' problems or address specific needs in each market. The key to successful product design is an understanding of the end-user customer, the person for whom the product is being created. Product designers attempt to solve real problems for real people by using both empathy and knowledge of their prospective customers' habits, behaviours, frustrations, needs, and wants. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- Effective use of modelling/prototyping techniques (2D and 3D) in the generation, manipulation, and presentation of design ideas.
- Identification of market Opportunity, user needs and use context.
- Creative solution ideation (through conceptual design strategies).
- Time management and effective working practice.

**UNIT 1 Introduction 9 hours**

Design methodology and philosophy, types of design, design models, development product life cycle. Product development process, reverse engineering and redesign of product development process, theory, and methodology in design.

**UNIT 2 Design Process 9 hours**

Need, analysis, scope of the product, mission statement, customer study, Kano-diagram. Establishing product function, functional decompositions, FAST and SOP, functions structures. Building up a design team. Designing quality into product, product discovery.

**UNIT 3** **Plan for Design** **8 hours**

Product teardown, planning for deliverables, building a plan, product specifications-QFD, contradiction to generate ideas, theory of inventive machines-TRIZ, Decision matrix.

**UNIT 4** **Embodiment Design** **8 hours**

Product architecture, configuration, parametric design, systems approach, and other consideration of embodiment design.

**UNIT 5** **Industrial Design** **8 hours**

Human factor in design, design for easy operations, serviceability, aesthetics, and environment. Value Engineering: Cost evaluation, categories of cost, overhead cost, methods of development cost estimate, manufacturing cost, value analysis costing.

**Textbooks:**

1. Kevin Otto and Kristin Wood, Product Design, Pearson, 2004.
2. Karl T. Ulrich and Steven D. Eppinger, Production Design and Development, Tata McGraw Hill, 2007.

**References:**

1. David G. Ullman, The Mechanical Design Process, McGraw Hill, 2003.
2. George E. Dieter, Engineering Design, McGraw Hill, 2000.

**Course Outcomes:**

- Use the Product Design and Development Process, to manage the development of an idea from concept through to production.
- Employ research and analysis methodologies as it pertains to the product design process, meaning, and user experience.
- Use basic fabrication methods to build prototype models for hard-goods and soft-goods and packaging.
- Demonstrate, apply, explain, and recognize basic engineering, mechanical, and technical principles.
- Demonstrate, apply, explain, and recognize basic family of materials used in soft-goods and hard-goods, including sustainable materials and manufacturing processes.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | 2 | | 2 | 3 | 2 | | | | | 2 | 1 | 2 | 3 | 2 |
| **CO2** | | 2 | | 1 | 3 | 3 | | | | | | 2 | 2 | 1 | 2 |
| **CO3** | | 1 | | 2 | 2 | 3 | | | | | | 2 | 2 | 1 | 2 |
| **CO4** | | 1 | | 2 | 2 | 2 | | | | | 1 | 2 | 2 | 1 | 2 |
| **CO5** | | 1 | | 1 | 2 | 2 | | | | 2 | 1 | 2 | 2 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

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SDG Justification:

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| MECH2071 | INTRODUCTION TO ROBOTICS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | NONE | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | Basic of electrical and electronic Engineering, Engineering mathematics, Kinematics of machinery | | | | | | |

**Course Description:**

*This course helps in understanding the basics of robotics such as origin of robotics, types of robotics and various generation of robots. This course teaches the fundamentals of robotics required to design the robot anatomy, kinematics of robots, robot dynamics, robot drive systems, robot programming and its applications. The Knowledge gained from this course is to apply the concepts in handling the automated systems like assembly systems, material handling systems, storage, and retrieval systems. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- To familiarize the history and automation of robot, robot anatomy and its applications.
- To enhance the knowledge about robot end effectors, sensors, and their design as well as their applications.
- To illustrate the working of sensors and robotic vision system in robot operations/environment.
- To impart computational skills related to kinematic model of robots and acquire knowledge about Robot Programming methods & Languages of robot.
- To develop the ability of designing the robotic work cell systems and to maintain safety rules in integration of collaborative robots.

**UNIT 1 Fundamentals of Robotics 8 hours**

Introduction to robot, definition need and scope of robots, laws of robotics, robot anatomy, co-ordinate system, work envelop, robot classification, robot parts and functions, need of robot and its applications

**UNIT 2 Robot Drive systems and Control 10 hours**

Design of drive systems, Mechanical, hydraulic, and pneumatic drives, electric drives, motors, designing of end effectors, mechanical, hydraulic, vacuum, and magnetic grippers, Open and close loop control, linear control and PID control schemes of robotic manipulators.

**UNIT 3** **Robot Sensors and Machine vision** **8 hours**

Sensors in robotics, need of sensors, position sensor, tactile sensor, proximity and range sensors, wrist-force sensing, frame grabbers, robotic vision system, components of vision systems, image representation, image processing industrial applications of vision-controlled robotic systems

**UNIT 4** **Robot Kinematics and Robot Programming** **10 hours**

Forward and inverse kinematics of manipulators, Homogeneous transformations, D-H parameter notation, Jacobian notation, Joint space techniques, Cartesian space techniques, trajectory planning. Robot Programming Methods, and programming languages for robotics.

**UNIT 5** **Robot Cell Design and Application** **8 hours**

Robot work cell design and control, safety in robotics, robot cell layouts, multiple robots and machine interference, robot cycle time analysis. Industrial application of robots.

**Textbooks:**

1. Robotics and Control / Mittal R K &Nagrath I J / TMH
2. Robotics: Control, sensing, vision and intelligence, Fu, K., Gonzalez, R. and Lee, C. S. G McGraw Hill.

**References:**

1. Robotics: Fundamental concepts and analysis, A. Ghosal, Oxford university press
2. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, Industrial Robotics, Technology programming and Applications, McGraw Hill International Edition, 2014
3. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics Control, Sensing Vision and Intelligence, McGraw Hill Book Company, 2008

**Course Outcomes:**

1. Illustrate different types of robots as per their configuration and workspace
2. Understand the basic components of robots drive systems, robot grippers and the control mechanism of robot manipulators
3. Comprehend and interpret various aspects relating to the sensors of robots and robot vision system
4. Compute and analyse the Forward and inverse kinematic models of robots, robot programming languages
5. Design of robot work cells and their operational work-space characteristics, interpret basic safety guidelines for robotic applications

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | P O8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 1 | 3 | 0 | 0 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 1 | 2 | 0 | 0 | 1 | 1 | 2 | 1 | 2 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 2 | 1 | 3 | 0 | 0 | 1 | 1 | 2 | 1 | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 1 | 1 | 0 | 0 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 1 | 2 | 0 | 0 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

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SDG Justification:

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<table>
<tr><td rowspan="2">MECH2081</td><td rowspan="2">ADVANCED STRENGTH OF MATERIALS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">MECH2051 Strength of Materials</td></tr>
<tr><td>Co-requisite</td><td colspan="7">NONE</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">NONE</td></tr>
</table>

**Course Description:**

*This course introduces advanced topics in solid mechanics such as columns, thick cylinders, and curved beams. It explains the failure phenomenon to be considered for the design of structures as well as techniques to solve statically indeterminate structures. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To introduce the concept of columns and struts
- To demonstrate the calculation of bending moments and deflections of fixed and continuous beams.
- To explain the concept of shear center and curved beams
- To calculate stresses in thick & compound cylinders
- To analyze fracture in solids

**UNIT 1 Columns and Struts 10 hours**

Euler's theory, equivalent length, limitations of Euler's theory, Rankine formula, strut with eccentric loading, strut with initial curvature- Simple problems.

**UNIT 2 Fixed and continuous beams 10 hours**

Moment-area method, Macaulay's method, Clapeyron's three-moment equation, moment distribution method.

**UNIT 3 Shear Centre and Curved Beams 8 hours**

Shear centre: Shear flow in thin-walled sections, shear centre for axi-symmetric and unsymmetrical sections.
Curved Beams: Winkler-Bach formula, Neutral axis of rectangular, circular, and trapezoidal cross-sections, problems related to stresses in curved beams.

**UNIT 4** **Thick Cylinders** **8 hours**

Lame's equation for stresses in thick cylinders, Stress distribution in Compound Cylinders – Shrink fits.

**UNIT 5** **Fracture Mechanics** **9 hours**

Brittle Fracture, Stress Intensity Factor, Fracture Toughness, Fracture Conditions, Fracture Modes

**Textbooks:**

1. S. S. Rattan, Strength of materials, 3/e, Tata McGraw-Hill, 2016.
2. L. S. Srinath, Advanced mechanics of solids, 3rd Edition, McGraw-Hill, 2009.

**References:**

1. R. G. Budynas, Advanced Strength and Applied Stress Analysis, 2nd Edition, McGraw Hill, 1999.
2. P. Boresi, R. J. Schmidt, Advanced Mechanics of Materials, 6th Edition, John Willey and Sons, 2009.
3. M. H. Sadd, Elasticity: theory, applications, and numeric, 3rd edition, Academic Press, 2014.

**Course Outcomes:**

After successful completion of this course student will be able to

1. Design and analyze a column/strut for different loading conditions [L3]
2. Evaluate the moments, deflections in fixed and continuous beams [L4]
3. Locate shear center and calculate stresses in curved beams [L4]
4. Analyze stresses due to shrink fits in cylindrical pressure vessels [L4]
5. Analyze the modes of failure due to various types of loading [L4]

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 2 |
| CO2 | 3 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 2 |
| CO3 | 3 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 1 |
| CO4 | 3 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 2 |
| CO5 | 3 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

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SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH2091</td><td rowspan="2">FINITE ELEMENT ANALYSIS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">MECH2051 Strength of Materials and MECH2011 Thermodynamics</td></tr>
<tr><td>Co-requisite</td><td colspan="7">NONE</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Basics of calculus, numerical methods</td></tr>
</table>

**Course Description:**

*Finite Element Analysis is an approximate technique to solve the complex domain problems for which no closed form solutions are available. This course exposes the students to deal with various modeling techniques and uses different numerical methods for solving a system of governing equations over the domain of a continuous physical system, which is discredited into simple geometric shapes called finite element. This course also capitalizes on knowledge of mechanics and solves problems that can only be tackled numerically on the computer. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- Introduce the basic principles of finite element analysis.
- Teach procedure to develop FEA model that represent a physical structure.
- Discuss the finite element solutions to static and dynamic structural problems.
- Demonstrate the methodology to model and to solve complex problems in engineering applications
- Familiarize the students with the knowledge and skills needed to effectively use commercial finite element software.

**UNIT 1 Introduction and Fundamental Concepts 8 hours**

**Introduction:** Historical Perspective of FEM and applicability to mechanical engineering problems.

**Fundamental Concepts:** Stresses and Equilibrium, Boundary conditions, Strain-Displacement relations, Stress-Strain relations, Plane stress, Plane strain, Temperature effects, Potential energy, and Equilibrium. Raleigh-Ritz method, Galerkin's method, Saint Venant‟s principle.

**UNIT 2 One-dimensional Problems and Trusses 8 hours**

**One-dimensional Problems**: Finite element modeling coordinates and Shape functions. Potential energy approach. Galerkin'sapproach, Assembly of the global stiffness matrix- mass matrix and load vector, Treatment of boundary conditions, Quadratic shape functions, Temperature effects.
**Trusses:** Plane trusses, Three-dimensional trusses.

**UNIT 3 Two-dimensional Problems Using Constant Strain Triangles and Axisymmetric Solids subjected to Axisymmetric Loading 8 hours**

**Two-dimensional Problems Using Constant Strain Triangles:** Finite element modeling, Constant strain triangle, in plane and bending, problem modeling and boundary conditions. **Axisymmetric Solids subjected to Axisymmetric Loading:** Axisymmetric formulation, Finite element modeling -triangular element, Problem modeling and boundary conditions

**UNIT 4 Isoperimetric Elements and Beams Two-dimensional Isoperimetric Elements and Numerical Integration and Beams 8 hours**

**Isoperimetric Elements and Beams Two-dimensional Isoperimetric Elements and Numerical Integration:** Four-node quadrilateral, Numerical integration, Higher-order elements.
**Beams:** Finite element formulation, Load vector, Boundary considerations, Shear force and bending moment

**UNIT 5 Dynamic considerations and Scalar field problems 8 hours**

**Dynamic considerations:** formulation, element mass matrices, evaluation of Eigen values and Eigen vectors.
**Scalar field problems:** Steady state heat transfer conduction and convection.

**Textbooks:**

1. Tirupathi.R. Chandrupatla, Ashok.D. Belegundu "Introduction to Finite Elements in Engineering", Pearson Education Limited, fourth edition ,2015
2. S.S. Rao, "Finite element method in engineering", Elsevier Butterworth-Heinmenn publications, fourth edition, 2011.

**References:**


1. OcZienkiewicz, Rl Taylor, Jz Zhu,” Finite Element Method Its Basis &fundamentals” Reed Elsevier India Pvt.ltd, 2015 edition.
2. JN Reddy, “An Introduction to the Finite Element Method” McGraw-Hill, 3rd edition, 2006.
3. P. Seshu ,“Finite element Analysis”, PHI Learning Pvt. Ltd, first edition, 2003.


**Course Outcomes:**

Understand the capability of FEA in mechanical engineering problems

1. Comprehend the solution path to engineering problems.
2. Apply the theoretical FEA concepts in solving simple to complex multi-physics FEA problems using advanced software’s.
3. Infer and analyze the results obtained from finite element analysis software
4. Make transparent judgments` with regards to the design or issues related to engineering problems

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | 2 | 3 | | | | | | | | | |
| **CO2** | 1 | 3 | 3 | 3 | | | | 2 | 1 | | 3 | | 2 | | 3 |
| **CO3** | 3 | 3 | 3 | 3 | | 3 | | 2 | | | 3 | | 3 | 1 | 1 |
| **CO4** | | | 3 | 3 | | 1 | | 2 | | | 1 | | 3 | 2 | 1 |
| **CO5** | | | 1 | 1 | | 2 | 3 | 3 | 2 | | 2 | 1 | 3 | 1 | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

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| MECH3161 | PRODUCT LIFE CYCLE MANAGEMENT | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | NONE | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | NONE | | | | | | |

**Course Description:**

*Leading manufacturing firms aim to base their product realisation processes on the use of digital models of the product and the IT-systems that support the product throughout its lifecycle. Information Technology (IT) supports a wide range of tasks throughout a product's lifecycle including managing requirements, generating concepts, defining geometry, simulating function and properties, planning production, managing spare parts, maintaining, recycling and retirement of the product. Industry has a strong need for engineers who are competent in using and adapting modern IT tools for product development and manufacturing. This requires knowledge and skills ranging from understanding the overall business down to the adaptation of IT tools. The course Product Lifecycle Management (PLM) aims to develop these skills. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- Familiarize with various strategies of PLM
- Understand the concept of product mapping and simulation.
- Develop New product development, product structure and supporting systems
- Interpret the technology forecasting and product innovation and development in business processes.
- Understand product building and Product Configuration

**UNIT 1 Introduction To Product Life Cycle Management 8 hours**

Product life cycle – Introduction, growth, maturity & decline, Product Lifecycle Management-Definition & Overview, Background for PLM-corporate challenges, Need of PLM, Components/Elements of PLM, Emergence of PLM, Significance of PLM - life cycle problems to be resolved, product development problems to be resolved.

**UNIT 2 Digital Life Cycle 8 hours**

Collaborative Product Development, Mapping Requirements to specifications. Part Numbering, Engineering Vaulting, Product reuse, Engineering Change Management, Bill of Material and Process Consistency. Digital Mock up and Prototype development. Virtual testing and collateral. Introduction to Digital Manufacturing.

**UNIT 3 Product Life Cycle Management System 8 hours**

Product life cycle management system- system architecture, Information models and product structure, Information model, the product information data model, the product model, functioning of the system. Reasons for the deployment of PLM systems.

**UNIT 4 Product Life Cycle Environment 8 hours**

Product Data issues – Access, applications, Archiving, Availability, Change, Confidentiality. Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Company’s PLM vision, The PLM Strategy, Principles for PLM strategy, preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection.

**UNIT 5 Components Of Product Life Cycle Management 8 hours**

Different phases of product lifecycle and corresponding technologies, Foundation technologies and standards e.g., visualization, collaboration and enterprise application integration, Core functions e.g., data vaults, document and content management, workflow and program management, Functional applications e.g., configuration management. Human resources in product lifecycle. PLM Case Study.

**Textbooks:**

1. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1852338105
2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006

**References:**

1. Product Lifecycle Management, Michael Grieves, Tata McGraw Hill, 2006.
2. Antti Saaksvuori, AnselmiIlmmonen, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003).

**Course Outcomes:**

1. Explain the various strategies of PLM and Product Data Management
2. Describe decomposition of product design and model simulation
3. Apply the concept of New Product Development and its structuring.
4. Analyze the technological forecasting and the tools in the innovation.
5. Apply the virtual product development and model analysis

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 0 | 0 | 2 | 2 | 2 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| **CO2** | 1 | 1 | 0 | 0 | 2 | 2 | 2 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| **CO3** | 1 | 1 | 0 | 0 | 2 | 2 | 2 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| **CO4** | 1 | 1 | 0 | 0 | 2 | 2 | 2 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| **CO5** | 1 | 1 | 0 | 0 | 2 | 2 | 2 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

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| MECH2101 | MECHANICAL VIBRATIONS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | MECH3001 Mechanics of Machinery | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | Mathematics basics | | | | | | |

**Course Description:**

*The primary objective of this course is to enable to build and solve mathematical models of vibrating systems. The response of single and two degree of freedom systems and continuous system under free and forced vibrations will also be covered. This course also introduces various vibrating instruments. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To introduce the concept of vibration and its classifications.
- To explain the response of a vibratory system under harmonic force.
- To explain the analysis of two degree of freedom systems.
- To evaluate the natural frequencies and mode shapes of vibrating systems.
- To explain different vibration measuring instruments.

**UNIT 1 Fundamentals of Vibration and Free Vibration of Single Degree of Freedom Systems 8 hours**

**Fundamentals of Vibration:** Brief history of vibration, Importance of the study of vibration, basic concepts of vibration, classification of vibrations

**Free Vibration of Single Degree of Freedom Systems**: Introduction, Free vibration of an undamped translational system, free vibration of an undamped torsional system, Raleigh's energy method, free vibration with viscous damping

**UNIT 2 Harmonically Excited Vibrations 8 hours**

Introduction, Equation of motion, response of an undamped system under harmonic force, Response of a damped system under harmonic force, Response of a damped system under harmonic motion of the base.

**UNIT 3 Two Degree of Freedom Systems 8 hours**

Introduction, Equation of motion for forced vibration, free vibration analysis of an undamped system, Torsional system

**UNIT 4 Determination of Natural Frequencies and Mode Shapes 8 hours**

Introduction, Dunkerley's formula, Rayleigh's method, Holzer's' method, Matrix iteration method, Jacobi's method

**UNIT 5 Vibration Measurement 8 hours**

Variable Resistance Transducers, Piezoelectric Transducers, Electrodynamic Transducers, Linear Variable Differential Transformer Transducer, Vibration Pickups – Vibrometer, Accelerometer, Velometer, Phase Distortion Frequency-Measuring Instruments, Vibration Exciters-Mechanical Exciters, Electrodynamic Shaker.

**Textbooks:**

1. S.S. Rao, Mechanical Vibrations, 5/e, Pearson publications, 2010.

**References:**

1. G.K. Grover, Mechanical Vibrations, 8/e, S. Chand & Co.
2. W.T. Thomson, Mechanical Vibrations, 2/e, Prentice Hill India.
3. S. Graham Kelly, Fundamentals of mechanical vibrations, 2/e McGraw-Hill.

**Course Outcomes:**

1. Develop the differential equation of motion of vibratory systems and analyze spring constants, masses, damping constants, natural frequency of single degree of freedom systems
2. Analyse harmonically excited single-degree-of-freedom vibration systems.
3. Formulate the equations of motion of two-degree-of-freedom systems
4. 4Determine the natural frequencies of vibration and the modal vectors by using Dunkerley's formula, Rayleigh's method, Holzers' method, Matrix iteration method, Jacobi's method
5. Design and conduct experiments to predict the vibrations.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 2 | 2 | 1 |
| **CO2** | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 2 | 2 | 1 |
| **CO3** | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 2 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 2 | 2 | 1 |
| **CO5** | 3 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 0 | 2 | 2 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

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| MECH3171 | MOBILE ROBOTICS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | MECH2071 Introduction to Robotics | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | Engineering mathematics, dynamics of machinery | | | | | | |

**Course Description:**

*This course is designed with fundamentals of mobile robots and study of algorithms for mobile robots. This course provides a general understanding of mobile robotics and related concepts such as kinematics and dynamics of mobile robots, sensing perception, localization, motion control, and planning. The unifying themes of this course are how mobile robots can navigate in known and unknown worlds and how to structure software to control a mobile robot. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To understand the basic concepts of robot locomotion and control systems of mobile robots.
- To impart and analyse the computational skills of robot kinematics and drive systems in mobile robots.
- To develop the ability to solve the problems and approaches of dynamic models in mobile robotics.
- To acquire the knowledge on vision-based sensors and localization systems and apply the concepts in robotic operation/environment.
- To offer knowledge on path planning algorithms to develop a robot for a given real-life application.

**UNIT 1 Robot Locomotion 8 hours**

Types of locomotion wheeled and legged mobile robots, stability of mobile robots (non-holonomic, omnidirectional) - controllability and maneuverability

**UNIT 2 Mobile Robot Kinematics 8 hours**

Forward and inverse kinematics, holonomic and nonholonomic constraints (unicycle, differential drive, tricycle, and car-like wheeled mobile robots (WMRs)) - kinematic models of 3-wheel, 4-wheel, and multi-wheel omni-directional WMRs.

**UNIT 3 Mobile Robot Dynamics 8 hours**

Dynamic modelling concepts and techniques of robots, dynamic models of simple car and legged robots, dynamic model of mecanum wheels and omni-directional robots, and dynamics simulation of mobile robots.

**UNIT 4 Perception and Localization 8 hours**

Passive and active sensors, sensors for mobile robots like global positioning system (GPS), Doppler effect-based sensors, vision-based sensors. Odometric position estimation, probabilistic mapping, Markov localization, Bayesian localization, and positioning beacon systems

**UNIT 5 Introduction to planning and navigation 8 hours**

Path planning algorithms based on A-star, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP)

**Textbooks:**

1. R. Siegwart, I. R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, The MIT Press, 2011
2. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, Principles of Robot Motion: Theory, Algorithms and Implementations, PHI Ltd.,

**References:**

1. Peter Corke, Robotics, Vision, and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.
2. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, Industrial Robotics, Technology programming and Applications, McGraw Hill International Edition, 2014
3. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics Control, Sensing Vision and Intelligence, McGraw Hill Book Company, 2008

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 1 | 3 | 0 | 0 | 1 | 1 | 2 | 1 | 0 | 0 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 1 | 2 | 0 | 0 | 1 | 1 | 2 | 1 | 0 | 3 | 0 |
| **CO3** | 3 | 2 | 3 | 2 | 1 | 3 | 0 | 0 | 1 | 1 | 2 | 1 | 3 | 0 | 0 |
| **CO4** | 3 | 3 | 3 | 2 | 1 | 1 | 0 | 0 | 1 | 1 | 2 | 1 | 0 | 0 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 1 | 2 | 0 | 0 | 1 | 1 | 2 | 1 | 2 | 0 | 0 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

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| MECH2111 | COMPUTATIONAL METHODS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | NONE | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | Intermediate Mathematics | | | | | | |

**Course Description:**

*This course is designed for Mechanical Engineering undergraduate students. It is designed for the students for the basic understanding of techniques for the numerical solution of algebraic equations, differentiation, integration used to solve engineering application problems. It addresses different numerical methods to solve differential and partial differential equations. It emphasizes application of different numerical techniques to practical engineering problems. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities*

**Course Educational Objectives:**

- To develop the mathematical skills in the areas of numerical methods.
- To focus on the theory and applications of numerical methods in many engineering subjects which require solutions of linear systems, finding eigen values, eigenvectors, interpolation, and applications, solving ODEs, PDEs.
- To help in the foundation of computational mathematics for postgraduate courses, specialized studies, and research.
- To train in developing the codes for implementing the numerical methods using any programming languages.
- To formulate a mathematical model for a given engineering problem.

**UNIT 1 Mathematical Modeling of Engineering Problems 9 hours**

**Mathematical Modeling of Engineering Problems:** Approximations: Accuracy and precision, round-off and truncation errors, error problem with example problems.
**Roots of Equations:** Formulations of linear and non-linear algebraic equations, solution with bisection, False-Position Method, Newton-Raphson and Secant methods.

**UNIT 2 Algebraic Equations 9 hours**

**Algebraic Equations:** Formulation of linear algebraic equations from engineering problems, solution of these problems by Gauss elimination method, pitfalls of elimination and techniques for improving the solutions, Gauss Seidel, convergence of iteration methods. LU decomposition methods for symmetric (Chelosky) matrices and solution of Tri-diagonal matrix (Thomas Algorithm).

**UNIT 3 Numerical Integration& Optimization 8 hours**

**Numerical Integration:** Numerical Integration: Trapezoidal, Simpson's 1/3 and 3/8 rule and Gauss quadrature method.
**Optimization:** Golden section search, Newton's method.

**UNIT 4 Initial Value Problems & Boundary Value Problems 8 hours**

**Initial Value Problems:** Ordinary differential equations, Euler, Heun's and Ralston methods. Runge-Kutta method of 3ed and 4th order.
**Boundary Value Problems:** Linear and nonlinear ordinary differential equations, boundary value problems over semi-infinite domain, solution of nonlinear equations by finite difference method

**UNIT 5 Finite Difference Methods 8 hours**

**Finite Difference Methods:** Laplace Equations: Finite difference discretization of computational domain, different types of boundary conditions, solution to elliptic equations. Parabolic Transient Diffusion Equations: Explicit and implicit formulation, Crank Nicolson Method.

**Textbooks:**

1. S.C. Chapra, R.P. Canale, ' Numerical Methods for Engineers ', Tata McGraw-Hill, India, 2016, 978-9352602131
2. S.P. Venkateshan, P. Swaminathan,' Computational Methods in Engineering ', Ane Publisher, India,2014, 978-9382127611

**References:**

1. S.K. Gupta,' Numerical Methods for Engineers ', New Age International, India,2019, 978-9387788794

**Course Outcomes:**

1. Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems
2. Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
3. Analyse and evaluate the accuracy of common numerical methods
4. Implement numerical methods using any programming language
5. Demonstrates mathematical models for a given engineering problem.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| **CO2** | 3 | 2 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 |
| **CO3** | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| **CO4** | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 0 |
| **CO5** | 2 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 1 | 0 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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| MECH2121 | CONTROL SYSTEMS ENGINEERING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | NONE | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | Basic of electrical and electronic Engineering, Engineering mathematics | | | | | | |

**Course Description:**

*This course is designed with the fundamentals of control system for advanced courses. It lays foundation for designing a control system, finding out its transfer function using different techniques, conversion from time domain to either s-domain or frequency domain, identifying the stability condition of the control system. It also aids in studying about sampled data control system, ways to identify stability of the system along with sampling process for sampled data control system. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To provide adequate knowledge about open and closed loop control systems.
- To analyze the transfer function of physical systems and introduce the control system components.
- To evaluate the response of the different order systems and analyze steady state error.
- To analyze the stability of the control systems and to study about sampling process.
- To understand sample data control system

**UNIT 1 Introduction to Control Systems 8 hours**

Basic elements of control systems. Examples of control systems: Simple pneumatic, hydraulic and thermal systems, open loop and closed loop control systems, series and parallel electrical systems, analogies, mechanical and electrical components

**UNIT 2 Techniques to Find Transfer Function 8 hours**

Feedback characteristics and effects of feedback, transfer function, Block diagram reduction technique, reduction of block diagrams, output to input rations. signal flow graph (SFG) technique, Mason's gain formula, block diagram to SFG, representation of linear equations in SFG form.

**UNIT 3 Transient and Steady-State Response Analyses 8 hours**

Laplace transformation, response of systems to different inputs viz. Step, impulse, pulse, parabolic and sinusoidal inputs, time response of first and second order systems, Time domain specifications, steady state errors and error constants of unity feedback circuit.

**UNIT 4 Stability Analysis 8 hours**

Stability definitions, characteristic equation, location of roots in the s-plane for stability, Routh - Hurwitz criteria of stability, frequency response, basic concepts of Nyquist stability criteria.

**UNIT 5 Sampled Data Control Systems 8 hours**

Sampled data control systems - functional elements, sampling process, z-transforms, properties, inverse z-transforms, response between samples-modified z-transforms, ZOH and first order hold process, mapping between s and z planes, pulse transfer functions, step response, stability analysis - Jury’s stability test.

**Textbooks:**

1. Katsuhiko Ogata., Modern Control Engineering, 4/e, Prentice Hall of India, 2004.
2. I J Nagrath and Gopal M., Control Systems Engineering, 4/e, New Age International, 2006.

**References:**

1. Benjamin, C Kuo, Automatic Control System, 7/e, Prentice Hall of India, 1993.
2. Richard, C. Dorf and Robert H. Bishop., Modern Control System Engineering, Addison Wesley, 1999.

**Course Outcomes:**

1. Design solutions for complex control system using different models.
2. Formulate a model and apply the basic principles to analyse it.
3. Apply the knowledge to solve complex control systems.
4. Select and apply appropriate techniques for analyzing the stability of the control systems.
5. Analyze the response of different order systems for various inputs.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 |
| **CO2** | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 |
| **CO3** | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 1 |
| **CO4** | 2 | 1 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 1 |
| **CO5** | 0 | 3 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| MECH2131 | TURBO MACHINERY | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | Fluid Mechanics, Thermodynamics | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | NONE | | | | | | |

**Course Description:**

*Turbo machines are basically rotodynamic machines which work on the principles of dynamic action. This course deals with the definition of a turbo machines, main parts, classification, and its comparison with positive displacement machines. The first and second laws of thermodynamics, adiabatic efficiency, drawing of velocity triangles diagram, dimensionless parameters are the common factors for the calculation of power of the turbo machines. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- Evaluate which turbine to be used in a Hydro Power Plant or a Gas Power Plant.
- Calculate the main dimensions of hydro- and steam-turbines.
- Evaluate which pump or compressor to be used in a process-, gas- or a fluid-system.
- To have knowledge about Hydro turbines, Gas turbines, Pump turbines, Centrifugal pumps, and Compressors.
- Use this knowledge in projects where this turbo machinery is a part of for example a process system or a power plant

**UNIT 1 Introduction and Thermodynamics of fluid flow 8 hours**

**Introduction:** Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification of turbo machines, Dimensionless parameters and their significance, UNIT and specific quantities, model studies and its numerical.
**Thermodynamics of fluid flow:** Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, overall isentropic efficiency, stage efficiency and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process.

**UNIT 2 Energy transfer in Turbo machines and General Analysis of Turbo 8 hours**

**machines**

**Energy transfer in Turbo machines:** Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor.

**General Analysis of Turbo machines:** Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance. General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles

| **UNIT 3** | **Steam Turbines and Reaction turbine** | **8 hours** |
|---|---|---|

**Steam Turbines:** Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, multi-stage impulse turbine, expression for maximum utilization factor

**Reaction turbine** – Parsons's turbine, condition for maximum utilization factor, reaction staging.

| **UNIT 4** | **Hydraulic Turbines and Kaplan and Propeller turbines** | **8 hours** |
|---|---|---|

**Hydraulic Turbines:** Classification, various efficiencies.

**Pelton Wheel** – Principle of working, velocity triangles, design parameters, maximum efficiency

**Franci's turbine** – Principle of working, velocity triangles, design parameters

**Kaplan and Propeller turbines** - Principle of working, velocity triangles and design parameters. Theory and types of Draft tubes.

| **UNIT 5** | **Centrifugal Pumps, Centrifugal Compressors andAxial Flow Compressors** | **8 hours** |
|---|---|---|

**Centrifugal Pumps:** Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel.

**Centrifugal Compressors:** Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging

**Axial Flow Compressors**: Expression for pressure ratio developed in a stage – work done factor, efficiencies, and stalling.

**Textbooks:**

1. Turbo Machines B.U. Pai Wiley India Pvt, Ltd 1st Edition Universities Press, Hyderabad, 2006.Machines, McGraw Hill Education, 2017
2. An Introduction to Energy Conversion, Volume III, Turbo machinery V. Kadambi and Manohar Prasad New Age International Publishers reprint 2008 Applications, 3/e, Tata McGraw Hill, 2013.
3. Turbo machines M. S. Govind Gowda and A. M. Nagaraj M. M. Publications 7Th Ed, 2012
4. Fundamentals of Turbo Machinery B.K Venkanna PHI Publishers

**References:**

1. Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier 2005
2. Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002 3. Principals of Turbo machines D. G. Shepherd the Macmillan Company 1964

**Course Outcomes:**

1. Understand the basics of turbo machines including dimensional analysis (L1)
2. To understand the principles and energy transfer process in turbo machines. (L2)
3. To understand the structural and functional aspects of major components of turbo machines. (L3)
4. Analyse the turbo machines to improve and optimize its performance (L4)
5. To understand control and maintenance aspects of turbo machines (L4)

**CO-PO Mapping:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 2 |
| **CO2** | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| **CO3** | 2 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 3 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

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<table>
<tr><td rowspan="2">MECH2141</td><td rowspan="2">COMPUTATIONAL FLUID DYNAMICS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Fluid Mechanics, Heat and Mass Transfer</td></tr>
<tr><td>Co-requisite</td><td colspan="7">NONE</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">NONE</td></tr>
</table>

**Course Description:**

*This course helps to understanding the importance of governing equations while solving fluid flow problems. It explains the importance of Navier-Stokes equation, boundary conditions and various types of boundary conditions. Also, it explains essence of boundary conditions while solving the realistic physics involved in the engineering problems. The course helps to acquire the knowledge on formulation of mathematical model and its solution using finite difference and finite volume method. In addition to, various errors come across during simulation and importance of convergence, consistency of the solution. Moreover, it provides various grid generation and FVM methods to solve fluid flow problems. It explains the introduction to turbulence modelling and various models used in fluid flow. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To provide the students with essential background to understand the mathematical representation of the governing equations for fluid flow problems.
- To equip the students to formulate fluid flow problems by approximating the governing differential equations with boundary conditions through Finite difference and finite volume discretization methods.
- To acquire the knowledge of various grid generation methods and approximation of errors while solving problems subsequently suitability for different engineering applications.
- To introduce various turbulence for solving engineering problems.

| **UNIT 1** | **Introduction** | **8 hours** |
|---|---|---|

CFD overview, importance of CFD in modelling the engineering problems, application of CFD in various engineering field. Conservative and Non-conservative form, Governing equations-Mass, Momentum and Energy.

**UNIT 2** **Biomass Pyrolysis** **8 hours**

Numerical solution of PDE: Classification of PDEs- elliptic, parabolic and hyperbolic Boundary conditions: Classification of boundary conditions, explain with suitable example, definition of BVP and IVP; Finite difference method (FDM): Basic aspects of Discretization-Comparison of finite difference, finite volume, and finite element techniques

**UNIT 3** **Biomass Gasification** **8 hours**

Finite difference method (FDM): Forward, Backward and Central difference schemes, Transient 1D and 2D conduction - Explicit, implicit. Stability analysis and error estimation

**UNIT 4** **Biomass Combustion** **8 hours**

Finite volume method (FVM): Concept of discretization, methods of deriving discretization equations, finite volume method for one dimensional steady state diffusion, conservativeness, boundedness, transportiveness, four basic rules for FV discretization, assessment of central and upwind differencing schemes

**UNIT 5** **Biogas** **8 hours**

Incompressible Fluid Flow: Discretization of the momentum equation. Primitive variable approach, staggered grid and collocated grid, SIMPLE algorithm, SIMPLER algorithm. Introduction to turbulence models

**Textbooks:**

1. J.D. Anderson Jr., Computational Fluid Dynamics, 2/e, McGraw Hill, 2012.
2. H.K. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Pearson, 2007

**References:**

1. Gautam Biswas, Somenath Mukherjee, Computational Fluid Dynamics, Narosa, 2013
2. T.J. Chung, Introduction to Computational Fluid Dynamics, Cambridge University Press, 2010
3. J.H. Ferziger, M.Peric, Computational Methods for Fluid Dynamics, Springer, 2002

**Course Outcomes:**

1. Apply mathematics and engineering fundamentals to formulate mathematical problem by imposing appropriate boundary conditions and governing equations
2. Solve 1D and 2D governing equations using FDM schemes
3. Adopt appropriate grid generation methods for solving engineering problems

accurately.
4. Solve fluid flow and heat transfer problems using commercial CFD tools.
5. Comprehend the application of turbulence models used in incompressible fluid flow analysis.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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| MECH2151 | REFRIGERATION AND AIR CONDITIONING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | Heat and Mass Transfer | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | NONE | | | | | | |

**Course Description:**

*This course helpful to understand the working of various refrigeration systems and their applications. It helps to explore desired properties of refrigerants and selection of refrigerant for eco-friendly environment. The course provides fundamental understanding the concept of thermal comfort, prediction of thermal comfort and indices. It provides importance of infiltration and IAQ in assessing the thermal comfort of inhabitants. Also, it helps to understand the estimation of thermal load in a building and discussion of few methods and pertinent parameters. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities*

**Course Educational Objectives:**

- To provide the students with essential background to understand concept of refrigeration and refrigeration systems.
- To understand the importance of refrigerant properties and effect on environment
- To acquire the knowledge of thermal comfort concept and relevant indices to measure. Also, to explore the importance of IAQ parameters
- To introduce various aspects of cooling/heating load estimation.
- To understand the periodic heat transfer through building wall and roof.

**UNIT 1 Introduction 8 hours**

Definition of Refrigeration and Air Conditioning, History of Refrigeration and Air conditioning History from conceptual point of view - Ice production by nocturnal cooling in ancient India and application of evaporative cooling in India. Vapour Compression Refrigeration Systems-working and analysis, efficiency, Vapour Absorption Refrigeration Systems- Water- Ammonia Systems, Practical problems, Lithium- Bromide System.

**UNIT 2** **Refrigerant** **8 hours**

Refrigerants – Early refrigerants ($SO_2$, $CO_2$, $CH_3Cl$, $CH_4$, $C_2H_6$ etc.), Thermodynamic properties and desired properties of refrigerants, Introduction of CFCs and HCFCs, Ozone layer depletion, Comparison between different refrigerants, Special issues and practical implications.

**UNIT 3** **Design of air-condition systems** **8 hours**

Air conditioning systems for comfort - Thermal comfort. Heat transfer from human body by sensible and latent heat transfer. Metabolic heat generation, steady state and unsteady state model for heat transfer, effect of clothing and definition of effective temperatures. PMV and PPD. ASHRAE comfort chart. Inside and Outside design conditions, summer air conditioning systems, Winter air conditioning systems, All year air conditioning systems

**UNIT 4** **Air requirements in air conditioners** **8 hours**

Infiltration- Infiltration and ventilation, Infiltration due to stack effect, temperature difference and wind velocity, Infiltration due to door openings. Indoor Air Quality (IAQ)-Sources of indoor air pollution, Methods of control of IAQ, Fresh air requirements for ventilation and IAQ

**UNIT 5** **Load calculations** **8 hours**

Heating and Cooling load calculations- Differences between winter and summer load calculations, Solar Radiation-Distribution of solar radiation, Direct and diffuse solar radiation, Earth sun angles and their relationship. Thermal resistance of various building materials, Periodic heat transfer through walls and roof-Governing equations, Methods of solution, Decrement factor and Time lag method, Equivalent Temperature difference Method and CLTD Method.

**Textbooks:**

1. Air conditioning principles and systems by Edward G. Pita, PHI (Prentice Hall of India).
2. Arora, C. P., “Refrigeration and Air Conditioning”, Tata McGraw-Hill

**References:**

1. Refrigeration and Air Conditioning by W.F. Stocker and J. W. Jones, McGraw-Hill
2. Refrigeration and Air Conditioning by Ameen Ahmadul, PHI India

3. Refrigeration and Air Conditioning by Manohar Prasad, New Age International Publisher

**Course Outcomes:**

1. classify different types of refrigeration systems and choose them for a particular application (L3)
2. classify different refrigerant and use for based on their ozone depletion potential (L2)
3. identify the comfort conditions of a geographical area based on atmospheric conditions (L2)
4. perform fresh air calculations for comfort conditions (L3)
5. perform cooling load calculations and design an air conditioning system (L3)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 3 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

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| MECH2161 | CRYOGENICS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | Heat and Mass Transfer, refrigeration and air conditioning | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | NONE | | | | | | |

**Course Description:**

*This course focuses mainly on the on the basics of cryogenic Engineering, different cryogenic fluids and their properties such as Thermal, chemical, mechanical, and electrical conductive properties, Applications, Gas separation and Purification, design of system, safety, components of cryogenic system, and Instruments. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To encourage the dissemination of information concerning low temperature processes and techniques.
- To understand the basic principles of cryogenic processes.
- To bring together those in all disciplines concerned with the applications of low temperature technology.
- To understand the basic design of a cryocooler
- To increase public awareness of the usefulness of cryogenic technology.

**UNIT 1** **Introduction to Cryogenics** **8 hours**

Introduction: Cryogenic engineering, properties of cryogenic fluids like Oxygen, Nitrogen, Argon, Neon, Florin, Helium, Hydrogen, Properties of material at cryogenic temperature-mechanical, thermal, and electrical-Super conductivity, application of cryogenic systems.

**UNIT 2** **Cryogenic Refrigeration** **8 hours**

Cryogenic refrigeration: Principle and Methods of production of low temperature and their analysis: Joule Thomson Expansion, Cascade processes, Ortho and para hydrogen conversion, cold gas refrigerators, Linde -Hampson cycles, Claude and cascaded systems, magnetic cooling, Stirling Cycle Cryocoolers, Philips refrigerators, Gifford single volume refrigerator, Pulse tube refrigerators

**UNIT 3** **Cryogenic Components** **8 hours**

Cryogenic requirements: Cryogenics Heat Exchangers, Compressors, Expanders, Effect of various parameters in performance and system optimization. Various insulations (expanded foams, gas filled, fibrous, vacuum, multi-layer etc.) and Storage equipment for cryogenic fluids, industrial storage and transfer of cryogenic fluids

**UNIT 4** **Gas separation and Purification** **8 hours**

Gas separation and purification systems – Properties of mixtures, Principles of mixtures, Principles of gas separation – Air separation systems- Cryogenic Refrigeration Systems, Working media- Cryostat – Cryon Coolers- Applications – Space technology.

**UNIT 5** **Safety and Applications of Cryogenics** **8 hours**

Cryogenic instrumentation and safety: Properties and characteristics of instrumentation, strain displacement, pressure, flow, liquid level, density, and temperature measurement in cryogenic range. Safety in cryogenic fluid handling, storage, and use. Applications: Super conductive devices such as bearings, motors, cryotrons, magnets, D.C. transformers, tunnel diodes, space technology, space simulation, cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsions

**Textbooks:**

1. Cryogenic Systems – R.F. Barron, Oxford University.
2. Cryogenics Engineering – R. B. Scott, Von Nostrand Inc, New Jersey, 1959
3. T.M Flynn, Cryogenic Engineering, Maxwell Dekker, 1997.
4. R W Yance and WM Duke, Applied Cryogenic Engineering, John Willey

**References:**

1. Cryogenic Engineering – Thomas M.
2. Handbook of Cryogenic Engineering – J.G.Weisend –II, Taylor and Francis, 1998
3. Cryogenic mixed Refrigerant processes by G. Venkataratnam, IIT Madras.

**Course Outcomes:**

1. Possess basic knowledge of cryogenics.
2. Design cryogenic systems.
3. Find applications of cryogenics
4. Demonstrate the knowledge of cryogenic instrumentation
5. Demonstrate the instruments of cryogenic systems

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | P O8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 3 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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<table>
<tr><td rowspan="2">MECH3181</td><td rowspan="2">VEHICLE TECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Thermal Engineering</td></tr>
<tr><td>Co-requisite</td><td colspan="7">NONE</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">NONE</td></tr>
</table>

**Course Description:**

*To acquire knowledge of Vehicle and to make the student understand the working of different Sub systems of vehicle and emphasize the need for maintenance of automotive equipment. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- To familiarize concepts of transmission system for power transfer from Prime mover to wheels.
- To explain different mechanisms and working of transmission system.
- To teach the concepts of clutches and gears
- To introduce the concept of Steering and suspension system
- To introduce the concept of Steering and suspensions system

**UNIT 1 Chassis and Clutches 8 hours**

Introduction: Classification of Vehicles.

Chassis: Introduction of chassis, classification, conventional construction - frameless construction, -transmission and arrangements.

Clutches: Necessity of clutch in an automobile, different types of clutches, friction clutches namely Single plate clutch, multi plate clutch, cone clutch, centrifugal clutch, electromagnetic clutch, hydraulic clutches, Clutch-adjustment, Clutch troubles and their causes, requirements of a clutch, Clutch materials, clutch lining Vacuum operated clutch. Fluid coupling

**UNIT 2 Transmission System 8 hours**

The need for transmissions, Necessity of gear box, Desirable ratios of 3-speed & 4-speed gear boxes, Constructional details of sliding-mesh gearbox, constant-mesh gear box, synchromesh gearbox, Automatic transmission: relative merits and demerits when compared to conventional transmission epicyclic, continuously variable transmission, torque converter, constructional and operational details of typical hydraulic transmission drives.

**UNIT 3** **Driveline** **8 hours**

Drive line: Effects of driving thrust and torque reaction. Hotchkiss drive. Torque tube drive, radius rods. Propeller shaft. Universal joints. Final drives – different types, double reaction final drive. Two speed rear axles. Rear axle construction–full floating, three quarter floating and semi-floating arrangements. Differential conventional type, no-slip type. Differential locks.

**UNIT 4** **Steering System and suspension systems** **8 hours**

Steering System: Types of steering systems, different steering mechanisms, power steering. Suspension systems: The need for suspension systems, Types of springs, shock absorbers, types of suspension systems

**UNIT 5** **Brakes, Rims and tires** **8 hours**

Types of brakes and brake actuation mechanisms, regenerative brakes. Types of rims and tires, tire rating.

**Textbooks:**

1. Kirpal Singh, Automobile Engineering, Vol.-1& 2,12/standard Publisher,2011.
2. Joseph Heitner, AutomotiveMechanics,2/e, AffiliatedEast-westPress,2013

**References:**

1. Crouse. W.H. and Angling. D.L., AutomobileMechanics,10/e, TataMcGraw-Hill,2007.
2. JudgeA.W, Modern Electrical Equipment of Automobiles, ChapmanandHall,1992

**Course Outcomes:**

1. To understand the different transmission systems and steering system in an automobile. (L2)
2. select proper transmission system for a vehicle, and to identify and solve problems related to transmission system. (L3)
3. To understand the vehicle structure and the suspension system(L3)
4. Choose a particular driveline for application (L4)
5. To understand and develop the braking systems in vehicles(L4)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | P O8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 3 | 2 | 2 |

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SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH2171</td><td rowspan="2">POWER PLANT ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Thermodynamics and Applied Thermodynamics</td></tr>
<tr><td>Co-requisite</td><td colspan="7">NONE</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">NONE</td></tr>
</table>

**Course Description:**

*This course introduces the various layouts and working mechanisms of steam power plant, gas power plant, nuclear power plant, and hydroelectric power plant. Power Plant Economics concepts will also be dealt in this course. This course introduces the working concepts of power generating devices like turbines and their components. This course is having integrity with industrial problems as prime movers are main components of power plants. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- Understand the basic knowledge of diverse types of thermal power plants states.
- Design of chimney, cooling tower operation in thermal power plants
- Perform basic analyses associated with each subsystem
- Improving skills to adopt modern methods in mechanical engineering as continuous improvement.
- Understand about the site selection of setting up a hydroelectric plant

**UNIT 1** **Steam Power Plants** **9 hours**

General layout, power plant cycles, coal-handling, storing, preparation and supply. Boiler Mountings and accessories, Draft systems, Flue gas testing and indicators (mechanical, electrical and chemical). Condensers and cooling towers

**UNIT 2** **Gas Turbine Power Plants** **8 hours**

Introduction, gas turbine plant- classification and comparison of different types of gas turbine power plants, components and different arrangements of the gas turbine plants, Indian gas turbine power plants, governing system of gas turbine plant.

**UNIT 3 Nuclear Power Plants 9 hours**

Classification of reactors, thermal utilization, fuels, fuel moderator and coolant, control and safety rods, special properties of structural materials required, induced radioactivity, gas cooled reactors, radiation hazards and shielding, radioactive waste disposal

**UNIT 4 Hydro Electric Plants and Different types of plants 8 hours**

Hydro Electric Plants: Selection of site, hydrology, hydrometric survey rainfall, catchment, reservoir, run-off flow and fall, storage, and pondage. Mass- duration and flood discharge. Losses due to percolation, evaporation, and transpiration. General layout of the plant. Different types of plants: Low, medium, and high head plants and pump storage plants. Head works, spillways, canals, tunnels, governing, lubrication, penstock, anchorages, and relief valves. Different types of surge tanks, intakes, gates, and valves

**UNIT 5 Power Plant Economics 8 hours**

Capacity factor, Load factor, Diversity factor, Peak load consideration, Factors governing capacity of plants. Cost of power plant, Cost of erection. Operating and maintenance expenses, Cost of production, distribution of power and determination of rates.

**Textbooks:**

1. P.K. Nag, Power plant engineering, Tata McGraw-Hill publishing Co., 2014 Universities Press, Hyderabad, 2006.
2. Machines, McGraw Hill Education, 2017
3. S.C. Arora and Domkundwar, A course in power plant engineering, DhanpatRai and Co, 2001
4. R.K. Rajput, A Textbook of Power Plant Engineering, 4/e, Laxmi Pub., 2007.

**Reference Books**

1. B.S. Magal, Solar Power Engineering, 1/e, Tata McGraw-Hill publishing Co., 1999.
2. Joel Weisman, Roy Eckart, Modern Power Plant Engineering, Prentice Hall of India, 1985.
3. D.K. Singhai, Fundamentals of Nuclear Power Engineering, 4/e, Khanna Publishers, 2001.
4. G.R.Nagpal, Power Plant Engineering, 14/e, Khanna Publishers, 1996.

**Course Outcomes:**

1. Study the working of typical systems subsystems of a steam power plants(L1)
2. Acquaint with the knowledge about recent advances in gas turbine power plants and apply the knowledge in industries for enhancing productivity (L2)
3. Choose appropriate site for plant and layout of hydroelectric power plant (L3)
4. Experiment with multi-disciplinary goals in the power plants [L3]
5. Analyse the turbo machines to improve and optimize its performance (L4)
6. Utilize the concepts of power plant economics and understand costs involved in power plants (L4)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | P O8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 3 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| MECH2181 | RENEWABLE ENERGY TECHNOLOGY | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*The course introduces energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application. It helps in exploring society's present need and future energy demands, examine conventional energy sources and systems. The course will also help in assessing the procedures in terms of technical, financial, and social, in the context of training as a Mechanical Engineer. The objective of the course is to ensure access to affordable, reliable, sustainable, and modern energy for all*

**Course Educational Objectives:**

- To understand the basic knowledge of conventional and non-conventional energy sources.
- To design and optimization of solar, wind, OTEC and Geo Thermal power plants,
- To perform basic analyses associated with each subsystem
- To apply the same in their project works as well as higher studies or in their job.

**UNIT 1 Introduction 8 hours**

Introduction: Role and potential of new and renewable sources. Solar Energy: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Solar energy storage- Different methods,
sensible, latent heat and stratified storage, solar ponds. Solar applications, solar heating/ cooling techniques, solar distillation and drying, nano materials used in solar photovoltaic cells. Next generation photovoltaic systems- Solar Ink, photovoltaic energy conversion.

**UNIT 2** **Wind Energy** **8 hours**

Wind Energy:
Sources and potentials, classification of windmills, horizontal and vertical axis windmills, effect of wind speed on power generation, site evaluation, wind turbine subsystems-rotors, drive trains, yaw control systems, electrical systems. Biogas: Properties, principles of production, classification- fixed dome-floating type, comparison, site selection, water removing device, environmental effect. Plant models in India: floating gas holder-KVIC, fixed dome - janata type, pragati model, deenbandhu model, constraints for implementation.

**UNIT 3** **Fuel Cells** **8 hours**

Fuel cells: Principle of fuel cells, Faradays laws, thermodynamic aspects. Performance limiting factors of fuel cells-reactivity-invariance, electrode losses-chemical polarization-concentration polarization-resistance polarization, types of fuel cells-hydrogen-oxygen fuel cells-biochemical cells regenerative cells.

**UNIT 4** **Geothermal Energy** **8 hours**

Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India. OTEC: Principles, utilization, setting of OTEC plants, thermodynamic cycles.
Tidal and Wave Energy: Potential and conversion techniques, tidal barrage, modes of operationebb generation- flood generation- two-way generation. Latest techniques used in TIDAL energy generation

**UNIT 5** **Direct Energy Conversion** **8 hours**

Direct Energy Conversion: Need for DEC, limitations, principles of DEC. Thermoelectric generators, seebeck, Peltier and Joule Thompson effects, figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD engine, power generation systems, electron gas dynamic conversion, economic aspects.

**Textbooks:**

1. G.D. Rai, Non-conventional Energy Sources, 6/e, Khanna Publishers, 2004.
2. R.K. Rajput, Non-Conventional Energy Sources and Utilization, 2/e, S. Chand Publishing, 2014.

**References:**

1. G.Boyle, Renewable Energy: Power for a Sustainable Future, 3/e, Oxford University Press India, 2012
2. D.P.Kothari, K.C.Singal, Ranjan Rakesh, Renewable Energy Sources and Emerging Technologies, 2/e, Prentice Hall India, 2011
3. B.H.Khan, Non-Conventional Energy Resources, 2/e, McGraw Hill India, 2009.

**Course Outcomes:**

1. understand the several types of conventional and non-conventional energy sources, their parts, working, and will be able to sort out realistic application to society. (L2)
2. analyseseparate set of operational parameters and constraints of solar energy systems for direct and indirect methods of usage, (L4)
3. improve the efficiency of the wind and biogas l energy systems. (L4)
4. understand concepts of fuel cells. (L2)
5. understand and analyze geothermal, tidal and wave energy conversion systems (L4)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 3 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| MECH2191 | ALTERNATIVE FUELS AND EMISSION CONTROL | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| Pre-requisite | None | | | | | | |
| Co-requisite | None | | | | | | |
| Preferable exposure | None | | | | | | |

**Course Description:**

*The course exposes the students to understand the concepts of different types of fuels and their properties. It mainly focuses on the mechanics of pollution formation which is very much essential for the students who work for the Automobile sector in the future and familiarizes the pollution control techniques. The objective of the course is to ensure access to affordable, reliable, sustainable, and modern energy for all*

**Course Educational Objectives**:

- Different fuels and their properties
- Different Testing methods of fuels
- Factors responsible for the emissions
- the methods to measure and control

**UNIT 1 Solid and liquid Fuels 8 hours**

Solid Fuels: classification of fuels – Conventional and Unconventional Solid, Liquid, gaseous fuels, and nuclear fuels. Coal – Carburization, Gasification and liquification – properties of coal, efficient use of solid fuels, solid fuel handling and storage. Liquid Fuels : Alcohols as fuels, Bio-diesel production from Vegetable oils and waste cooking oil, Blends, Fuel modifications to suit SI and CI engines, Ignition accelerators and other additives-Storage and Safety

**UNIT 2 Gaseous Fuels 8 hours**

Natural Gas, LPG, Hydrogen, CNG and Biogas: Availability, properties, modification required to use in engines, admission of gaseous fuels like Hydrogen, CNG, LPG, Natural Gas, Producer gas and Biogas in engines– Safety Precautions, storage and handling, performance and emissions

**UNIT 3** **Properties and testing of fuels** **8 hours**

Properties and testing of fuels: Required properties of fuels-biofuels and their importance in the context of IC Engines. Testing of fuels for their properties -Acid number- base number, Sulphur content, Flash point -fire point, cloud -pour point, corrosion resistance, Oxidation stability- viscosity -viscosity index, carbon residue – cetane number-cetane index

**UNIT 4** **Emission formation** **8 hours**

Pollution formation in SI and CI engines - Factors affecting emissions -Formation of NO and NO2 in Engines, Formation of CO, Flame quenching in SI engines. Unburned HC formation in SI engines, crevice HC, oil film HC and other sources, soot formation, Instrumentation to measure pollutants, Trends in vehicle emission standards, emission limits,

**UNIT 5** **Pollution control methods** **8 hours**

Control of emissions inside the engine: EGR, crankcase evaporative emission control. Control of emissions outside the engine- Exhaust gas after treatment, Thermal and catalytic reactors, Elements of catalytic reactors, catalysts, and substrates. Oxidation, reduction and 3-waycatalytic reactors, catalyst deactivation mechanism, cold start HC control, Lean de-no catalysts, no traps and SCR.

**Textbooks:**

1. Pundir, Engine Emissions: Pollutant Formation and Advances in Control Technology, Narosa Publishing House, New Delhi, 2007.
2. Alternate Fuels – Dr. S. S. Thipse – Jaico Publications
3. Osamu Hi rao and Richard K. Pefley, Present and Future Automotive Fuels, John Wiley and B Sons, 1988
4. Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications, 1990

**References:**

1. Pundir, Engine Emissions: Pollutant Formation and Advances in Control Technology, Narosa Publishing House, New Delhi, 2007.
2. Alternate Fuels – Dr. S. S. Thipse – Jaico Publications
3. Osamu Hi rao and Richard K. Pefley, Present and Future Automotive Fuels, John Wiley and B Sons, 1988
4. Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications, 1990

**Course Outcomes:**

1. understand the various kinds of fuels, their characteristics
2. Acquire knowledge about testing of fuels.
3. student will be enriched with enough knowledge to understand the formation of pollution
4. learn the concept to control pollution

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 3 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH2201</td><td rowspan="2">SOLAR ENERGY</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*To understand the fundamentals of solar energy and its conversion techniques for both thermal and electrical energy applications. Solar energy is the most secure of all energy sources. It is abundantly available. Renewable Power generation including Solar Photovoltaic (PV) and Solar Thermal (ST) power / steam / hot water generation offer an environmentally safe and sustainable alternative. The objective of the course is to ensure access to affordable, reliable, sustainable, and modern energy for all*

**Course Educational Objectives:**

- Summarize the fundamental concepts of the solar radiation and analyze the future scope of solar energy and their utilization
- Explain the working principle of solar cells and their modern manufacturing techniques
- Elaborate the students with various solar Thermal systems and their utilization
- Demonstrate the workings of various solar photovoltaic systems
- Appraise the knowledge related to latest life cycle analysis of solar Energy Systems

**UNIT 1 Introduction 8 hours**

Basic Heat Transfer Principles- Availability of Solar Energy- Nature of Solar Energy Solar Energy & Environment- Sun as the source of radiation- Solar radiation- Measurement of solar radiation Irradiance- Solar constant- Insolation- Radiosity- Emissive power- Earth's equator Meridian Longitude- Sun earth angles- Sunrise, sun set and day length- Solar time- Equation of time Various Methods of using solar energy- Photo thermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy.

**UNIT 2 Solar cells 8 hours**

Various generations- Semiconductor materials- Doping- Fermi level- PN junction and characteristics- Photovoltaic effect- Photovoltaic material- Parameters of solar cells- Effects of cell temperature on cell efficiency- Types of solar cells- Solar Unit and arrays- Advantages and limitations of solar energy system- Solar cell power plant- Silicon, thin film and polymer processing Silicon wafer based solar cells.

**UNIT 3** **Solar Thermal Energy** **8 hours**

Stationary collectors- FPC- CPC- ETC- Sun tracking concentrating collectors- PTC- PDR- HFC Fresnel collectors- Solar thermal power plants- Solar chimney power plant- Solar pond- Solar water heater- Solar cooker- Types- SODIS- Thermal energy storage- Solar cooling- Limitations of solar thermal energy.

**UNIT 4** **Solar Photovoltaics** **8 hours**

Photovoltaic cell function- Types of PV system- Design of PV system- Grid connected PV system Standalone PV system- Efficiency of PV unit - MPPT- Applications of PV system- SPV lighting system- Solar water pumping system- Solar vehicles- Solar dryer- BIPVFeatures of SPV system Case study- Solar water pumping system in Punjab- Performance study on solar drying system in Nepal.

**UNIT 5** **Economic analysis** **8 hours**

Economic analysis: Life cycle analysis of Solar Energy Systems – Time Value of Money – Evaluation of Carbon Credit of Solar Energy Systems.

**Textbooks:**

1. Soteris A. Kalogirou, Solar Energy Engineering: Processes and Systems, 2/e, Academic Press,2013
2. Tiwari G.N, Solar Energy – Fundamentals Design, Modelling and applications, AlphaScience, 2002

**References:**

1. John W. Twidell,Anthony D Weir,Renewable Energy Resources, Taylor&Francis,2005
2. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4/e, John Wileyand Sons, 2013
3. S P Sukhatme, J K Nayak, Solar Energy, 4/e,McGraw-Hill Education, 2017

**Course Outcomes:**

1. summarize the basic concept of solar radiation calculations. [L2]
2. demonstrate the working principle solar cells and their importance[L2]
3. analyze the solar collectors and their limitations [L4]

4. explain the function of solar photovoltaic and modern techniques of using solar energy in different application. [L2]
5. analyze economic analysis and life cycle of solar thermal systems. [L4]

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | P O8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 1 | 3 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 1 | 0 |
| **CO2** | 3 | 2 | 1 | 2 | 1 | 3 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 0 |
| **CO3** | 3 | 2 | 1 | 2 | 1 | 3 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 1 | 0 |
| **CO4** | 3 | 2 | 1 | 2 | 1 | 3 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 1 | 0 |
| **CO5** | 3 | 2 | 1 | 2 | 1 | 3 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 0 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

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| MECH3191 | WASTE TO ENERGY | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 1 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course introduces the basic principles and different technologies of converting waste to energy. Student will be able to appropriately identify the methods and build biomass gasification systems of different capacities depending on application requirements. The objective of the course is to ensure access to affordable, reliable, sustainable and modern energy for all*

**Course Educational Objectives:**

- to introduce the classification of waste for its usefulness in preparing different fuels
- to familiarize the biomass pyrolysis process and its yield issues
- to acquaint the student with biomass gasification processes and construction arrangements
- to impart the types and principles of biomass combustors
- to familiarize the calorific values and composition of biogas resources.

**UNIT 1 Introduction 8 hours**

Introduction to Energy from Waste: Classification of waste as fuel – Argo based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

**UNIT 2 Biomass Pyrolysis 8 hours**

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications

**UNIT 3 Biomass Gasification 8 hours**

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

**UNIT 4 Biomass Combustion 8 hours**

inclined grate combustors, Fluidized bed combustors, Design, construction, and operation - Operation of all the above biomass combustors. Biomass Combustion: Biomass stoves – Improved challahs, types, some exotic designs, Fixed bed combustors, Types.

**UNIT 5 Biogas 8 hours**

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

**Textbooks:**

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Handbook - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

**References:**

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

**Course Outcomes**

1. classify different types of waste for their usefulness in preparing different fuels(L3)
2. describe the biomass pyrolysis process and its yield issues(L2)
3. outline the different biomass gasification processes and their construction arrangements(L3)
4. explain the types and principles of biomass combustors(L2)
5. analyze the calorific values and composition of biogas resources(L5)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | P O8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 2 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

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SDG Justification:

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<table>
<tr><td rowspan="2">MECH3201</td><td rowspan="2">ENERGY CONSERVATION AND MANAGEMENT</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*This course helps to understand the energy consumption scenario in India and significance of energy conservation. It helps to understand the energy conservation act, various methods of energy audit methods. It provides the importance of BEE star labelling for various utilities, thermal systems, Furnaces etc. It helps to explore energy audit instruments and performance evaluation of various steam systems. The objective of the course is to ensure access to affordable, reliable, sustainable, and modern energy for all*

**Course Educational Objectives:**

- To understand the basic knowledge of conventional and non-conventional energy sources.
- To design and optimization of solar, wind, OTEC and Geothermal power plants,
- To perform basic analyses associated with each subsystem
- To apply the same in their project works as well as higher studies or in their job.

**UNIT 1 — Introduction — 8 hours**

Energy kinds: Indian energy scenario. Energy needs, energy security, energy conservation importance, energy conservation potential, industries and commercial establishments, energy conservation Act.

**UNIT 2 — Energy Efficiency in Thermal Systems: Boilers — 8 hours**

Performances evaluation, analysis of losses, feed water treatment; blow down, energy conservation opportunities. FBC boilers- mechanism and advantages. Steam System: Assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, energy savings.; Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.

**UNIT 3 Energy Efficiency in Electrical Utilities Energy Efficiency in Electrical Utilities 8 hours**

Electrical load management and maximum demand control, power factor improvement and its benefit, transformers, distribution and transformer losses, analysis of electrical power systems; Lighting System: Light source, choice of lighting, luminance requirements, and energy conservation

**UNIT 4 Energy Conservation in Utilities: Energy Conservation in Utilities 8 hours**

Fans, blowers, pumps, compressed air systems, refrigeration and air conditioning systems and cooling towers: Performance evaluation, efficient system operation and energy conservation

**UNIT 5 Energy Conservation and Auditing 8 hours**

Definition, need, and types of energy audit, energy management (audit) approach, understanding energy costs, bench marking, energy performance, optimizing the input energy requirements, energy audit instruments; Preliminary and detailed energy audit, energy conservation act, Duties and responsibilities of energy managers and auditors.

**Textbooks:**

1. Energy Manager Training Manual (4 Volumes) Bureau of Energy Efficiency: http://www.beeindia.in/energy_managers_auditors/ema.php?id=4
2. Y.P. Abbi, Shashank Jain, Handbook on Energy Audit and Environment Management, The Energy and Resources Institute, TERI, 2009

**References:**

1. Steve Doty, Wayne C. Turner Energy Management Handbook, 7/e, the Fairmont Press, Inc., 2009
2. F Keith, D. Y Goswami, Energy Management and Conservation handbook, CRC Press, 2008
3. YP Abbi and Shashank Jain. Handbook on Energy Audit and Environment Management, TERI Publications, 2006

**Course Outcomes:**

1. understand the different types of conventional and non-conventional energy sources, their parts, working, and will be able to sort out realistic application to society. (L2)

2. Analyse different set of operational parameters and constraints of solar energy systems for direct and indirect methods of usage, (L4)
3. improve the efficiency of the wind and biogas l energy systems. (L4)
4. understand concepts of fuel cells. (L2)
5. understand and analyze geothermal, tidal and wave energy conversion systems (L4)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 2 | 1 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

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| MECH3274 | WIND ENERGY | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course focuses on the fundamentals of wind energy, basics of fluid mechanics and wind turbines, fundamentals of power generation in wind turbines, introduction to wind turbine components, Introductions to wind parks. The objective of the course is to ensure access to affordable, reliable, sustainable, and modern energy for all*

**Course Educational Objective:**

- To Understand the basic knowledge of how wind is generated
- To Improve skills to visualize energy extraction from the sources with help of aerodynamics
- Learn how to design and estimate the potential of resource area
- Learn basic principles of modern wind electric turbines
- A brief idea about principal operation of wind farms and monitoring techniques

**UNIT 1** **Introduction** **8 hours**

Historical Perspectives on Wind Turbines, Indian Energy Scenario, Global Energy Scenario, Introduction to Indian Wind Industry, Wind Energy potential of India and Global Wind Installations Power in the wind, Wind Characteristics, Measurement of wind using anemometers (cup anemometer, propeller anemometer, pressure plate anemometer, pressure tube anemometer, sonic anemometer, and other remote wind speed sensing techniques), Turbulence, Wind Power Density. Average wind speed calculation, Statistical models for wind data analysis (Weibull and Rayleigh distribution), Energy estimation of wind regimes, Wind Rose, Wind Monitoring Station Siting, and Instrumentation.

**UNIT 2** **Aerodynamics** **8 hours**

Introduction to Aero foil design, NACA profiles, Lift and drag principle, Lift, and drag co-efficient, Axial Momentum theory, Momentum theory for rotating Wake, Blade element theory, Strip theory, Tip losses.

**UNIT 3 Rotor Design and Performance 8 hours**

Design of rotor, Wind Machine parameters (swept area, power co-efficient, torque coefficient, thrust, solidity, tip-speed ratio, angle of attack etc.), Power Curve, Energy Estimation, Capacity Factor

**UNIT 4 Wind Energy Conversion Systems 8 hours**

Types, Components of Modern Wind Turbine (HAWT and VAWT), Fixed and Variable Speed operations, Power Control (Passive stall, Active pitch, Passive pitch, and Active stall), Electrical aspects of wind turbine, Safety of wind turbines

**UNIT 5 Wind Farm Design and Health (Condition) Monitoring 8 hours**

Planning of wind farm, Site selection, Micrositing, Grid Integration, Power evacuation, Wind Farm Feasibility Studies, Preparation of DPR, Environmental Benefits and Impacts.
Small Wind Turbines: Water pumping windmills, offshore wind energy, Wind turbine testing, future developments.

**Textbooks:**

1. Wind Energy Fundamentals, Resource Analysis and Economics, Sathyajith Mathew, Springer Publications, ISBN 978-3-540-30906-2, 2006 edition

**References:**

1. A Guide to Small Wind Energy Conversion Systems, John Twidell, CAMBRIDGE UNIVERSITY PRESS, 2011, ISBN 10:0521281628
2. Offshore Wind Power, Edited by John Twidell And Gaetano Gaudiosi, 2009 Edition, ISBN 978-0906522-639
3. Robert Gasch And Jochen Twele, Wind Power Plants, Fundamentals, Design, Construction, And Operation. 2012

**Course Outcomes:**

1. During the course, student will be introduced to the wind energy resource,
2. Will learn the basic principles underlying the energy conversion process from wind,
3. At successful completion of course students will get a basic understanding of the aerodynamics, dynamics, and control of wind turbines,
4. Identify different components involved in Electrical aspects of wind turbine
5. Analyze techniques related safety and monitoring of wind turbines

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |
| **CO2** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |
| **CO3** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |
| **CO4** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |
| **CO5** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

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SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

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<table>
<tr><td rowspan="2">MECH1031</td><td rowspan="2">FUNDAMENTALS OF ELECTRIC AND HYBRID VEHICLES</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">BEEE, IC Engines</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*This course introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cell vehicles. This course is an intended for learning the Fundamentals of Automobile Hybrid vehicles. This course is giving the brief ideas of Hybrid vehicles propulsion methods- Hybrid architecture Hybrid power plant specifications- Fuel cell technology - and Nonelectric Hybrid propulsion systems. The objective of the course is to ensure access to affordable, reliable, sustainable, and modern energy for all*

**Course Educational Objectives:**

- To introduce different configurations of electric vehicles
- To familiarize knowledge of hybrid electric vehicles bots.
- To impart basic analyses associated with batteries and its types
- To enable hybrid vehicle configuration and its components, performance analysis
- To explain the concepts learnt for project work, higher studies, and industry**.**

**UNIT 1** **Introduction to Electric Vehicles** **8 hours**

History of Modern Transportation, air pollution-NOx, CO, UHC other pollutants, global warming, Economic and Environmental Impact of Electric Hybrid Vehicle, India Dependence on Foreign Oil EV Market.

**UNIT 2** **Architecture of Hybrid and Electric Vehicles** **8 hours**

Vehicle Power Plant and Transmission Characteristics, Basic in HEVs, Basic Architecture of Electric Drive Trains, Advantages and Disadvantages of Series-Parallel Combination Architecture of Hybrid Drive Trains and Analysis of Series and parallel Drive Train, Power Flow.

**UNIT 3 Energy Source 8 hours**

Battery- Battery Basics, Lead-Acid Battery, Nickel-Cadmium Battery, Nickel-Metal-Hydride (NiMH) Battery, Li-Ion Battery, Li-Polymer Battery, Zinc-Air Battery, Battery Parameters, Battery Capacity. Fuel Cells: Fuel Cell Characteristics, Fuel Cell Types- Alkaline Fuel Cell (AFC) Proton Exchange Membrane (PEM), Direct Methanol Fuel Cell (DMFC), Phosphoric Acid Fuel Cell (PAFC), Molten Carbonate Fuel Cell (MCFC), Solid Oxide Fuel Cell (SOFC, ITSOFC), Fuel Cell EV.

**UNIT 4 Electric Machines and their Controllers 8 hours**

DC-DC converters-Classification, DC-AC inverter-classification, Induction motors and Permanent Magnet Motors for HEV/EVs

**UNIT 5 Design of Hybrid and Electric Vehicles 8 hours**

Hybridness: parallel hybrid, series, mixed and range extender (plug-in) hybrids, Range extender, Techniques to enhance hybrid performance, Mild or micro hybrid features, Plug-in hybrid, All-wheel drive hybrid, Sizing of Electric machine, Brake System of EVs and HEVs, case study of HEV.

**Textbooks:**

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, CRC Press, 2010
2. E. Fuhs, Hybrid Vehicles and the Future of Personal Transportation, CRC Press, 2009

**References:**

1. James Larminie, Electric Vehicle Technology Explained, second editon, John Wiley & Sons, 2012.
2. Sandeep Dhameja, “Electric Vehicle Battery Systems”, Newness, 2000
3. Iqbal Hussain, Electric & Hybrid Vehicles – Design Fundamentals, Second Edition, CRC Press, 2011
4. Web references: https://nptel.ac.in/courses/108/103/108103009/

**Course Outcomes:**

1. Explain the need and advantages of electric vehicles in present scenario (L2)
2. Compare hybrid vehicle with IC engines (L2)
3. Analyse the modern trends in identifying energy sources in the form of fuel cells (L4)
4. Interpret different types of controllers and drive train systems (L2)

5. Define various DC and AC electrical machines for vehicle applications (L2)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |
| **CO2** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |
| **CO3** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |
| **CO4** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |
| **CO5** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

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<table>
<tr><td rowspan="2">MECH2211</td><td rowspan="2">FUEL CELL TECHNOLOGY AND HYDROGEN STORAGE SYSTEM</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">Fuel cell Basic</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

This course introduces the alternative energy source to fossil fuels in the form of Hydrogen, through fuel cell technology. As the global energy consumption increasing year-by-year causing threats like greenhouse effects, global warming there is a need of reducing consumption of fossil fuel. This fuel cell technology using in automobile sector may reduce these grave consequences. Basic concepts of electrochemical energy conversion, technology behind the production and storage of Hydrogen are discussed in this course. The objective of the course is to ensure access to affordable, reliable, sustainable, and modern energy for all.

**Course Educational Objectives:**

- To introduce the basic concepts of fuel cell, and electrochemical energy conversion states.
- Familiarize regarding various cell types and advantages
- Explain the performance and design characteristics and operating issues for various Fuel cells.
- Enable the student regarding the working of fuel cell and its economics
- Create awareness about the applications of fuel cell in automobiles

**UNIT 1 Introduction 8 hours**

Basic structure, critical functions of components –fuel cell stacking- fuel cell system types of advantages and disadvantages – applications and status. Fuel Cell Performance: Thermodynamic aspects of Electrochemical Energy conversion- Cell efficiency – Factors affecting the efficiency of Electrochemical Energy conversion

**UNIT 2 Alkaline Fuel cells (AFC) 8 hours**

Principle of operation – modules- fuel cell stacks-general performance characteristics-Attempts towards advancements-Ammonia as AFC fuel System issues Electrodes: materials and manufacturing- Stacks and systems- Factors affecting the performance of PAFC

**UNIT 3 Types of fuel cells 8 hours**

Solid Oxide Fuel Cells (SOFC) and Molten Carbonate Fuel Cells: Cell components- Anode and Cathode materials- Interconnects seals- Configurations and performance- Environmental impacts - General principle- Cell components- Mechanisms of Electrode reactions. Direct Methanol Fuel cells and Proton Exchange and Membrane Fuel Cells (PEM): Catalyst and Non catalyst aspects- Methanol cross over- Catalyst aspects and scale up-Engineering aspects - Scientific aspects and challenges- Modelling- Milestones in technology development- Approaches and challenges to high temperature operations.

**UNIT 4 Hydrogen production technologies 8 hours**

Hydrogen as a future energy carrier, Properties, Chemical production of hydrogen, steam reforming of methanol, natural gas, coal gas etc, shift conversion and thermal decomposition, purification (removal of CO and CO2), desulphurization, Electrolytic hydrogen production, Electrolyze Configurations.

**UNIT 5 Hydrogen storage technologies 8 hours**

Basic principles, compressed gas storage, Cryogenic liquid storage, Solid state Storage, Adsorption in compounds and metal hydrides, hydride heat pumps and compressors.

**Textbooks:**

1. B. Viswanathan and AuliceScibioh, Fuel Cells Principles and Applications, Universities Press,Hyderabad, 2006. Machines, McGraw Hill Education, 2017
2. J. Larminie& A. Dicks, Fuel Cell Systems Explained, Wiley, ISBN#0-471-49026-1, 2003. Applications, 3/e, Tata McGraw Hill, 2013.
3. B. Viswanathan and AuliceScibioh, Fuel Cells Principles and Applications, Universities Press,

**References:**

1. Fuel Cell Handbook, 7th Edition, US Department of Energy, 2004.
2. M. M. Mench, Fuel Cell Engines, Wiley, (ISBN: 978-0-471-68958-4), 2008
3. X. Li, Principles of Fuel Cells, Taylor & Francis, 2005.
4. S. Srinivasan, Fuel Cells: From Fundamentals and Applications, Springer, 2006

**Course Outcomes:**

1. Acquaint knowledge of fuels cells regarding their construction, performance and operational issues [L1]
2. Study the operating characteristics of fuel cell [L2]
3. Train the students to apply fundamental knowledge of thermodynamics, fluid mechanics and heat transfer in design, construction of fuel cell [L3]
4. Develop the application of fuel cell in automobiles [L3] plants. (L4)
5. Carryout experiments on metal hydrides for hydrogen storage [L5].

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |
| **CO2** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |
| **CO3** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |
| **CO4** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |
| **CO5** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 0 | 0 | 1 | 1 | 3 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

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<table>
<tr><td rowspan="2">MECH3211</td><td rowspan="2">VEHICLE ELECTRICAL POWER SYSTEM</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*To acquire knowledge of electric vehicle battery systems and to make the student understand the working of different Charging and discharging conditions and emphasize the need for maintenance of battery systems. The objective of the course is to ensure access to affordable, reliable, sustainable, and modern energy for all*

**Course Educational Objectives:**

- To familiarize concepts of batteries for electric vehicles.
- To explain different battery capacity
- To introduce the concept of charging and discharging of battery systems.
- To provide fundamental concepts of battery performance in electric Vehicles

**UNIT 1** **Electric Vehicle Batteries** **8 hours**

Introduction to electric vehicle batteries, choice of a battery type for electric vehicles, electric vehicle battery efficiency, effects of current density on battery formation, effects of excessive heat on battery cycle life, battery storage, the lithium-ion battery

**UNIT 2** **Electric Vehicle Battery Capacity** **8 hours**

Battery capacity, the temperature dependence of battery capacity, state of charge of a vrlabattery, capacity discharge testing of vrla batteries, battery capacity recovery, definition of NiMH battery capacity, li-ion battery capacity, battery capacity tests, energy balances for the electric vehicle

**UNIT 3 Electric vehicle battery charging 8 hours**

Charging a single VRLA battery, charge completion of a single vrla battery, temperature compensation during battery charging, charging NiMH batteries, rate of charge effect on charge acceptance efficiency of traction battery packs, environmental influences on charging, charging methods for NiMH batteries, charging technology, battery pack corrective actions, the fast charging process, fast charging strategies, the fast charger configuration, inductive charging—making recharging easier, range testing of electric vehicles using fast charging.

**UNIT 4 Electric Vehicle Battery Discharging 8 hours**

Definition of VRLA Battery Capacity, Definition of NiMH Battery Capacity, Discharge Capacity Behavior, Discharge Characteristics of Li-ion Battery, Discharge of an Electric Vehicle Battery Pack, Cold-Weather Impact on Electric Vehicle Battery Discharge

**UNIT 5 Electric Vehicle Battery Performance 8 hours**

The Battery Performance Management System, BPMS Thermal Management System, The BPMS Charging Control, High-Voltage Cabling and Disconnects, Safety in Battery Design, Battery Pack Safety—Electrolyte Spillage and Electric Shock, Charging Technology, Electrical Insulation Breakdown Detection, Electrical Vehicle Component Tests, Building Standards

**Textbooks:**

1. Sandeep Dhameja, Electric Vehicle Battery Systems, Newness publication, 2001
2. MasatakaWakihara and Osamu Yamamoto, Lithium-ion Batteries Fundamental and Performance, Wiley–VCH, Verlag GmbH, 1999

**References:**

1. Robert A. Huggins, Advanced Batteries – Materials science aspects, Springer, 2009

**Course Outcomes:**

1. After learning the course, the students should be able to:
2. To understand the different types of batteries for electric vehicles. (L2)
3. select proper batteries for electric vehicles for a vehicle, (L3)
4. To understand the charging and discharging of battery system (L3)
5. To understand and develop concepts of battery performance in electric Vehicles (L4)
6. Select batteries with safety features

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| **CO2** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| **CO3** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| **CO4** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| **CO5** | 2 | 3 | 2 | 3 | 1 | 3 | 0 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

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| MECH2221 | INTRODUCTION TO MACHINE LEARNING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | **None** | | | | | | |
| **Co-requisite** | **None** | | | | | | |
| **Preferable exposure** | **None** | | | | | | |

**Course Description:**

*Machine Learning is a flourishing subject in Computer Science which devises models that can automatically learn from data and detect patterns from data. The applications of machine learning are diverse ranging from self-driven cars to disaster management systems. With easy availability of data from different devices and measurements, machine learning techniques become imperative in analysing trends hidden in the data. This course focuses on the major tasks of machine learning viz., supervised, and unsupervised learning approaches that can robustly address data that is non-linear, noisy as well as high-dimensional in nature. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- Introduce the concepts of machine learning and the complete process model for working with real data
- Impart the various approaches to supervised learning.
- Demonstrate unsupervised learning approaches.
- Illustrate the performance of ensemble models and familiarize with dimensionality reduction techniques
- Differentiate between shallow and deep neural networks.

**UNIT 1 Machine Learning Fundamentals 8 hours**

Use of Machine Learning, Types of machine learning systems, machine learning challenges, testing and validating, working with real data, obtaining the data, visualizing the data, data preparation.

**UNIT 2 Supervised Learning 8 hours**

Classification, training a binary classifier, performance measures, multiclass classification, error analysis, multi label classification, multi output classification. Linear Regression, Polynomial Regression, Logistic Regression.

**UNIT 3** **Unsupervised Learning** **8 hours**

Clustering, K-Means, Using clustering for image segmentation, Semi- supervised learning, DBSCAN, other clustering algorithms. Gaussian Mixtures, anomaly detection, selecting number of clusters.

**UNIT 4** **Dimensionality Reduction** **8 hours**

The curse of dimensionality, main approaches for dimensionality reduction, PCA, Kernel PCA, LLE.

**UNIT 5** **Neural Networks** **8 hours**

From biological to artificial neurons, implementing MLPs with Kera's, fine tuning neural network hyperparameters.

**Textbooks:**

1. Aurelio Geron, Hands-on Machine Learning with Scikit-Learn, Kera's, and Tensor Flow: Concepts, Tools, and Techniques to build Intelligent Systems, 2/e, O'Reilly Media, 2019.

**References:**

1. Tom M. Mitchell, Machine Learning, McGraw Hill, 2017.
2. EthemAlpaydin, Introduction to Machine Learning, 3/e, PHI, 2015.

**Course Outcomes:**

1. Apply supervised learning approaches on real-time problems (L3)
2. Utilize unsupervised learning approaches for applications such as anomaly detection (L3)
3. Analyze ensemble models for performance improvement (L4)
4. Estimate significant feature subset to handle high dimensionality issue (L5)
5. Construct deep neural networks for computer vision applications (L6)

**CO-PO Mapping:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |

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SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH2231</td><td rowspan="2">INTRODUCTION TO AUTONOMOUS VEHICLES</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*This course is designed with fundamentals of Autonomous vehicles and study of mechanical, electrical, computer engineering systems and their controls. These systems have the overall impact of automating various driving functions, connecting the automobile to sources of information that assist with this task, and allowing the vehicles to make autonomous intelligent decisions. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To understand the basic concepts of Autonomous vehicles and systems
- To impart and analyse the computational skills of motion planning and drive systems in Autonomous vehicles.
- To develop the algorithms of Autonomous vehicle navigation and their control systems
- To acquire the knowledge on vision-based sensors and localization systems and apply the concepts in real time environment.
- To offer knowledge on advanced driver assistance systems

**UNIT 1** **Introduction to Autonomous Vehicles** **8 hours**

Automated guided vehicles, trucks, drones, or different types of special vehicles, such as mobile robots, autonomous armoured fighting vehicles, automated highway systems

**UNIT 2** **Autonomous Vehicle Technology** **8 hours**

Basic control system, operation of ecus, surroundings sensing systems and autonomy, wireless data networks and autonomy, autonomous driving technology, motion planning, feedback control, path and trajectory, traffic decider.

**UNIT 3 Autonomous Vehicle Navigation 8 hours**

Path planning algorithms, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP), intelligent motion planner

**UNIT 4 Computer vision for Perception and localization 8 hours**

Introduction, building computer vision hardware, computing, calibration target, multiple camera calibration, VSLAM overview, Running stereo datasets, Perception, and localization interface

**UNIT 5 Advanced Driver Assistance Systems 8 hours**

Radar Technology and Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems, Troubleshooting and Maintenance.

**Textbooks:**

1. R. Siegwart, I. R. Nourbakhsh, "Introduction to Autonomous Mobile Robots", The MIT Press, 2011
2. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, Principles of Robot Motion: Theory, Algorithms and Implementations, PHI Ltd., 2005

**References:**

1. Autonomous Vehicle edited by Andrzej Zak September 7th, 2016, DOI:10.5772/61898

**Course Outcomes:**

1. After completion of this course, the student will be able to
2. Illustrate different types of Autonomous vehicles and gain knowledge on autonomous systems.
3. Understand the operation of Autonomous vehicle technologies
4. Compute and predict the navigation of Autonomous systems
5. Apply the concepts of localization and Perception of Autonomous vehicles.
6. Become familiar with the various types of advanced driver assistance systems

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 1 | 1 | 1 | | 1 | | | 2 | 1 | 3 | 3 | 2 |
| **CO2** | 1 | 2 | 3 | 1 | 1 | 1 | | 2 | | | 2 | 1 | 3 | 3 | 2 |
| **CO3** | 2 | 2 | 3 | 1 | 2 | 1 | | | | | 2 | 1 | 3 | 3 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | 2 | 3 | | 1 | | | 2 | 1 | 3 | 3 | 2 |
| **CO5** | 3 | 2 | 3 | 2 | 2 | 3 | | 2 | | | 2 | 1 | 3 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| MECH3275 | MECHATRONICS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*Introduction to mechatronics with emphasis on analog electronics, digital electronics, sensors and transducers, actuators, and microprocessors. Lectures are intended to provide the student with foundational concepts in mechatronics and practical familiarity with common elements making up mechatronic systems. Laboratory experiments are designed to give the student hands-on experience with components and measurement equipment used in the design of mechatronic products. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- Familiarize the technologies behind modern mechatronic systems.
- Familiarize different types of sensors and transducers.
- Understand the principles and applications of drives and actuators.
- Understands the concepts of digital logics and micro mechatronic systems.
- Understand applications of mechatronic systems in different fields.

**UNIT 1 Introduction 8 hours**

Multi-disciplinary scenario, origins, evolution of mechatronics, an overview of mechatronics, introduction to manufacturing and design. System Modelling: Mechanical system, translational and rotational mechanical system with spring and damper, electrical systems, modelling electric motor, fluid systems, thermal systems, modelling pneumatic actuator.

**UNIT 2 Sensors and Transducers 8 hours**

Introduction and background, difference between transducer and sensor, transducer types, transduction principle, photoelectric transducers, thermistors, thermo devices, thermo couple, inductive transducers, capacitive transducers, pyroelectric transducers, piezoelectric transducers, Hall-effect transducers, Fibre optic transducers.

**UNIT 3 Drives and Actuators 8 hours**

Hydraulic and pneumatic drives, actuator types and application areas, mechanical actuation systems, electrical actuating systems, DC motors, AC motors, stepped motor, solid state switches, solenoids; Fluid power actuators, piezoelectric actuators.

**UNIT 4 Digital Logic 8 hours**

Digital logic, number systems, logic gates, Boolean algebra, Karnaugh maps, application of logic gates, sequential logic. Micro Mechatronic Systems: Micro sensors, micro actuators, smart instrumentation, microfabrication techniques- Lithography, etching, micro joining etc., application, examples

**UNIT 5 Applications in Mechatronics 8 hours**

Sensors for condition monitoring, mechatronic control in automated manufacturing, artificial intelligence in mechatronics, software applications in mechatronics, microsensors in mechatronics. Case studies in Data Acquisition and Control, robotics, road vehicles and medical applications.

**Textbooks:**

1. W. Bolton, Mechatronics, 4/e, Pearson Education, 2008.

**References:**

1. NitaigourPremchandMahalik, Mechatronics: Principles, Concepts and Applications, Tata McGraw Hill, 2003.
2. Devdas Shetty and Richard A. Kolk, Mechatronics System Design, PWS publishing company, 1997.
3. BardleyD.A, Dawson D, Burd N.C and Loader A.J.Chapman, Mechatronics, 1/e, Hall Publishers, 1991.

**Course Outcomes:**

1. Familiar with mechatronics systems in industry. (l2)
2. Able to demonstrate use of various sensors and transducers. (l3)
3. Able to demonstrate the principles and applications of drives and actuators. (l4)
4. Understand the concept of digital logic and various micro mechatronic systems. (l4)
5. Demonstrate the applications of mechatronic systems. (l6)

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | | | | | | | 2 | | 3 | 3 | 2 |
| **CO2** | | 3 | | | | 1 | | 2 | | | 2 | | 3 | 3 | 2 |
| **CO3** | 2 | | | 1 | 2 | 1 | | | | | 2 | | 3 | 3 | 2 |
| **CO4** | 3 | 2 | 1 | 2 | 2 | 3 | | | | | 2 | | 3 | 3 | 2 |
| **CO5** | 3 | 2 | 1 | 2 | 2 | 3 | | 2 | | | 2 | | 3 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

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SDG Justification:

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<table>
<tr><td rowspan="2">MECH3221</td><td rowspan="2">STATISTICAL QUALITY CONTROL</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Basic Statistics</td></tr>
</table>

**Course Description:**

*This course introduces various statistical tools which aid in the process of quality control. Quality control emphasizes testing of products to uncover defects and reporting to management to enable them to decide to allow or deny the release. Quality assurance attempts to improve and stabilize production, and associated processes, to avoid, or at least minimize, issues that lead to the defects. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To recognize the purpose of various tools used in quality control.
- To determine costs associated with quality
- To familiarize students with various control charts for attributes and variables.
- To investigate the process capability and methods to improve the capability.
- To understand the acceptance sampling plans

**UNIT 1 Quality Basics and History 8 hours**

Meaning of quality, Factors affecting quality, Quality Principles, Quality function, Quality control, Aims and objectives of quality control, Characteristics, Cost of Quality, Value of quality, Seven QC tools, Need of management of product quality, Historical perspective of quality control

**UNIT 2 Modelling Process Quality 8 hours**

Variation: Stem-leaf Plot, Frequency distribution Histogram, Box Plot, Discrete Distributions Hyper Geometric Distribution, Binomial distribution, Poison Distribution, Continuous Distributions- Normal, Gamma, Exponential and Weibull’s distribution

**UNIT 3 Statistical Quality Control 8 hours**

Introduction, Concept of variability, Common vs. Special Causes, Types of Control charts, Measurement of control limits, Control charts for variables -large sample data, Warning limits, Revised control limits, Group control chart, Control chart with line trend.

**UNIT 4 Control Charts for Attributes and Capability Analysis 8 hours**

Control Charts for Attributes: Control charts for non-confirming Models, control charts for fraction non- conforming.; Process and Measurement System Capability Analysis: Using Probability plot, process capability ratios, specification limits and Tolerances.

**UNIT 5 Acceptance Sampling 8 hours**

Introduction, Advantages and Disadvantages of Sampling methods, Sampling techniques, Sampling Risks and indices, Operating characteristic curves, Average outgoing quality Limit. Sampling plans Single, Double, Multiple and Sequential Sampling Plans Tightened Inspection.

**Textbooks:**

1. E. L. Grant Richard, R.S. Leavenworth, Design Statistical Quality Control, 7th Edition, McGraw- Hill Pvt Ltd New Delhi, 2011
2. D. C. Montgomery, Statistical Quality Control,7th Edition, John Wiley Sons

**References:**

1. M. Mahajan, Statistical Quality Control, Revised Edition, Dhanapat Rai & Co, 2007.
2. W.W. Hines, D. C.Montgomery, Probability and Statistics in Engineering and Management, Science, John Wiley and Sons, New York, 1990.

**Course Outcomes:**

1. Assess and estimate costs of quality. [L5]
2. Use tools of quality to quantify quality costs. [L3]
3. Plot control charts and control limits and revise the limits. [L3]
4. Estimate the capability of a process. [L2]
5. Select a sampling plan for a given scenario. [L1]

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 2 | 1 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

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| MECH2241 | OPERATIONS RESEARCH | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course is to aid decision making and improving efficiency of the system by applying advanced analytical methods. This course addresses a few quantitative tools and techniques and provides students with knowledge and skills needed to apply these tools and techniques for decision making in organizations. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To Introduce the basics of Operations research, formulation and solution of Linear Programming Problems using different methods
- To Learn Formulation and solve problems of optimization problems in transportation and assignment of jobs.
- To explore different queuing models and sequencing techniques for optimal schedule of jobs on machines
- To impart knowledge on replacement policies for estimation of economic life of equipment and the concept of game theory to arrive at the optimal business strategy for a given situation
- To introduce basic inventory models to optimize inventory costs and Project scheduling techniques – CPM & PERT for optimum time and costs

**UNIT 1 Basics of Operations Research and Linear Programming 10 hours**

Basics of Operations Research: History, definition, operations research models, phases of implementing operations research in practice.
Linear Programming: Introduction, formulation, graphical method, simplex method, Big M and Two-Phase methods, concept of duality.

**UNIT 2 Transportation Model and Assignment Model 8 hours**

Transportation Model: Formulation, methods for initial feasible solution, optimal solution – MODI method, unbalanced transportation problems, degeneracy in transportation problems.
Assignment Model: Formulation, optimal solution, Hungarian method, travelling salesman problem

**UNIT 3 Queuing Models and Sequencing Models 8 hours**

Queuing Models: Introduction, Kendall's notation, Empirical Queueing Models – (M/M/1): (GD/∞/ ∞), (M/M/C) :(GD/∞/ ∞), (M/M/1) :(GD/N/ ∞).
Sequencing Models: Introduction, assumptions, processing n-jobs through two machines, n-jobs through three machines, n-jobs through m-machines, graphic solution for processing 2 jobs through n machines with different order of sequence.

**UNIT 4 Replacement Models and Game Theory 8 hours**

Replacement Models: Introduction, replacement of items that deteriorate with time - value of money unchanging and changing, simple probabilistic model for replacement of items that fail completely.
Game Theory: Introduction, game with pure strategies, game with mixed strategies, dominance property, graphical method for 2xn and mx2 games

**UNIT 5 Inventory Models and Project Management 8 hours**

Inventory Models: Introduction, inventory costs, purchase and manufacturing models, inventory models with quantity discounts.
Project Management: Introduction, phases of project management, network construction, numbering the events-Fulkerson's rule, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT)

**Textbooks:**

1. Paneerselvam R., Operations Research, 2/e, Prentice Hall of India, 2010
2. Gupta P K. & Hira D.S., Operation Research, 6/e, S Chand Publishers, 2006

**References:**


1. Harvey M. Wagner, Principles of Operations Research: With Applications to Managerial Decisions, 2/e, Prentice Hall of India, 1975
2. Kanti Swarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research, 7/e, Sultan Chand &Sons, 2005
3. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7/e, Tata McGraw Hill, 2009


**Course Outcomes:**

After successful completion of this course, the students will be able to

1. develop the mathematical models and propose the optimal resource allocation [L3&L6]
2. formulate and solve transportation & assignment models for optimum resources [L6&L3]
3. analyze the queue system and to propose the optimal sequence of jobs on machines [L4 & L6]
4. evaluate the optimal replacement policy of the equipment and to analyze the strategic interaction between rational decision-makers [L6&L4]
5. design the inventory systems and to plan the project activities [L6]

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 2 | 1 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

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| MECH2251 | PLANT LAYOUT AND FACILITIES PLANNING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | Manufacturing Systems | | | | | | |

**Course Description:**

*The workspace is one of the main resources to deliver products/services with the expected level of quality with minimum cost. To achieve the organizational effectiveness and efficiency proper utilization of the workspace must be ensured. This course has been designed to highlight the basic issues, concepts, and the techniques related to Plant layout and assembly lines. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*

**Course Educational Objectives:**

- To impart knowledge on plant layout and plant location Theories.
- To understand and introduce SLP procedure for plant layout preparation.
- To learn the basics of material handling techniques.
- To understand the line balancing techniques and labour optimization in industry.

**UNIT 1** **Plant Engineering** **8 hours**

Plant Layout, Introduction, Types of Plant Layout, Phases of Layout Planning, Plant Location, Urban v/s Rural Location, Single facility location problems, Multi facility location Problems.

**UNIT 2** **Systematic Layout Planning** **8 hours**

P-Q Analysis, Flow of Materials Analysis, Activity Relationship Analysis, Space Requirements & Availability, Modifying Considerations, Practical Limitations, Selection of Layout, Installation of Layout, CORELAP, CRAFT, ALDEP Algorithms Procedure and application, Problems.

**UNIT 3** **Material Handling** **8 hours**

Functions, Principles of Material Handling, MH Equipment-Conveyors, MH Equipment-Cranes, MH Equipment-Trucks, Systematic Handling Analysis, Classification of Materials

**UNIT 4** **Mass Production Management (Line Balancing)** **8 hours**

Basic idea of assembly line balancing, Optimization of number of stations with given production rate, Minimization of cycle time with fixed number of stations.

**UNIT 5 Line Balancing Algorithms 8 hours**

Kilbridge and Wester, Rank Positional Weight method, COMSOAL, Moodie and Young method.

**Textbooks:**

1. R.L Francis and J.A White, Facilities layout and location-An analytical approach, Prentice Hall, 1992.

**References:**

2. R. Panneerselvam, Production and operations management,3rd Edition, Prentice Hall Inc, 2012.
3. J.M. Apple, Plant Layout and Material Handling, McGraw Hill, 1972.
4. P. Rama Murthy, Production and operations management, 2nd Edition, New Age International, 2006.

**Course Outcomes:**

1. Learn about plant location factors for rural and urban places.
2. Effectively design and analyze facility layouts.
3. Apply and evaluate appropriate facility location models.
4. Apply algorithms for layout Preparation.
5. Apply algorithms for line balancing

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 |
| **CO3** | 1 | 1 | 2 | 1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 1 | 1 | 2 | 1 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 |
| **CO5** | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

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SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| MECH2261 | PRODUCTION PLANNING AND CONTROL | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

Production Planning and Control helps manufacturers in allocating resources such as people, materials, machines, and money for their efficient and optimum utilization to meet the product demand from customers. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation**.**

**Course Educational Objectives:**

- Know the importance of Production Planning and Control, Forecasting and Master Production Schedule.
- Acquaint with deterministic inventory models.
- Evaluate costs of production and inventory.
- Familiarize with planning procedure, seasonal and non-seasonal demand, make or buy decisions.
- Understand types of production control, applications of computers in production planning and control

**UNIT 1 Introduction 8 hours**

Objectives of production planning and control, definition, functions of production planning and control, organization of production planning and control department, the internal organization of the department. Forecasting: Forecasting models, aggregate production planning, master production scheduling, materials requirements planning.

**UNIT 2 Inventory Control and Systematic Control of Inventory 8 hours**

**Inventory Control:** Objectives, economic and social complications of inventory management, limitations of inventory control. Functions of inventory, demand, and production characteristics. Measures of inventory performance.

**Systematic Control of Inventory:** Fixed order quantity systems, fixed interval systems, (s, S) systems, classification of items in inventory. Computer-based inventory control systems.

**UNIT 3 Cost Factor, Economic Quantities of Manufacture or Purchase and Uncertainty 8 hours**

**Cost Factor:** The importance of costs, elements of costs, principles of cost determination and accounting systems, production and inventory cost factors, other costs to the firm.
**Economic Quantities of Manufacture or Purchase:** Lot size problems, finite production rates in manufacturing, quantity discounts.
**Uncertainty:** Effects of uncertainty, demand, and supply, safety stock, role of forecasting in production and inventory control. Uncertainty in production cycling.

**UNIT 4 Production Planning 8 hours**

Scope of planning, types of production planning, demand analysis, seasonal and non-seasonal demand. Planning procedures, short term, and long-term planning - make and buy decisions, product design and process selection, Scheduling, Loading.

**UNIT 5 Production Control 8 hours**

Control objectives, problems in production control, types of production and production control systems, controlling production, Dispatching, Controlling. The layout of the physical system, design of production planning, and control systems. Application of computers in production planning and control.

**Textbooks:**

1. O. P Khanna, Industrial Engineering and Management, 4/e, DhanpatRai Publications, 2011.
2. Samuel Eilon, Elements of Production Planning and Control, Universal Publishing Corporation, 1999.

**References:**

1. Magee and Boodman, Production Planning and Inventory Control, 2/e, McGraw Hill, 1967.
2. John E Biegal, Production Control: A Quantitative Approach, 2/e, Prentice Hall, 1971.
3. EH Mac Niece, Production Forecasting, Planning and Control, 3/e, John Wiley and Sons, 1961.
4. Seetharaman L Narasimhan, Dennis W, McLeavey, Peter J Billington, Production Planning and Inventory Control, 2/e, PHI, 2004.

**Course Outcomes:**

1. After successful completion of this curse the student will be able to
2. acquaint with basic concepts of production planning and control and apply appropriate forecasting models to predict the demand.
3. solve problems pertaining to inventory by choosing right models.
4. acquire fundamental of cost accounting and evaluate the inventory models to reduce inventories costs.
5. apply planning strategies and scheduling, loading and other functions for smooth running of the organization.
6. Apply controlling functions to manage manufacturing processes effectively.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 1 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | 3 | 1 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 3 | 1 | 3 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 1 | 3 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH2271</td><td rowspan="2">INVENTORY CONTROL</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*The course exposes the students to understand the concepts and analytical approaches of inventory control its significance. It mainly focuses on the inventory control techniques under different demand and lead time varying environments. The course caters to the students who work with the industries in the future and familiarizes the inventory control techniques. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- Introduce to basic concepts of Inventory Management and its significance in Organization.
- Explore the different Static Inventory models under risk
- Analyze the Dynamic Inventory models
- Acquire knowledge of selective inventory control systems
- Analyze the inventory models with quantity discounts and acquaint with concepts of material handling, JIT, MRP.

| **UNIT 1** | **Introduction** | **8 hours** |
|---|---|---|

Operating Environment. Supply Chain Concept, Material Flow, Supply Chain Metrics. Production Planning System: Manufacturing Planning and Control System. Sales and Operations Planning, Manufacturing Resource Planning. Enterprise Resource Planning. Makingthe Production Plan.

| **UNIT 2** | **Inventory Fundamentals** | **8 hours** |
|---|---|---|

Aggregate Inventory Management, Item Inventory Management, Inventory and Flow of Material, Supply and Demand Patterns, Functions of Inventories, Objectives of Inventory Management, Inventory Costs, Financial Statements and Inventory, ABC Inventory Control.Order Quantities: Economic Order Quantity (EOQ), Variations of EOQ Model. Quantity Discounts, Use of EOQ when Costs are not known, Period Order Quantity (POQ).

**UNIT 3 Independent Demand Ordering Systems 8 hours**

Order Point System, Determining Safety Stock.
Determining Service Levels, Different Forecast and Lead Time Intervals, determining whenOrder Point is reached, Periodic Review System, Distribution Inventory.

**UNIT 4 Purchasing 8 hours**

Establishing Specifications, Functional Specification Description, Selecting
Suppliers, Price Determination, Impact of MRP on Purchasing, Organizational Implications ofSCM.

**UNIT 5 Physical Inventory and Warehouse Management 8 hours**

Warehousing Management, Physical Control and Security, Inventory Record and Accuracy. Physical Distribution: Physical Distribution System, Interfaces, Transportation. Legal Types of Carriage. Transportation Cost Elements, Warehousing, Packaging, Materials Handling. Multi-Warehouse Systems.

**Textbooks:**

1. Starr M K & Miller D W, Inventory Control Theory and Practice, Prentice-Hall

**References:**

1. S. D. Sharma, Operations Research, 14/e, Kedar Nath Ram Nath & Co., 2005

**Course Outcomes:**

1. List the advantages and disadvantages of inventory control and costs associated. [L1]
2. classify the inventory models. and define the terms [L2]
3. solve problems pertaining to inventory by choosing right models. [L3]
4. Solve problems in price discounts and multi-level inventory problems. [l3]
5. apply latest emerging concepts like JIT, ABC, VSN and MRP for business organizations. [l4]

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 1 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | 3 | 1 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 3 | 1 | 3 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 1 | 3 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

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<table>
<tr><td rowspan="2">MECH2281</td><td rowspan="2">SUPPLY CHAIN MANAGEMENT</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*The course under logistics and supply chain management has been designed to cover the basic concepts of operations management and supply chain management. The students will understand the role of logistics, drivers and metrics in supply chain and how to design the network. The students will understand the globalization and its risks and forecasting in supply chan. The students will understand collaborative planning and replenishment strategies and how to manage uncertainties in inventory. The students shall also be able to understand the role of information technology in inventory management and transportation in supply chain. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- To introduce operations management, role and responsibilities of operations manager.
- To explain the importance of logistics and supply chain management and the relevant drivers and metrics.
- To demonstrate the technique of forecasting to reduce uncertainty by identifying the risks in a global supply chain setting
- To impart knowledge of collaborative planning, forecasting and replenishment methodologies to achieve better coordination in a supply chain.
- To summarize the importance of technology in operations, logistics and supply chain management.

**UNIT 1 Introduction to Operations Management 8 hours**

History of operations management, types of manufacturing systems, roles and responsibilities of operations manager, Product operations and service operations, Current Trends in Operations Management

**UNIT 2 Understanding the Logistics and Supply Chain 8 hours**

Introduction to supply chain, supply chain links, role of logistics in supply chain, drivers and metrics in supply chain, designing the supply chain network, online sales and distribution network, factors influencing the network design.

**UNIT 3 Impact of Uncertainty in Network 8 hours**

Globalization and supply chain, risk management in global supply chain, demand forecasting in supply chain role of information technology in forecasting.

**UNIT 4 Coordination in Supply Chain 8 hours**

Collaborative planning and replenishment strategies, CPFR, managing uncertainties in inventory.

**UNIT 5 Impact of Replenishment Policies in Safety Inventory 8 hours**

Role of information technology in inventory management, transportation in supply chain.

**Textbooks:**

1. SuNone Chopra, Supply Chain Management, Pearson Publications, 2012.

**References:**

1. Sridhara Bhatt, Logistics and Supply Chain Management, Himalaya Publishers, 2011
2. D.K Agarwal, Logistics and Supply Chain Management, Macmillan Publishers, 2013.

**Course Outcomes:**

1. Identify various operations required for successful management of manufacturing systems.
2. Understand the design of distribution networks by interpreting the drivers and metrics.
3. Apply forecasting techniques to quantify the risks and lessen uncertainty.
4. Illustrate inventory management through the application of CPFR techniques.
5. Determine the role of latest technologies for effective inventory and transportation management.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

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<table>
<tr><td rowspan="2">MECH3231</td><td rowspan="2">ENTERPRISE RESOURCE PLANNING</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">Production Systems</td></tr>
</table>

**Course Description:**

*This course ENTERPRISE RESOURCE PLANNING focuses on Industry specific enterprise application like manufacturing and service industry. This course also covers different functional areas covered by ERP and Enterprise. It includes applications of ERP in various areas such as human capital management, customer relationship management, financial management etc. It also includes lifecycle of ERP/Enterprise Applications. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- To provide awareness about the ERP concepts and the technologies
- To Understand ERP Implementation Procedure
- To know the process of Post Implementation of ERP.
- To provide knowledge of ERP for various units.
- To help in understanding how companies have implemented ERP successfully.

**UNIT 1 Introduction 8 hours**

Concept of Enterprise, ERP Overview, Integrated information system, the role of Enterprise, Business Modeling, Myths about ERP, Basic ERP Concepts, Intangible benefits of ERP, Justifying ERP investment, Risks of ERP, Benefits of ERP

**UNIT 2 Implementation 8 hours**

Life Cycle, Methodologies, Strategy, Business Case and Return on Investment Analysis for ERP, Selecting Consulting Partner, ERP Package Selection, ERP Project Team and Project Organization Structure, ERP Project Management, Managing Requirements, Business Process Re-engineering, Business Process Modeling and Business Modeling.

**UNIT 3** **Post ERP Implementation** **8 hours**

Post-Implementation Review of ERP Systems, Post-Implementation Support, Maintenance and Security of ERP, Gaps Identification and Strategies to Bridge the Gap, Configuring and Testing of the Solution, Data Migration, Cutover Planning and Go Live Preparation, Training, Change Management, Success, or Failure of ERP Implementation.

**UNIT 4** **ERP Functional Units** **8 hours**

Human Capital Management, Financial Management Procurement, Inventory Management through ERP, Supplier Relationship Management, Production Planning, Execution, Supply Chain Planning, Sales and Service, Logistics Execution, Warehouse and Transport Management, Customer Relationship Management, Quality Management, Maintenance Management, Enterprise Asset Management, Product Lifecycle Management.

**UNIT 5** **ERP Applications** **8 hours**

Portal, Content Management, Knowledge Management, Data Warehousing, Data Mining, Business Intelligence and Analytics, ERP and Enterprise Applications, Emerging Trends, ERP for Industries- ERPs for Different Manufacturing Industries, ERPs for Different Service Industries, Case Studies.

**Textbooks:**

1. Rajesh Ray, Enterprise Resource Planning, 1stEdition, McGraw Hill Education, 2010.
2. Robert D. Hisrich, Michael P. Peters, Mathew J. Manimala and Dean A. Shepherd, Entrepreneurship, 9thEdition, McGraw Hill Education, 2010

**References:**

1. D. P. Goyal, Enterprise Resource Planning A Managerial Perspective, 1stEdition, McGraw Hill Education, 2011
2. L.Wagner, Concepts in Enterprise Resource Planning, 4th Edition, engage Learning India Pvt. Ltd, 2014.
3. A. leon, Enterprise Resource Planning, 3rdEdition, McGraw Hill Education, 2014.

**Course Outcomes:**

1. obtain a basic understanding of the concept of ERP. [L-1]
2. comprehend the significance of the ERP implementation Procedure. [L-2]
3. apply design principles for various business modules in ERP. [L-4]
4. learn various ERP units and software's related to ERP. [L-3]
5. analyze security issues in procuring and implementing ERP. [L-4]

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

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| MECH3241 | MANAGEMENT INFORMATION SYSTEMS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*The course is a unified approach on computer-based information systems in business firms and government agencies. MIS combines the work of computer science, management science, and operations research with a practical orientation toward developing system solutions to real-world problems and managing information technology resources. It is also concerned with behavioural issues surrounding the development, use, and impact of information systems, which are typically discussed in the fields of sociology, economics, and psychology. The modules and topics mentioned in this course are designed to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.*

**Course Educational Objectives:**

- To provide overall understanding of the fundamental concepts of information systems, and to highlight the importance of information systems in modern organizations and societies
- To understand the information processing pertaining to achieving goals, objectives and targets of business organization
- To understand how Decision Support Systems (DSS) use models to process data and information
- To impart knowledge on basic components of information technology infrastructure
- To gain insight of concepts of Business process reengineering (BPR) and process improvement, business value of systems

**UNIT 1 Organizations, Management, and the Networked Enterprise 8 hours**

Managing digital firm; Necessity of information systems (IS); New Role of IS in organizations; New opportunities with technology for IS. IS in the Enterprise: Major types, functional perspective, and enterprise applications. IS, organizations, management, and strategy.

**UNIT 2 Information Technology Infrastructure 8 hours**

Categories of computer systems, types of software, managing hardware and software assets. Managing data resources; Telecommunications and networks.

**UNIT 3 Management and Organizational Support Systems for Digital Firm 8 hours**

Managing knowledge for the digital firm; Information and knowledge work systems, artificial intelligence, other intelligence techniques. MIS and decision support system (DSS).

**UNIT 4 Building Information Systems in the Digital Firm 8 hours**

Redesigning the organization with IS; Systems as planned organizational change; Business process reengineering (BPR) and process improvement. Understanding the business value of systems

**UNIT 5 Managing Change 8 hours**

Importance of change management in IS success and failure, Managing implementation.

**Textbooks:**

1. K.C.Laudon and J.P. Laudon, Management Information Systems - Managing the Digital Firm, 8/e, PHI, 2004.

**References:**

1. Data C.J, An introduction to Data Base Management System, Narosa Publication House, 1985.
2. Murdic, Ross and Clagget, Information Systems for Modern Management, PHI, 1985.
3. Davis Gordon, Management Information Systems – Conceptual Foundations, McGraw Hill, 1993

**Course Outcomes:**

1. Assess role of MIS in ever evolving complex business scenario
2. Assimilate knowledge obtained in core concepts like Decision support systems and AI.
3. Appreciate the role of MIS in organizations related to service and manufacturing sectors
4. Analyze real cases study by studying BPR (business process reengineering) to manage resources effectively and incorporating latest-cutting edge technology
5. Develop IT skills to become a successful IT and Business managers

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

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| MECH3251 | ENGINEERING OPTIMIZATION | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | Probability & Statistics | | | | | | |

**Course Description:**

*This course exposes the evaluation of the best possible solution for various engineering planning and design problems. The aim of the course is to train the students to develop a mathematical model and to solve the model by applying an appropriate mathematical programming technique. This course also covers advanced optimization techniques to solve dynamic and integer programming problems. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To illustrate the importance of optimization techniques in theory and practice.
- To formulate and solve engineering design problems in the industry for optimal results
- To test the analytical skills in solving real engineering problems by applying appropriate optimization technique
- To demonstrate various advanced optimization techniques being developed in recent times.
- To develop and promote research interest in problems of Engineering and Technology

**UNIT 1 Introduction to optimization and Classical Optimization techniques 8 hours**

**Introduction to optimization:** Introduction, engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function, classification of optimization problems.

**Classical Optimization techniques:** Introduction, single variable optimization, multi variable optimization with no constraints, multi variable optimization with equality and inequality constraints.

**UNIT 2** **One Dimensional Minimization Methods** **8 hours**

Introduction, unimodal function, elimination methods-exhaustive search, interval halving method, Fibonacci method, golden section method, interpolation methods-quadratic & cubic interpolation methods, direct root methods-Newton method, secant method.

**UNIT 3** **Unconstrained Minimization Methods** **8 hours**

Introduction, Direct Methods- random search methods, univariate method, Powell’s method. Descent method - steepest descent method (Cauchy’s method)

**UNIT 4** **Dynamic Programming** **8 hours**

Introduction, Bellman’s optimality principle, application of Dynamic Programming - **Shortest** Path Problem, cargo-loading problem, optimal subdividing problem, Linear programming problem.

**UNIT 5** **Integer Programming** **8 hours**

Introduction, All Integer and Mixed Integer Programming problems-Gomory’s cutting plane method & Branch-and-bound method. Bala’s algorithm for zero-one programming.

**Textbooks:**

1. S.S. Rao, Engineering optimization theory and practice,3rd Edition, New age international,2007

**References:**

1. H.A. Taha, Operations Research, 9th Edition, Prentice Hall of India, 2010
2. S. Hillier, and G.J. Lieberman, Introduction to Operations Research, 7th Edition, TMH, 2009.

**Course Outcomes:**

1. classify optimization problems and apply classical optimization techniques to solve NLPPs having differentiable functions [L2&L3]
2. apply the concept of uni-modal function to solve one dimensional minimization problems [L3]
3. solve any multi variable optimization problems[L3]
4. solve any complex optimization problem as a dynamic programming problem and analyze its solution [L3&L4]
5. recognize the significance of integer and/or binary solutions and apply a suitable algorithm for better decision making [L1&L3]

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | P O8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
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| **CO5** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |

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<table>
<tr><td rowspan="2">MECH2291</td><td rowspan="2">PROJECT PLANNING AND MANAGEMENT</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*This course provides an in-depth insight into the concepts, principles, formulation of projects and network techniques of project management, The appraisal Techniques to evaluate the projects which could be successfully used for improving the quality of managerial decisions. The students will study this course with a generalist approach. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- This course is an introduction to the basic processes of project management for instructional design projects.
- Students will be introduced to organizational issues, methods of planning, and techniques for managing the business and creative processes that determine the success of a project.
- Students will learn to use project management software for organizing scheduling and monitoring project progress.

**UNIT 1 Project Planning 8 hours**

Analysis and Appraisal Generation of project ideas, Scouting for project ideas, Preliminary screening, Project rating index, Cost of project.

Investment Appraisal: Social cost benefit analysis, UNIDO approach, Net benefit in terms of economic prices, Measurement of impact on distribution, Savings impact and its value, Income distribution impact, Adjustment for merit and demerit, Goods Little Mirrless approach, Shadow prices.

**UNIT 2 Project Implementation 8 hours**

Development of project network, Dummy activities, Activity on node networks, Cyclic network, Forward pass and backward pass computations, Algorithm for critical path, Total slacks, free slacks, and their interpretations.

**Time-cost Trade off Procedure:** Schedule related project costs, Time cost trade off, lowest cost schedule.

**PERT Network:** Three time estimates for activities, Estimation of mean and variance of activity times, Event oriented algorithm for critical path, Probability of meeting a schedule date.

**UNIT 3 Network Analysis 8 hours**

Algorithms for shortest route problems-Dijkstra's, Floyd’s, and Pollack’s, algorithms.
Algorithms for minimal spanning tree- Kruskal's algorithm and Prim's algorithm.
Algorithms for maximal flow problems-Ford and Fulkerson's algorithm.

**UNIT 4 Linear Programming Formulation of Network Problems 8 hours**

A flow network interpretation for determination of critical paths, Time cost trade off and maximal flow, Chance constrained linear programming for probabilistic durations of activities in PERT network.

**UNIT 5 Project Scheduling with Limited Resources 8 hours**

Complexity of project scheduling with limited resources, levelling the demands on key resources, a simple heuristic program for resource allocation.

**Textbooks:**

1. Parameshwar P. Iyer. Engineering Project Management with Case Studies, Vikas Publishing House Pvt. Ltd. New Delhi, 2005.
2. Prasanna Chandra, Projects Planning, Implementation and Control, Tata McGraw Hill Publishing Company Limited, New Delhi, 1995.

**References:**


1. Project Management Institute (PMI), A Guide to the Project Management of Knowledge Newton Square, PA, 1996
2. J.R. Meredith and S.J. Mantel. Project Management: A Managerial Approach. John Wiley and Sons, New York, 1995.
3. L.S. Srinath, PERT & CPM Principles & Applications, 3rd edition, East west Press,2001.


**Course Outcomes:**

1. Apply theoretical aspects and approaches to managing technology-based projects
2. Identify potential factors that impact successful project management including scope creep, budgeting
3. Apply algorithms to solve real time network problems
4. Solve by linear programming in real time network problems
5. outline the operation of projects under resource constrained environment and closing the projects

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
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| **CO3** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH3261</td><td rowspan="2">DECISION MODELLING</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*The primary course objective is to improve managerial effectiveness through clearer thinking about complex decision issues, and through the application of powerful analytical tools to a wide variety of common management problems. This course will include advanced topics and tools for decision analysis of problems with "real-world" complications, such as integer programming with emphasis to its relation with linear programming. The principle behind decision natures and their utility towards decision making process in deterministic as well as stochastic models are focused. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To primarily understand the basic operation research methods and their sensitivity analysis course objective is to improve managerial effectiveness through clearer thinking about complex decision issues, and through the application of powerful analytical tools to a wide variety of common management problems.
- Identify real-life problems and choose appropriate tool/technique to model them, being aware of the assumptions underlying the tools. To introduce and conceptualize of integer programming and its types like branch and bound and cutting plane method.
- To make reader understand the advanced topics and tools for decision analysis of problems with "real-world" complications such as decision analysis and understand the need and origin of the Decision models
- To make use of principles of branch and bound and outer linearization methods for mixed integer problems to solve integer linear programming problems.
- To solve single variable unconstrained Non-Linear programming problems and also to analyze in solving single variable constrained Non-Linear programming problems

| **UNIT 1** | **Introduction to optimization** | **8 hours** |
|---|---|---|

Introduction, Theory of Simplex Method, Duality Theory, Duality theorems, Dual simplex method, revised simplex, Bounded variables algorithm, Sensitivity analysis.

**UNIT 2 Integer Programming 8 hours**

Cutting plane method, Branch, and bound method. Network Models and Solutions, Shortest Route problems, Minimal spanning tree problems, Maximal flow problem.

**UNIT 3 Introduction to Decision Making 8 hours**

Decision analysis, Decisions under risk, Decision trees, Decision analysis with experimentation, Utility theory, Decisions under uncertainty, Introduction to multi-objective Decision Models.

**UNIT 4 Sequential Decision Making (Deterministic Case) 8 hours**

Sequential decision models, Dynamic programming, Bellman’s principle of optimality, Forward recursion, and backward recursion, Sequential Decision Making (Stochastic Case): Stochastic processes, Markov processes, Markov chains, Markov decision problems.

**UNIT 5 Algorithms for Unconstrained and constrained Optimization 8 hours**

Algorithms for Unconstrained Optimization, Fibonacci search method, Golden section search method, Hooke and Jeeves’s method, Newton-Raphson method, Cauchy's (Steepest descent) method

Algorithms for Constrained Optimization: Penalty function methods, Quadratic programming, Separable convex programming.

**Textbooks:**

1. Hillier, F.S. and Lieberman, G.J. Introduction to Operations Research, 8/e, McGraw-Hill, 2008.
2. Rao, S.S. Optimization: Theory and Applications, 3/e, Wiley Eastern, 2008.

**References:**

1. Ravindran, A., Philips, D.T., and Solberg, J.J., Operations Research: Principles and Practice, 3/e, John Wiley & Sons, 2006.
2. Taha, H.A., Operations Research: An Introduction, 6/e, Prentice-Hall, 1999.
3. Sharma, J.K. Operations Research: Theory and Applications, 5/e, MACMILLAN.

**Course Outcomes:**

1. To understand the need, origin of the optimization methods and to suitably choose the optimization method needed to solve the problem.
2. To apply the basic formulation and solve integer linear programming models and also to efficiently interpret network diagrams for proper decisions making of the model.
3. To use the principles of the need, types and procedure of decision analyzing.
4. To use the principles of need and problem solve using sequential decision-making concept which are deterministic and stochastic in nature.
5. To use the working of the steps involved in algorithm generation of un-constrained and constrained optimization decision models**.**

**CO-PO Mapping:**

| | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO 1** | **PSO 2** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">ENVS3041</td><td rowspan="2">INDUSTRIAL SAFETY</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*Through the course content, you will learn more about safety, incident management, risk reduction and crowd management along with other principles that relate to law enforcement and public protection. In the event of any emergency conditions the role of Industrial safety cannot be overemphasized. When major accidents, state of emergency is declared, the public looks to trained individuals for guidance, comfort, and a course of action. The priority is always to save lives and always ensure public stability. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To understand the importance of maintaining a safe workplace.
- To maintain safety standards in compliance with regulatory requirements and within engineering limits understand personal safety and industrial safety.
- To create a job safety analysis (JSA) for a given work project.
- To follow safety recordkeeping and management, and the role of the safety manager.
- To utilize personal proactive equipment.

**UNIT 1 — Safety — 8 hours**

Introduction, importance of the safety, Principles of industrial safety, definition – Accident, Incident, Hazard, explosion, Contamination, Fire, protection, housekeeping, safe measures. Safety training and education.

**UNIT 2 — Occupational Health — 8 hours**

Concept of health and occupational health, Spectrum of health, Occupational and work-related diseases, Levels of prevention, History of occupational health, Characteristics of occupational diseases, Essentials of occupational health service, personal protective equipment’s (respiratory and non-respiratory

**UNIT 3 Hazards in workplaces – Safety in Process plants 8 hours**

Nature and types of workplaces, type of Hazards, hazards due to improper housekeeping, workers exposure to hazardous chemicals, Physical and chemical properties of chemical leading to accidents like fire, explosion, ingestion and inhalation – atmospheric pollution, dangers of dusts, fumes, vapors in work spots., Noise and Vibration hazards.

**UNIT 4 8 hours**

Control of Fire Hazards Factors contributing towards fire. Chemistry of fire. Classification of fires. Common causes of industrial fires. Determination of fire load. Fire resistance of building materials. Design of building plant, exits, etc. for fire safety. Prevention of fire. Portable extinguishers. Water systems, carbon-di-oxide systems. Foam extinguisher system. Dry chemical extinguishing system. Industrial fire detection and alarms. Sprinkle systems.

**UNIT 5 Safety Management 8 hours**

Management: Concept, definition, nature and importance, Role and functions of a manager, Elements, and functions of Management. Management Principles: Authority, responsibility & power of Management, Span of Control. Delegation and decentralization of authority. General principles of Management.

**Textbooks:**

1. R.K. Jain and SuNone S. Rao, Industrial Safety, Health and Environment Management Systems, Khanna publishers, New Delhi.

**References:**

1. Slote.L. Handbook of Occupational Safety and Health, John Willey and Sons, New York
2. Frank P. Lees, Loss of prevention in Process Industries, Vol. 1 and 2, Butterworth-Heinemann Ltd., London
3. Industrial Safety -National Safety Council of India
4. The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai
5. Grimaldi and Simonds, Safety Management, AITBS Publishers, New Delhi

**Course Outcomes:**

1. Understanding of Safety principles.
2. Analyze different types of exposure and biological effects, exposure guidelines and basic workplace monitoring Ability to do Hazard analysis.
3. Demonstrate an understanding of workplace injury prevention, risk management, and incident investigations.
4. Understand the acute and chronic health effects of exposures to chemical, physical and biological agents in the workplace.
5. Demonstrate knowledge of the types of hazards, planning, organization, and training needed to work safely with hazardous materials.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 0 | 0 | 0 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| CO2 | 0 | 1 | 1 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| CO3 | 0 | 1 | 1 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| CO4 | 0 | 1 | 1 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| CO5 | 0 | 1 | 1 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

<table>
<tr><td rowspan="2">MECH3271</td><td rowspan="2">TOTAL QUALITY MANAGEMENT</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*This Course is to introduce the applications to formulate new plans/procedures to be implemented to achieve the desired quality status by knowing about the various principles of quality management. The total quality management tools will help the student to understand the procedures in measuring the quality of the organization/process and will also enable them to identify the parameters that are improving/depriving the quality. By knowing about the quality ISO systems, the student will maintain processes/documentation properly so that the quality maintained by the organization gets recognized. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- The overall purpose of the course is to provide an understanding of the process of managing quality and managing services.
- The principles of Quality, Quality Assurance, and Total Quality Management will provide an insight into the concepts of Excellence and Best Value and the contribution of quality to strategic management.
- Understand the usage of several techniques and quality management tools.
- Identify the elements that are part of the quality measuring process in the industry.
- Learn various Customer satisfaction measurement techniques

**UNIT 1 Quality, Strategic Planning and Competitive Advantage 8 hours**

Brief history, definitions of quality. Quality in manufacturing and service systems. Quality and price, quality and market share, quality and cost, quality & competitive advantages. ISO 9000, 14000.

**UNIT 2 Managing and Organization for Quality 8 hours**

Quality policy, quality objectives, leadership for quality, quality and organization culture, cross-functional teams, supplier/customers partnerships.

**UNIT 3 Quality Control and Improvement Tools 8 hours**

Cheek sheet, histogram, pareto chart, cause and effect diagram, scatter diagram, control chart, graph, affinity diagram, tree diagram, matrix diagram, process decision program chart, arrow diagram, acceptance sampling, process capability studies, zero defect program (POKA-YOKE)

**UNIT 4 Quality Circles 8 hours**

Concept and total quality through bench marking, Japanese 5-S, quality management systems QS 9000, ISO 14000. Statistical process control: Control chart - X bar R, P, np and C Charts, benefits of control charts and applications.

**UNIT 5 Customer Focus and Six sigma principles 8 hours**

Customer satisfaction measurement techniques, customer relationship management techniques, Concept of Six Sigma, Six Sigma for manufacturing, Six Sigma for service, Understanding Six Sigma organization.

**Textbooks:**

1. J.M. Juran, & F.M. Gryna, Quality Planning and Analysis, McGraw-Hill, 1993
2. 2Dale H. Besterfiled, et al., “Total Quality Management”, Pearson Education, Inc.2003. (Indian reprint 2004).
3. Evans. J. R. & Lindsay. W, M “The Management and Control of Quality”, (5thEdition), Southwestern (Thomson Learning), 2002
4. Geoff Tennant, Six Sigma: SPC and TQM in Manufacturing and Services, 1/e, Gower Publishing Ltd., 2001.

**Reference Books**

1. J. Bank, Essences of Total Quality Management, Prentice Hall, 2007
2. Joel E. Ross - Text & Cases, Total Quality Management, St. Lucie Press, 1995
3. D.L. Goetsch& S. Davis, Introduction to Total Quality, Prentice- Hall, 2002.
4. R. Cavanagh, R. Neuman, P. Pande, what is Design for Six Sigma, 1/e, Tata McGraw- Hill, 2005.

**Course Outcomes:**

1. Understand the fundamental principles of Total Quality Management
2. Choose appropriate statistical techniques for managing and improving processes in Organizations
3. Develop skills on Quality control and improvement tools
4. Understand benefits of control charts and their applications
5. Analyse Customer relationship management techniques

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: Engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

SDG Justification:

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| MECH3276 | AUTONOMOUS MAINTENANCE | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**Course Educational Objectives:**

- To learn basic knowledge about total product maintenance
- Lean about technologies to identify abnormalities
- Learn concepts on predictive and preventive maintenance
- Learn about sources of contamination and its prevention
- Learn about heat assessment of machines

**UNIT 1 Basics of TPM Concepts (JH Pillar) 8 hours**

Eight pillars of TPM, TPM small group activities organization, management decision, educational campaign, creation of organizations, establishment of basic policies and goals, TPM implementation.

**UNIT 2 Abnormalities identification 8 hours**

Methods of Identifying Abnormalities, Failure Mode Effect Analysis, Root Cause Analysis, 5-WHY Analysis, ISHIKAWA (Fish Bone Diagram), Fault Detection Diagnosis.

**UNIT 3 Maintenance Management 8 hours**

Predictive maintenance, preventive maintenance, and condition-based proactive maintenance, maintenance schedules, repair cycle - Principles and methods of maintenance management

**UNIT 4 Source of contamination (SOC/SODDL) 8 hours**

Types of contamination, Causes and Prevention, Physical contamination, Chemical contamination, biological contamination,
Common Sources of Product Contamination in Manufacturing, Controllable vs. Uncontrollable contaminations

**UNIT 5 Health technology assessment (HTA) 8 hours**

Origins of Technology Assessment and definition, Early Health Technology Assessment, Prevention programmes, Diagnostic tests, procedures in Health Technology Assessment, countermeasures for HTA.

**Textbooks:**

1. Fumio Gotoh, Masaji Tajiri, Autonomous Maintenance in Seven Steps: Implementing TPM on the Shop Floor. Taylor & Francis, 28-May-1999 - Business & Economics - 352 pages
2. Nakajima, Seiichi. Introduction to TPM: Total Productive Maintenance. United States, productivity Press, 1988.

**References:**

1. Srivastava S.K., “Industrial Maintenance Management”, - S. Chand and Co., 1981

**Course Outcomes:**

At the end of the course, the student will be able to

1. Apply knowledge of total product maintenance in factories
2. identify abnormalities in functioning of machinery
3. choose methods for predictive and preventive maintenance
4. identify the sources of contamination and its prevention
5. assess the health f machines

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | P O8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

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SDG 9: The modules and topics mentioned in this course are designed to ensure the engineers build resilient infrastructure which promote inclusive and sustainable industrialization and foster innovation.

| MECH3277 | MECHANICAL ENGINEERING SYSTEMS | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | None | | | | | | |

**Course Description:**

*This course introduces the design procedures for various mechanical elements. The course aims to throw knowledge on design against static and fatigue loadings. The course addresses designing of machine components and limited to strength and rigidity-based designs, the structure and specification of mechanical transmission, the fundamentals of pneumatic equipment's and the fundamentals of hydraulic equipment's. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.*

**UNIT 1 Quality, Strategic Planning and Competitive Advantage 8 hours**

Machine elements: Structure, classification, applications, and typical troubles of bolt and nut; keys; bearing; gear; belt and pulleys; chain and joint. Gasket specifications and food grade quality. Mechanical seals.

Faulty Finding and Adjustment of Accuracy: Structure and specification of mechanical transmissions such as spindles, gear trains, and driving gears. Finding faults in machine elements by checking noises and temperature. Methods to adjust machine elements (LLF)

**UNIT 2 Managing and Organization for Quality 8 hours**

Lubricant Management: Lubrication – Types and applications. Selection, Functions, and effects of lubricant in driving systems Classification, specification, lifetime, and viscosity of lubricant. Inspection and maintenance of lubricator, Usage and maintenance of grease, specifications, and usage of food grade lubricant.

**UNIT 3** **Introduction to pneumatics** **8 hours**

Definition, force, pressure, and its units.
Physical Fundamentals: - Air composition, definition of atmospheric pressure, absolute pressure, gauge pressure; Safety requirements for pneumatic systems; Air compressors: - Principal operation of reciprocating compressor and applications; Air receiver; Compressed air refrigerant / desiccant air dryers, air dew point temperature and significance of dry compressed air. Functional description of pressure gauge, FRL (Filter, regulator, lubricator) service unit; Compressed air distribution system controls.

**UNIT 4** **Basic Hydraulics** **8 hours**

Pascal's law; Application of hydraulics
Hydraulic Pump: - Concept of positive displacement and non-positive displacement pumps; Positive displacement pumps – Functional description of Gear pump, Vane pump, Piston pump, Function of fluid, type of fluid,

**UNIT 5** **Centrifugal pumps** **8 hours**

Types of centrifugal pumps Single-stage, Two-stage, or Multi-stage, Parts, purpose. Hydraulic actuators: - Functional description of hydraulic element: -- single and double acting cylinder, hydraulic gear motor
Hydraulic circuit: - brief description of hydraulic circuit of regeneration circuit, counterbalance circuit, bypass circuit, pressure sequence circuit; General maintenance procedure for hydraulic and pneumatic control system.

**Textbooks:**

1. V.B. Bhandari, Design of Machine Elements, 3/e, Tata McGraw Hill, 2010.

**References:**

1. R.K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publication (p) LTD, 2010

**Course Outcomes:**

At the end of the course, the student will be able to

1. To understand the basics of various machine elements to analyze quality assurance.
2. To understand the importance of the management of lubrication in machine elements.
3. To understand and analyze various pneumatic systems.
4. To learn the concept of various hydraulic systems.
5. To analyze the working of various circuits of pumps.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| CO2 | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| CO3 | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS :29-4-2021** **ACADEMIC COUNCIL: 17-9-2021**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

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<table>
<tr><td rowspan="2">MECH2331</td><td rowspan="2">INTRODUCTION TO OPERATIONS RESEARCH</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**

*This course is to aid decision making and improving efficiency of the system by applying basic analytical methods. This course addresses a few quantitative tools and techniques and provides students with knowledge and skills needed to apply these tools and techniques for decision making in organizations. The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities*

**Course Educational Objectives:**

- To Introduce the basics of Operations research, formulation and solution of Linear Programming Problems using different methods
- To solve optimization problems in transportation and assignment of jobs
- To explore different queuing models for optimal planning of Queue systems
- To impart knowledge on the concept of game theory to arrive at the optimal business strategy for a given situation
- To introduce Project scheduling techniques – CPM & PERT
-

**UNIT l Introduction to Operations Research and Linear Programming 8 hours**

Introduction to Operations Research: History, definition, operations research models, phases of implementing operations research in practice.

Linear Programming: Introduction, formulation, graphical method, simplex method, artificial variables, concept of duality, solution using TORA/MATLAB/EXCEL

**UNIT 2 Transportation and Assignment Models 8 hours**

Transportation Model: Methods for initial feasible solution, optimal solution – MODI method, unbalanced transportation problems, degeneracy in transportation problems. solution using TORA/MATLAB.

Assignment Model: optimal solution-Hungarian method, travelling salesman problem, solution using TORA/MATLAB.

**UNIT 3 Queuing Models 8 hours**

Queuing Models: Introduction, Kendall's notation, Empirical Queueing Models – (M/M/1):(GD/∞/ ∞), (M/M/C) :(GD/∞/ ∞), (M/M/1) :(GD/N/∞), (M/M/1) :(GD/N/N), solution using TORA/MATLAB.

**UNIT 4 Game Theory 8 hours**

Game Theory: Introduction, game with pure strategies, game with mixed strategies, dominance property, graphical method for 2xn and mx2 games, solution using TORA/MATLAB

**UNIT 5 Project Scheduling 8 hours**

Project Scheduling: Introduction, network construction, numbering the events-Fulkerson's rule, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT), solution using TORA/MATLAB

**Textbooks:**

1. Paneerselvam R., Operations Research, 2/e, Prentice Hall of India, 2016
2. Gupta P K. & Hira D.S., Operation Research, 6/e, S Chand Publishers, 2015

**References:**

1. Hamdy A Taha., Operations Research – An introduction to research, 10/e, Pearson Education, 2019
2. S. Hillier, and G.J. Lieberman, Introduction to Operations Research, 11th Edition, Mc Graw Hill, 2021
3. Rao V.Dukkipati, MATLAB: "An Introduction with Applications", Anshan, 2010

**Course Outcomes:**

At the end of the course, the student will be able to

1. develop the mathematical models and propose the optimal resource allocation [L6]
2. formulate and solve transportation & assignment models for optimum resources [L4]
3. analyze and design the queue system [L6]
4. analyze the strategic interaction between rational decision-makers [L4]
5. schedule and analyze the project activities [L4]

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 0 | 0 | 3 | 2 | 2 | 0 | 0 | 0 | 3 | 2 | 0 | 2 | 2 | 2 |
| **CO2** | 3 | 0 | 0 | 3 | 2 | 2 | 0 | 0 | 0 | 3 | 2 | 0 | 2 | 2 | 2 |
| **CO3** | 3 | 0 | 0 | 3 | 2 | 2 | 0 | 0 | 0 | 3 | 2 | 0 | 2 | 2 | 2 |
| **CO4** | 3 | 0 | 0 | 3 | 3 | 2 | 0 | 0 | 0 | 3 | 2 | 0 | 2 | 2 | 2 |
| **CO5** | 3 | 0 | 0 | 3 | 2 | 2 | 0 | 0 | 0 | 3 | 2 | 0 | 2 | 2 | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

**BOS : 21-4-2023** **ACADEMIC COUNCIL: 16-05-2023**

**SDG No. & Statement:**

SDG 4: Ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

**SDG Justification:**

SDG 4: The modules and topics mentioned in this course are designed to ensure all-inclusive and thorough education with equity to all persons and always promote learning opportunities.

| MECH2321 | BASICS OF INDUSTRIAL ENGINEERING | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 2 | 1 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | Basic Mathematics | | | | | | |
| **Co-requisite** | NONE | | | | | | |
| **Preferable exposure** | NONE | | | | | | |

**Course Description:**

*This course is versatile and applicable across various functional areas of business in different sectors of the economy, including manufacturing, services, and process industries. It equips students with the skills necessary to excel in managerial positions within organizations of all kinds, including those in manufacturing, services, IT, logistics, and apparel. The course emphasizes the use of quantitative techniques to analyze and design service operations, as well as instilling in students a passion for improving service delivery. To succeed in this course, students should possess a combination of creativity, inquisitiveness, analytical ability, attention to detail, and effective communication skills, both oral and written.*

**Course Educational Objectives:**

- Acquire a foundational understanding of industrial engineering and business process reengineering.
- Gain knowledge in production planning and control techniques.
- Understand various plant layouts and choose different material handling equipment based on different entities and outline the concept of cellular manufacturing.
- Familiarize with inventory concepts, including different inventory models such as selective inventory techniques.
- Understand quality management and measurement techniques.

**UNIT 1 Definition of Industrial Engineering 8 hours**

**Definition of Industrial Engineering:** Definition of Industrial Engineering: Objectives.
**Introduction to Business Process Reengineering:** Definition and objectives of BPR, Historical background and evolution, Key drivers and benefits. Process Identification and Selection-Process identification techniques, Criteria for selecting processes for reengineering. Process Analysis and Diagnosis- Techniques for process analysis, Value stream mapping, Root cause analysis, Performance measurement, and metrics

**UNIT 2 Production Planning and Control 8 hours**

**Production Planning and Control:** Objectives, types of productions, production cycle, product design and development, process planning, forecasting- simple problems, production control functions.

**UNIT 3 Plant Layout and Material Handling 8 hours**

**Plant Layout and Material Handling:** Plant layout and location, types of layouts, principles, the concept of UNIT load, selection of material handling equipment. **Continuous Flow and Cellular Manufacturing:** Flow manufacturing concepts and benefits, Cellular manufacturing and work cell design.

**UNIT 4 Materials Management 8 hours**

**Materials Management:** Strategic importance of materials in manufacturing industries, inventory control models, inventory control systems, safety stock, selective Inventory control – ABC, FSN, and VED analysis.

**Waste management principles:** Waste avoidance, re-use, recycling, recovery, removal

**UNIT 5 Quality Management 8 hours**

**Quality Management**: Definition of quality, various approaches, concepts of quality assurance systems, statistical quality control, variables & attributes, charts, acceptance sampling.

**Textbooks:**

1. ILO, Introduction to Work Study, 3/e, Oxford and IBH Publishing, 2015
2. Sanjay Mohapatra, Business Process Reengineering: Automation Decision Points in Process Reengineering, Springer Science & Business Media, 2012.
3. David Mann, Creating a Lean Culture: Tools to Sustain Lean Conversions, Productivity Press; 3rd edition (October 22, 2014)

**References:**

1. O.P. Khanna, Industrial Engineering and Management, 14/e, Dhanpat Rai Publications, 2018.
2. Chary, S. N., Production and Operations Management, 4/e, Tata McGraw Hill Publications, 2017
3. M.T. Telsang, Industrial Engineering and Production Management, 2/e, S Chand and Co., 2006.

**Course Outcomes:**

At the end of the course, the student will be able to

1. Understand the concepts of Business Process Reengineering.
2. Explain the concepts of production planning control
3. Evaluate various plant layouts and explore various material handling equipment.
4. Apply inventory techniques for optimal inventory costs.
5. Explore the causes for variation in quality of products and suggest improvements.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 3 | | 2 | 1 | | | | | | | | | |
| **CO2** | | 2 | | 1 | 1 | | | | 1 | | | | | | |
| **CO3** | | 2 | 1 | 2 | | | | | | | | | | | |
| **CO4** | 2 | 2 | 3 | 1 | 1 | | | | | | | | | | |
| **CO5** | 2 | 2 | 3 | 2 | 2 | | | | | | | | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

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<table>
<tr><td rowspan="2">MECH2301</td><td rowspan="2">ENGINEERING ECONOMICS</td><td>L</td><td>T</td><td>P</td><td>S</td><td>J</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Pre-requisite</td><td colspan="7">None</td></tr>
<tr><td>Co-requisite</td><td colspan="7">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

**Course Description:**
*An introduction to engineering economics. Fundamental economic concepts, cost concepts, preparation of accounts, ; break-even analysis, depreciation, types and principles of organization, Management principles and leadership styles.*

**Course Educational Objectives:**

- Define the basic terms of economics and analyze law of demand and elasticity of demand
- Explain cost concepts and interpret financial statements
- Apply break even analysis concept in business organization and understand the methods of calculating the depreciation of the assets.
- Discuss the structures and advantages of different forms of business organization
- Elaborate the principles of Management.

**UNIT 1 Introduction to Economics 8 hours**

**Introduction to Economics**: Classification, nature and scope of economics, market economy, Utility, value, wealth, consumption, wants necessaries, comforts and luxuries.
**Demand**: Law of demand, types of elasticity of demand, Measurement of price elasticity of demand, factors affecting elasticity of demand, simple problems.

**UNIT 2 Costing and Accounting 8 hours**

**Costing**: Cost concepts, elements of cost, methods of distribution of overhead costs, Simple problems.
**Accounts**: Journal and Ledger, Preparation of Trading, profit and loss account and balance sheet (outlines only).

**UNIT 3 Break Even Analysis 8 hours**

**Break-Even Analysis** –Representation of BEA Mathematically and Graphically, Assumptions and Limitations, simple problems
**Depreciation:** Depreciation methods - Simple problems.

**UNIT 4 Principles of Organization 8 hours**

**Forms of Business Organization:** Single trader, partnership and public limited company **Principles of Organization:** Types of organization; Span of management; Authority, delegation and decentralization, difference between authority and power, line and staff authority

**UNIT 5 Principles of Management 8 hours**

**Principles of Management**, Management, a science or art - Management, a profession, Importance of management, roles of a manager;; Functions of management. Leadership: Difference between a leader and a manager, characteristics of leadership, functions of a leader, simple case studies.

**Textbooks:**

1. Engineering Economics by Tarachand, 14th edition, Personal, Professional, Publications, tidbits , 2019
2. Managerial Economics And Financial Analysis ; Author, Aryasri ; Publisher, McGraw Hill Education (India) Pvt Limited

**References:**

1. Industrial Engineering and Management. by O. P. Khanna. Edition, 4, revised. Publisher, Dhanpat Rai, publications, 2007.
2. Economics For Engineers 2e by H L Bhatia, S N Maheshwari, Vikas Publishing House Pvt. Ltd
3. Engineering Economics by Panneerselvam R, PHI Learning Private Limited,2012

**Course Outcomes:**

At the end of the course, the student will be able to

1. Interpret and summarize the country’s economy and market economics, as an entrepreneur.
2. Analyze various cost concepts, accounting concepts and financial management techniques for preparing effective profit and loss statements and Final statements.
3. Examine and analyze break even evaluation concepts for identification of minimum production volume for survival and to gain profits
4. Interpret the various hierarchial structures in the organisations, understand the delegation and decentralization.
5. Examine and analyze break even evaluation concepts for identification of minimum production volume for survival and to gain profits.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | | | |
| **CO2** | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | | | |
| **CO3** | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| **CO4** | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| **CO5** | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 1 | 0 | | | |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

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| MECH2311 | FUNDAMENTALS OF PROJECT MANAGEMENT | L | T | P | S | J | C |
|---|---|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 | 0 | 3 |
| **Pre-requisite** | None | | | | | | |
| **Co-requisite** | None | | | | | | |
| **Preferable exposure** | Basic mathematics | | | | | | |

**Course Description:**

*In this course, project management theory, terminology, and ideas are introduced. The project life cycle will be introduced to students, and they will learn how to create a successful project from pre-implementation through conclusion. It will cover project management fundamentals like resources, expenses, deadlines, and project scopes.*

**Course Educational Objectives:**

- To explain the phases of project planning and find the cost of project.
- To compute PERT and CPM calculations and find out the total project duration.
- To understand network algorithms like shortest route problems, MST, and Maximum flow problems.
- To analyse crashing concepts of critical path method and applying for projects.
- To expose the concepts of Resource levelling and resource smoothing concepts in project management.

**UNIT 1 Introduction to Project Management 8 hours**

**Introduction to Project Management:** Basic concepts of Project - classification; characteristics, project life cycle, project identification, generation of ideas, SWOT analysis, preliminary screening, project rating index, SCBA

**UNIT 2 Network based Project Scheduling Techniques 8 hours**

**Network based Project Scheduling Techniques:** Development of project network, Dummy activities, Forward pass and backward pass computations, Critical Path Method, Total, free and floats and their interpretations. PERT-Three-time estimates for activities, Estimation of mean and variance of activity times, Probability of meeting a schedule

**UNIT 3 Network Techniques 8 hours**

Network Techniques: Algorithms for shortest route problems-Dijkstra's and Floyd's Algorithm. Algorithms for minimal spanning tree- Kruskal's algorithm and Prim's algorithm; Algorithm for maximal flow problems-Ford and Fulkerson's algorithm.

**UNIT 4 Crashing of Project Network 8 hours**

**Crashing of Project Network:** Normal cost, Crash cost; Crashing of project network, General guidelines for network crashing, crashing of project network using time cost trade-off. Problems.

**UNIT 5 Project Resource Optimization 8 hours**

**Project Resource Optimization:** Introduction, Techniques - Resource Levelling and Resource Smoothing

**Textbooks:**

1. Paneerselvam R., Operations Research, 2/e, Prentice Hall of India, 2016.
2. Prasanna Chandra, Projects Planning, Implementation and Control, Tata McGraw Hill Publishing Company Limited, New Delhi, 2014.
3. Sharma S.C., Operations Research, PERT, CPM and cost analysis, 2006.

**References:**

1. Hamdy A Taha., Operations Research – An introduction to research, 10/e, Pearson Education, 2019.
2. L.S. Srinath, PERT & CPM Principles & Applications, 3rd edition, East West Press, 2001.

**Course Outcomes:**

At the end of the course, the student will be able to

1. Understand the importance of project planning and the phases involved in the project planning process.
2. Identify and generate Network diagrams and calculate total project durations of CPM and PERT
3. Develop network algorithms for various projects.
4. Estimate the optimal time and cost for network models.
5. Apply resource levelling and resource smoothing concepts to various projects.

**CO-PO Mapping:**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | 1 | | | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | | 3 |
| **CO2** | | 1 | | | 1 | | 1 | 2 | 1 | 2 | 2 | 1 | 1 | | 2 |
| **CO3** | | 1 | | | 2 | 1 | 1 | 1 | 1 | 1 | | 1 | 2 | | 1 |
| **CO4** | | 1 | | | 1 | 1 | 1 | 2 | | 2 | 2 | 1 | 3 | | 1 |
| **CO5** | | 1 | | | 2 | 1 | | 1 | 1 | 2 | 3 | 1 | 1 | | 2 |

Note: 1 - Low Correlation 2 - Medium Correlation 3 - High Correlation

**APPROVED IN:**

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**GITAM School of Technology**

**GITAM (Deemed to be University)**

**Visakhapatnam | Hyderabad | Bengaluru**