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
UBTEN01: B.Tech. Biotechnology

w.e.f. 2023-24 admitted batch

(Updated on 31st July 2023)

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

UBTEN01: B.Tech. Biotechnology

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

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 01	To impart knowledge of mathematics, science, and engineering to design and deliver solutions related to biotechnological issues
PEO 02	To inculcate analytical abilities among the students to meet the needs of biotechnology in medicine, agriculture, industry, and environment
PEO 03	To provide a platform for the graduates to design a plant for commercial production
PEO 04	To instill teamwork, leadership, communication skills as well as professional, ethical and human values to become responsible citizens of the society

Mapping of the Mission of the School with the PEOs

	PEO1	PEO2	PEO3	PEO4
M1	H	H	L	L
M2	L	H	M	H
M3	M	H	L	H
M4	L	M	L	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 Understand the emerging and advanced engineering concepts in Biotechnology by applying the essentials of Biology and Chemical engineering

PSO2 Enable applications of Biotechnology in industry and research

PSO3 Apply Biotechnology to develop products with improved characteristics thereby increasing farmers' income, improving human health and decreasing environmental pollution.

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
PHYS1241	1	Physics of Optoelectronic 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**
BTEN1011	1	Biotechnology Workshop	0	0	2	0	0	1
BTEN1031	1	Process Calculations	2	0	0	0	0	2
BTEN2001	2	Biochemistry	2	0	2	0	0	3
BTEN2011	2	Microbiology	2	0	2	0	0	3
BTEN2021	2	Instrumental Methods of Analysis	2	0	0	0	0	2
BTEN2031	2	Genetics & Molecular Biology	3	0	0	0	0	3
BTEN2041	2	Fluid Mechanics & Mechanical Operations	2	0	2	0	0	3
BTEN2051	2	Biochemical Thermodynamics	3	0	0	0	0	3
BTEN3001	3	Biochemical Reaction Engineering	2	0	2	0	0	3
BTEN3011	3	Fundamentals of Heat and Mass Transfer	3	0	2	0	0	4
BTEN3021	3	Genetic Engineering and its Applications	3	0	2	0	0	4
BTEN3031	3	Bioprocess Engineering	3	0	2	0	0	4
BTEN3041	3	Immunotechnology	2	0	2	0	0	3
BTEN3051	3	Principles of Bioinformatics	3	0	0	0	0	3
BTEN4001	4	Plant Biotechnology	2	0	2	0	0	3
BTEN4011	4	Process Dynamics and Control	2	0	2	0	0	3
BTEN4021	4	Bio separation technology	2	0	2	0	0	3
BTEN4031	4	Animal Biotechnology	2	0	0	0	0	2

Programme Elective (PE)								
Course code	**Level**	**Course Title**	**L**	**T**	**P**	**S**	**J**	**C**
BTEN3062	3	Advanced Cell Biology	3	0	0	0	0	3
BTEN3072	3	Environmental Biotechnology	3	0	0	0	0	3
BTEN3081	3	Bioprocess Technology	3	0	0	0	0	3
BTEN3212	3	Food Processing Technology	3	0	0	0	0	3
BTEN3092	3	Sea & Dairy Food processing	3	0	0	0	0	3
BTEN3101	3	Concepts in Biophysics	3	0	0	0	0	3
BTEN3111	3	Food handling, packaging & storage	3	0	0	0	0	3
BTEN4041	4	Food safety & quality management	3	0	0	0	0	3
BTEN3121	3	Essentials of Marine Biotechnology	3	0	0	0	0	3
BTEN3131	3	Pharmaceutical Biotechnology	3	0	0	0	0	3
BTEN3142	3	Artificial Neural Networks and Deep Learning	3	0	2	0	0	3
BTEN4052	4	Bioprocess Plant Design	3	0	0	0	0	3

BTEN3152	3	Machine Learning in Biotechnology	3	0	0	0	0	3
BTEN3162	3	Metabolomics & Metabolic Engineering	3	0	0	0	0	3
BTEN4062	4	Modelling & Simulation in bioprocesses	3	0	0	0	0	3
BTEN4072	4	Molecular diagnostics and its applications	3	0	0	0	0	3
BTEN4082	4	Molecular Modeling& Drug Design	3	0	0	0	0	3
BTEN4091	4	Systems Biology	3	0	0	0	0	3
BTEN3172	3	Proteomics & Protein Engineering	3	0	0	0	0	3
BTEN3181	3	Applied Biocatalysis& Biotransformation	3	0	0	0	0	3
BTEN4101	4	Genomics & Genome Engineering	3	0	0	0	0	3
BTEN3191	3	Nanobiotechnology	3	0	0	0	0	3
BTEN3201	3	Stem cells & Tissue engineering	3	0	0	0	0	3
BTEN4111	4	Synthetic Biology	3	0	0	0	0	3
BTEN4121	4	Biomedical Engineering	3	0	0	0	0	3
BTEN4131	4	AI and ML for Bioengineers	3	0	0	0	0	3
BTEN2061	2	Life Sciences for Engineers	3	0	0	0	0	3
BTEN2071	2	Biotechnology for Society	3	0	0	0	0	3
BTEN2081	2	Biopesticides and Biofertilizers	3	0	0	0	0	3
BTEN4141	4	Biological NMR spectroscopy	3	0	0	0	0	3
BTEN3221	3	Introduction to Nuclear Magnetic Resonance	3	0	0	0	0	3
# 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

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.

<table>
<tr><td rowspan="2">CLAD1001</td><td rowspan="2">EMOTIONAL INTELLIGENCE & REASONING SKILLS (SOFT SKILLS 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>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:

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.

<table>
<tr><td rowspan="2">CLAD1021</td><td rowspan="2">VERBAL ABILITY & QUANTITATIVE ABILITY
(SOFT SKILLS 3)</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:

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.

CLAD1031	PRACTICING VERBAL ABILITY & QUANTITATIVE APTITUDE (SOFT SKILLS 4)	L	T	P	S	J	C
		0	0	2	0	0	1
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

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.

<table>
<tr><td rowspan="2">CLAD2001</td><td rowspan="2">PREPARATION FOR CAMPUS PLACMENT -1 (SOFT SKILLS 5A)</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 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.

<table>
<tr><td rowspan="2">CLAD2031</td><td rowspan="2">PREPARATION FOR CAMPUS PLACEMENT-2
(SOFT SKILLS 6A)</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:

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.

<table>
<tr><td rowspan="2">CLAD2041</td><td rowspan="2">PREPARATION FOR HIGHER EDUCATION (GRE/GMAT)-2 (SOFT SKILLS 6B)</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 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.

<table>
<tr><td rowspan="2">CLAD2051</td><td rowspan="2">PREPARATION FOR CAT/ MAT – 2
(SOFT SKILLS 6C)</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 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.

<table>
<tr><td rowspan="2">DOSL1021</td><td rowspan="2">CLUB ACTIVITY – LEADER OF THE CLUB</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-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.

DOSL1031	CLUB ACTIVITY – COMPETITOR	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-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.

DOSL1051	COMMUNITY SERVICES - MOBILIZER	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 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.

<table>
<tr><td rowspan="2">DOSP1071</td><td rowspan="2">TABLE 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 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.

DOSP1091	BASKETBALL	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 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.

DOSP1101	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 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 Fundamentals of Investing Saving Money for the future Personal and Family Financial Planning 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. 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 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	Brain-storming, mapping of key terms (content specific), reading and note-making (individual),oral questioning, discussion

	idiomatic expressions.	
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:

	PO 1	PO 2	PO3	PO 4	PO 5	PO6	PO 7	PO8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15	PO 16	PSO 1	PSO 2	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.	

<table>
<tr><td rowspan="2">LANG1022</td><td rowspan="2">COMMUNICATION SKILLS IN ENGLISH – ADVANCED</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 (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 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

<table>
<tr><td rowspan="2">CHEM1001</td><td rowspan="2">CHEMISTRY</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 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 MnO2 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.

<table>
<tr><td rowspan="2">CSEN1021</td><td rowspan="2">PROGRAMMING WITH PYTHON</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 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 modular 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.

		L	T	P	S	J	C
CSEN1031	**ARTIFICIAL INTELLIGENCE APPLICATIONS**	**0**	**0**	**2**	**0**	**0**	**1**
Pre-requisite	CSEN1011: Problem Solving and Programming with C 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:

EECE1001	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	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 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:

<table>
<tr><td rowspan="2">HSMCH102</td><td rowspan="2">UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY</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:

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

MATH1031	DIFFERENTIAL EQUATIONS	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 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

<table>
<tr><td rowspan="2">MATH1021</td><td rowspan="2">TRANSFORM TECHNIQUES</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">MATH1031</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 (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, 15^{th} edition, 2008.
2. Operations Research An Introduction by Hamdy A. Taha, 8^{th} edition, Pearson, 2007.

References:

1. Linear Programming by R K Gupta, Krishna Prakashan Mandir, 13^{th} 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, 8th 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

<table>
<tr><td rowspan="2">MATH2311</td><td rowspan="2">NUMBER THEORY</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 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 τ and σ, 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
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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">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,4th 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.

MATH2341	PROBABILITY THEORY AND RANDOM 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:

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

MATH2331	COMPUTATIONAL METHODS	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 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
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">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**

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

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), $\chi 2$ - test for goodness of fit, $\chi 2$ - 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.

<table>
<tr><td rowspan="2">MECH1041</td><td rowspan="2">TECHNOLOGY EXPLORATION & PRODUCT ENGINEERING</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">Engineering Visualization and Product Realization</td></tr>
<tr><td>Preferable Exposure</td><td colspan="7">Power tools and Basic Electronics</td></tr>
</table>

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.

MECH1001	DESIGN THINKING	L	T	P	S	J	C
		0	0	2	0	0	1
Pre-requisite	**Nil**						
Co- requisite	**Nil**						
Preferable exposure	**Nil**						

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. ➢ Make sure that you are sufficiently creative in the analysis process, because the focus is on technical "details". ➢ Boost the efficiency of the analysis process by avoiding empty runs. ➢ 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. ➢ Summarize the results from the "understand" and "observe" phases and discuss with the team.	Exercise

➢ Highlight unexpected results and generate new perspectives.
➢ In general, share insights, ideas, and results (solutions) with others.
➢ Explore untapped market opportunities. — Exercise
➢ Provide differentiated and new offers based on the user needs.
➢ Adapt a strategy to new market needs by understanding the competitive edge.
➢ Establish the right vision for the design challenge or a road map for stepby-step implementation and control mechanisms.
➢ Find out at an early stage whether the basic need is satisfied and the product attracts interest on the market. — Exercise
➢ Find out through iterative testing whether the user need is met with a minimally functional product and how the product should be enhanced.
➢ Find out through user feedback how much demand there is for the product before developing further details and features.
➢ Minimize the risk of investing in a solution for which there is little demand on the market, thus saving time, money, and energy.
➢ Perform a true A/B test or several variants of a prototype in the form of a multi-variants test or as split testing. — Exercise
➢ Do a quantitative evaluation.
➢ Carry out a qualitative survey and evaluate the number and content of feedbacks.
➢ Compare individual variants of a function or a prototype (e.g. buttons, visuals, arrangement).
➢ Collect and appraise experiences made in the project in a structured manner. — Exercise
➢ Learn from experience and make use of it in the next project.
➢ Facilitate a positive attitude toward mistakes and appreciate progress.
➢ Identify and document the findings; make them applicable and usable.
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:

<table>
<tr><td rowspan="2">PHYS1241</td><td rowspan="2">PHYSICS OF OPTOELECTRONIC DEVICES</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 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:

PROJ3999	CAPSTONE PROJECT – FINAL	L	T	P	S	J	C
		0	0	0	0	6	6
Pre-requisite	PROJ2999						
Co- requisite							
Preferable exposure							

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:

<table>
<tr><td rowspan="2">PROJ3888</td><td rowspan="2">PROJECT EXHIBITION 2</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">PROJ2888</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:

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:

BTEN1021	INTRODUCTION TO BIOTECHNOLOGY-II	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 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:

<table>
<tr><td rowspan="2">FINA1031</td><td rowspan="2">PRINCIPLES AND PRACTICE OF BANKING</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:

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:

HRMG1021	HUMAN RESOURCE MANAGEMENT	L	T	P	S	J	C
		3	0	0	0	0	3
Pre-requisite	Nil						
Co- requisite	Nil						
Preferable exposure	Nil						

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

MKTG3011	SALES AND DISTRIBUTION MANAGEMENT	L	T	P	S	J	C
		3	0	0	0	0	3
Pre-requisite	Nil						
Co- requisite	Nil						
Preferable exposure	Nil						

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

<table>
<tr><td rowspan="2">BTEN1011</td><td rowspan="2">BIOTECHNOLOGY WORKSHOP</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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:

This laboratory course provides hands on training to the students in the basic experiments of engineering biotechnology. The student will be familiarized with the usage of equipment, calibration of pH meter, concepts of distillation, microbiology, division of cells, etc.

Course Educational Objectives:

- provide fundamental concepts of microbiology, fermentation, bioinformatics, mass transfer and reaction engineering
- demonstrate bioreactor and flow cytometer
- understand and visualize different phases of mitosis

1. Biological production of Wine

After completion of this experiment, the student will be able to prepare wine using cells and raw materials.

2. Demonstration of bioreactor operation and its control

After completion of this experiment, the student will be able to understand the operation and control of Bioreactor.

3. Distillation: Extraction of essential oils using steam distillation

After completion of this experiment, the student will be able to understand the distillation technique and its importance.

4. Viscosity: To study the viscosity of any food sample

After completion of this experiment, the student will be able to study the viscosity of any given sample

5. Texture Analysis of food materials

After completion of this experiment, the student will understand the various applications of a texture analyser.

6. Control of Microbial Growth

After completion of this experiment, the student will be able to acknowledge the various methods of controlling microbial growth.

7. Measurement of oxygen diffusion in water

After completion of this experiment, the student will be able to measure the amount of oxygen present in water.

8. Mitosis cell division in onion root tips

After completion of this experiment, the student will be able to observe mitotic cell

division in onion root tips.

9. Estimation of sugar content by Brix meter

After completion of this experiment, the student will be able to estimate the sugar content in any liquid sample.

10. Calibration of pH meter and pH measurement.

After completion of this experiment, the student will be able to calibrate the pH meter for measuring pH of any given liquid sample.

11. Batch growth of yeast cells

After completion of this experiment, the student will be able to prepare the media and grow the yeast cells in a conical flask.

12. Demonstration of flow cytometry for animal cell counting

After completion of this experiment, the student will be able to understand the principle of Flow cytometry and its usefulness in counting animal cells.

Course Outcomes:

The student will be able to:

1. Use the texture analyzer and microscope
2. Measure viscosity, dissolved oxygen, pH, sugar content
3. Observe cell division and control microbial growth
4. Grow yeast cells and
5. Produce and analyse wine
6. Explain the operation and control of bioreactors

CO-PO Mapping:

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

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

APPROVED IN:

BOS: 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement: 12

Ensure sustainable consumption and production patterns

SDG Justification:

This workshop is designed to provide information and hands-on over the various equipment’s existing in the department laboratories

BTEN1031	PROCESS CALCULATIONS	L	T	P	J	S	C
		2	0	0	0	0	2
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Large scale production in biotechnology industry involves a wide range of processes. This course introduces the concepts, laws and physico-chemical properties that are useful for bioprocess calculations. These calculations also enable the students to estimate the amount of chemicals required/heat released or absorbed in a bioprocess.

Course Educational Objectives:

- To introduce the concepts of chemical calculations
- To provide the basis for chemical reactions
- To familiarize the concepts of material and energy balance
- To explain the material and energy balance calculations
- To expose the material and energy balance concepts to bioprocesses

UNIT 1 Basic chemical calculations 6 hours

Mole, atomic mass, molar mass, equivalent mass, stoichiometric and composition relationships for solids, liquids, solutions, gases: Weight percent, volume percent and mole percent, density and specific gravity, Behaviour of ideal gases, application of the ideal gas law, Dalton and Amagat laws of gaseous mixtures, Composition of gases on dry and wet basis.

UNIT 2 Gases, Vapours and Liquids 8 hours

Equations of state, Vapor pressure, effect of temperature on vapor pressure: Clausius-Clapeyron equation, Antoine equation. Reference substance vapor pressure plots: Cox chart and Duhring’s plot, Vapor pressure of immiscible liquids, Ideal solutions and Raoult's law, non-volatile solutes, humidity, saturation, humid heat, humid volume, Dew point, humidity chart and its uses. Wet and dry bulb temperatures. Adiabatic vaporization and adiabatic saturation temperature.

UNIT 3 Material balances 8 hours

Process flow sheet, Material balance without chemical reactions, Degrees of freedom, Tie element basis for calculations. Material balance calculations involving drying, dissolution and crystallization, continuous filtration, batch mixing, Recycling and bypassing operations, Material balance with chemical reactions, concept of excess reactant, limiting reactant, conversion, yield, degree of completion.

UNIT 4 Energy balance 10 hours

Components of energy balance equation, Concept of Enthalpy and heat capacity, Heat effects accompanying chemical reactions, standard heats of reaction, combustion and formation, Hess's law, effect of temperature on standard heats of reaction, steady state energy balance.

UNIT 5 Stoichiometry of microbial growth and product formation 6 hours

Elemental balances, degree of reduction, yield coefficients, biomass yield, product stoichiometry, Theoretical oxygen demand, Maximum possible yield, Thermodynamics of microbial growth, Heat of reaction with oxygen as electron acceptor and without oxygen, Energy balance equations for fermentation and cell culture.

Textbooks:

1. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering", 8/e., Pearson,2015.

2. Bhatt, B. I., Vora, S. M., "Stoichiometry", 4/e Tata McGraw Hill,2004.

References:

1. Felder, R. M.; Rousseau, R. W., "Elementary Principles of Chemical Processes", Third Edition, John Wiley & Sons,2000

2. Hougen, O. A., Watson, K. M., Ragatz, R. A., "Chemical Process Principles, Part-I Material & Energy Balances", Second Edition, CBS Publishers & Distributors,2004

3. Venkataramani, V., Anantharaman, N., Begum, K. M. Meera Sheriffa, "Process Calculations", Second Edition, Prentice Hall ofIndia.

4. Sikdar, D. C., "Chemical Process Calculations", Prentice Hall ofIndia.

5. Pauline M.Doran, Bioprocess Engineering Principles, 1/e, Academic Press,2009.

Course Outcomes:

1. explain the relationship between reactants and products.
2. Outline the concept of adiabatic saturation and thermodynamic wet bulb temperature
3. solve material balance for various unit processes with and without recycling
4. identify various components of energy balance equation
5. apply the material and energy balance concepts to fermentation and cell culture

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement: 13

Take urgent action to combat climate change and its impacts

SDG Justification:

This course is designed to apply the laws of conservation of mass and energy, in order to account for all material and energy inputs in to different Unit processes and Unit operations.

BTEN2001	BIOCHEMISTRY	L	T	P	J	S	C
		2	0	2	0	0	3
Pre-requisite	CHEM1001, BTEN10001, BTEN1021, BTEN1011,1. Biology background 2. Chemistry 3. basic knowledge of biomolecules (NCERT), 4. Physiology (NCERT) and 5. Hormones and Vitamins (NCERT)						
Co-requisite	BTEN2021						
Preferable exposure	None						

Course Description:

All living beings consist of assemblies of molecules. Few of these molecules serve as structural elements, others are responsible for production, storage, and transfer of energy, encoding and decoding of genetic information. This course introduces the structure, properties and function of molecules that are the constituents of biological systems. This course is prerequisite for molecular biology and biochemical engineering.

Course Educational Objectives:

Introduce the biochemical basis of life from biomolecules.

- Impart knowledge of enzymes and kinetics
- Understanding how changes in structure affect function.
- Summarize structure and properties of biomolecules
- Explain the metabolic pathways with significance.
- Discuss the biological importance of lipids, proteins, nucleic acids, and hormones.

UNIT 1 Introduction to Biochemistry, proteins, and enzymes 8 hours

Introduction to Biochemistry: Organization of life, Chemical foundations of biology, non-covalent bonds

Amino acids and peptides: Structure and properties of amino acids, Classification of amino acids, peptide bond structure.

Proteins: Structure and classification of proteins, Structural organization of protein: primary structure of proteins, secondary structure of proteins – helix and pleated sheets, tertiary structure of protein. Structure and functions of hemoglobin.

Enzymes and Enzyme kinetics: Nomenclature, classification of enzymes, active site, factors affecting enzyme activity. Michaelis–Menten approach to enzyme kinetics, Mechanism of enzyme action. Nutritional aspects of proteins

UNIT 2 Carbohydrates 8 hours

Classification, structure, and functions of monosaccharide (ribose, glucose, and galactose), disaccharides (Maltose, sucrose and lactose), polysaccharides (starch, cellulose and glycogen). Metabolic pathways: Glycogenesis and glycogenolysis, glycolysis and TCA cycle, HMP shunt pathway, gluconeogenesis, Electron transport chain and Oxidative phosphorylation.

UNIT 3 **8 hours**

Classification, structure and physiological functions of triglycerides, fatty acids, phospholipids, cerebrosides, gangliosides and cholesterol. Digestion and absorption of fats. Synthesis and degradation of fatty acids. Nutritional aspects fatty acids.

UNIT 4 **Nucleic acids** **8 hours**

Structure of nucleic acids (DNA and RNA), structure and functions of purines, pyrimidines, nucleotides, Types of DNA and RNA. Biosynthesis and degradation of purine and pyrimidine nucleotides. Urea cycle.

UNIT 5 **Hormones and Nutritional Biochemistry** **8 hours**

Inborn errors of metabolism (amino acids, carbohydrates, and nucleic acids), Classification of hormones and their functions. and fatty acids. Vitamins.

Biochemistry Laboratory

This lab Provide concepts in preparation of buffers, tests for identification of bio molecules, quantification methods, enzyme assay, and enzyme kinetic parameters. Understand the separation of bio molecules by various chromatography techniques; visualize bio molecules in electrophoresis techniques. Demonstrate absorption spectra of proteins and nucleic acids.

1. Preparation of buffers: Acetate, Phosphate and Citrate buffers
2. Qualitative analysis of mono and disaccharides
3. Qualitative analysis of amino acids
4. Estimation of total carbohydrates by Anthrone method
5. Estimation of proteins by Biuret method
6. Determination of Iodine value of lipids
7. Assay of amylase and determination of kinetic parameters
8. Separation amino acids by paper chromatographic technique
9. Separation of sugars / amino acids by thin layer chromatographic technique
10. Separation of proteins by Gel filtration
11. Absorption spectra of proteins and nucleic acids
12. Demonstration of SDS-PAGE

Text Books :

1. Donald Voet, Judith G. Voet, Charlotte W. Pratt **Voet's PRINCIPLES OF BIOCHEMISTRY** 5/e, John Wiley, 2018.Language: English, Country of origin: USA, ISBN-10: 1119451663
2. David L. Nelson and Michael M. Cox, Lehninger Principles of Biochemistry, 8/e, W. H. Freeman, 2021 Language: English, Country of origin: Germany, ISBN-10: 1319381499; ISBN-13 : 978-1319381493
3. U Satyanarayana, U. Chakrapani, Biochemistry, 5/e, Elsevier, 2020. Language:

English, Country of Origin: India, ISBN-10: 8131262537; ISBN-13 : 978- 8131262535

References:

1. Jeremy M. Berg, LubertStryer, John Tymoczko, and Gregory Gatto, Biochemistry 9/e, WH Freeman, 2019.Language: English, Country of Origin: India, SBN-10: 1319114652;

ISBN-13:978-1319114657

Course Outcomes:

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

1. Describe the structure and properties of common biomolecules
2. Describe standard metabolic pathways
3. Explain the functional properties of enzymes
4. Explain role of hormones in human body.
5. Explain nutritional aspects of proteins and fatty acids.

CO-PO Mapping:

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

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

APPROVED IN:

BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement: 4

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

SDG Justification:

This course is designed to introduce students to the biological macro molecules structure & their function in living systems, metabolic pathways and hormones

BTEN2011	MICROBIOLOGY	L	T	P	J	S	C
		2	0	2	0	0	3
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Microbes are a diverse group of organisms that are too small to be seen by the human eye. Some microbes possess unique physiological and biochemical properties that can be utilized for industrial production. Other microbes are responsible for human, agricultural and veterinary diseases. This course describes the applications of microbiology in food, agriculture and environmental technology.

Course Educational Objectives:

- Impart knowledge of history, salient developments and key contributors in microbiology.
- Describe the morphological structure of Viruses, Yeast, Molds and Bacteria.
- Explore the effect of various parameters on microbial growth.
- Explain the role of microbes in industrial fermentation techniques.
- Describe the microbial decontamination techniques.

UNIT 1 Microbial World 10 hours

History, and important developments in Microbiology. Contributions of Nobel Laureates in Microbiology (Robert Koch, Emil, A.Von Behring, Ronald Ross and Barry Marshall). Microbial Taxonomy and diversity of Bacteria. Microbial Taxonomy and diversity of Archea. Molecular approaches to Microbial Taxonomy. Physiology and adaptation of extremophiles. Physiology and significance of Thermophiles, Psychropiles, Halophiles, and Methanogens.

UNIT 2 Morphology of Microbes 9 hours

Morphology of Viruses ; size, shape, symmetry, replication of viruses- lytic and lysogenic cycle. Bacteria: Ultra structure of Bacteria, cell wall, cell membrane, flagella, pili, capsule, endospore, and cell inclusions, differences between prokaryotic and eukaryotic cell. Bacterial growth kinetics. Yeasts and Molds: life cycle, economic importance of Yeast and Aspergillus.

UNIT 3 Microbial nutrition 8 hours

Nutrition requirements, nutritional types of bacteria, uptake of nutrients by cell. Microbial metabolism: Respiration, Photosynthesis and Nitrogen fixation.

UNIT 4 Control of microorganisms and Applied Microbiology 10 hours

Sterilization and Disinfection, effect of physical (moist and dry heat, radiation and filtration) and chemical agents. Antibiotics: classification, mode of action and resistance. Water, Food and Milk borne contamination and remedy. Basic microbial genetics - conjugation, transformation and transduction. Strain improvement of microbes of industrial importance.

UNIT 5 Industrial Microbiology 8 hours

Fermentation technology for production of alcohol, wine and beer. Role of microbes in bread making and bakery products, Production of enzymes (amylases and cellulases), Oil eating bacteria, Microbes in agriculture.

Practical Experiments	
Topic	**Type**
Preparation of nutrient both, nutrient agar and inoculation of bacteria.	Experiment
Isolation of pure cultures.	Experiment
Staining of microbes- simple staining, Gram staining, negative staining, capsule staining, and spore staining.	Experiment
Motility of microbes.	Experiment
Motility of microbes.	Experiment
Morphology of fungi (Aspergillus Niger)	Experiment
Morphology of yeast (Saccharomyces cerevisiae)	Experiment
Biochemicaltests-IMViCtest, Amylasetest, HydrogenSulphideproductiontest.	Experiment
Testing of microbiological quality of milk.	Experiment
Testing of microbiological quality of water.	Experiment
Microbial assay of antibiotics.	Experiment
Evaluation of disinfectant.	Exercise
Production of alcohol.	Project

Text Books :

1. Reba Kanungo,'Ananthanarayan and Paniker's Textbook of Microbiology',11,Universities Press (India) Pvt. Ltd.,India,2020,978-9389211436 - All Units

2. Pelczar, M. J. Jr., Chan, E. C. S. and Krieg, N. R.,'Microbiology: Application Based Approaches. ',10,Tata Mc Graw Hill Education,India,2009,978-0070151475 - All Units

3. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., Stahl, D. A. ,'Brock Biology Of Microorganisms, Microbiology ',14,Pearson Education,India,2017,978-9332586864 - All Units

References:

1. Alberts, et. al.,'The Molecular Biology of the Cell',6,W. W. Norton & Company,USA,2014,978-0815344322 - Unit- II, III, IV

2. Gerard J. Tortora, Berdell R. Funke and Christine L. Case,'Microbiology: An Introduction',13,Pearson,India,2020,9780134605180 - All Units

3. Joanne M Willey; Linda M Sherwood; Christopher J Woolverton; Lansing M Prescott; John P Harley; Donald A Klein,'Prescott, Harley, and Klein's Microbiology',7,New York : McGraw-Hill Higher Education,USA,2008,0071267271 9780071267274 - All Units

4. Stanier RY, Ingraham JL, Wheelis ML, Painter P,,'General Microbiology ',5,Palgrave Macmillan,USA,1999,978-0333763643 - All Units

5. Simon Baker, Carolone Griffiths and Jane Nicklin,'BIOS Instant Notes in Microbiology',4,Taylor& Francis,India,2012,978-0415607704 - All Topics

Course Outcomes:

1 Isolate and identify the microorganisms.

2 Analyze and apply the microbial metabolism for process or strain improvement

3 Define, describe and utilize microbial growth in fermentation and biological process.

4 Perform sterilization techniques.

5 Assess the quality of milk, water and biological samples.

CO-PO Mapping:

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

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

APPROVED IN:

BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement: 4

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

SDG Justification:

This course is designed to introduce students to theworld of microbes

<table>
<tr><td rowspan="2">BTEN2021</td><td rowspan="2">INSTRUMENTAL METHODS OF ANALYSIS</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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">BTEN1011, BTEN1031</td></tr>
<tr><td>Co-requisite</td><td colspan="7">BTEN2001</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

Course Description:

Instrumental methods of analysis are extensions of the human senses for perceiving the world. Some of these methods enable us to observe the organization of biological systems at a much higher level of resolution than the human eye, whereas others provide information for which there is no human equivalent sense, such as information regarding identity, purity and composition. The objective of this course is to describe the principles of instrumental methods for quantitative and qualitative analysis in biotechnology with examples related to quality control, process monitoring, biomolecular system characterization and diagnostic applications..

Course Educational Objectives:

- Summarize methods for quantitative and qualitative analysis of biomolecules and biomolecular systems (L2)
- Compare methods for determination of molecular mass and particle size distribution (L4)
- Explain the principles of the methods for determination of molecular structure (L2)
- List methods for studies of biomolecular interactions (L1)
- Identify methods for high throughput analysis (L3).

UNIT 1 Separation methods 5 hours

Principles of Centrifugation, Analytical Centrifugation. Preparative centrifugation. Principles of Chromatography. Types of Chromatography. Principles of Electrophoresis, Gel Electrophoresis.

UNIT 2 Optical Methods 7 hours

UV-Visible spectroscopy. Vibrational spectroscopy. Fluorescence spectroscopy. Refractometry, Polarimetry and Circular Dichroism. Microscopy: Confocal light microscopy. Cryo-electron microscopy. Determination of particle number and particle size from light scattering data. Structure determination of biomolecules and biomolecular assemblies from X-ray diffraction data.

UNIT 3 Mass spectrometry 5 hours

Principles and components of mass spectrometers. Ionization methods. Determination of empirical formula. Determination of structure of small organic molecules. Oligonucleotide sequencing. Peptide and protein sequencing. Mass spectroscopy for Metabolomics and Proteomics.

UNIT 4 NMR spectroscopy 6 hours

Principles of Magnetic Resonance. Principles and components of Fourier Transform NMR spectrometer. Chemical shift, coupling constants and peak areas. Structure determination of small organic compounds using NMR spectroscopic data. Multidimensional NMR spectroscopy. Application of solution NMR spectroscopy for protein structure determination. NMR spectral fingerprinting. Principles of MRI.

UNIT 5 Micro Analytical Methods 7 hours

Principles, applications and types of Biosensors. Glucose Biosensors. Principles and applications of Microarrays. Microarray fabrication. Detectors for microarrays. Introduction to Micro Electro Mechanical systems. Fabrication of MEMS. Principles and applications of Microfluidic systems. Lab-on-a-chip devices exemplified with PCR-chips. Point of care devices for diagnostic applications.

Text Books :

1. Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce,'Spectrometric Identification of Organic Compounds. ',8th Edition,Wiley,USA,2015,9788126556595,Unit-2

2. Andreas Manz, Petra S Dittrich, Nicole Pamme, Dimitri Iossifidis,'Bioanalytical Chemistry ',2nd Edition, World Scientific.,USA,2015,1783266724,Units:1-4

References:

1. David A. Wells. ,'High Throughput Bioanalytical Sample Preparation: Methods and Automation Strategies. 2nd ed. ',2nd Edition,Elsevier,Europe,2020,1,Unit-5

2. Xiujun James Li, Yu Zhou,'Microfluidic Devices for Biomedical Applications.',2nd Edition,Woodhead Publishing. Elsevier,Europe,2021,0128199717,Unit-5

3. Jaime Castillo-León, Winnie E. Svendsen,'Lab-on-a-Chip Devices and Micro-Total Analysis Systems: A Practical Guide ',1st Edition,.Springer,USA,2014,9783319086866,Unit-5

Journal (s)

1. Rienzoetal.,,'Lab on a Chip: High-throughput optofluidic screening for improved microbial cell factories via real-time micron-scale productivity monitoring',2021,2901,Unit-5

Course Outcomes:

1 Compare methods for determination of mass and particle size

2 Explain the principles of optical methods for characterization of biomaterials

3 Determine the sequence of proteins from mass spectrometry data

4 Analyze data from NMR spectroscopy

5 List the applications of high-throughput and miniaturized devices in biotechnology

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement: 4

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

SDG Justification:

This course is designed to introduce students to the fundamentals of a wide range of techniques that will provide foundations for current and future technologies

<table>
<tr><td rowspan="2">BTEN2031</td><td rowspan="2">GENETICS & MOLECULAR BIOLOGY</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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">BTEN1001, BTEN1021, BTEN1011, BTEN2011</td></tr>
<tr><td>Co-requisite</td><td colspan="7">BTEN3021</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

Course Description:

Genetics explains the transmission of characters from one generation to the next generation. Molecular biology explains the molecular basis for the transmission of this information. In addition, molecular biology also describes how genetic information is decoded by cellular machines made of molecular assemblies and how this information is utilized in biological systems. This course is prerequisite for genetic engineering.

Course Educational Objectives:

- Describe the principles of genetics in inheritance of character
- Provide knowledge in prokaryotic, eukaryotic cells and their organelles
- Describe Gene structure, function, cell cycle and signaling
- Describe DNA replication, gene expression and regulation at different levels
- Introduce the molecular basis of Mutations, DNA repair and genomics.

UNIT 1 Principles of Inheritance 9 hours

Principles of Inheritance: Mendelian and non-Mendelian inheritance. Linkage and crossing over, mapping of genes. Cytoplasmic inheritance. Hardy-Weinberg equilibrium.

UNIT 2 Cell biology and cell cycle 8 hours

Structure of cell membrane, cellular organelles and their structure and functions. Organization of the chromosome, euchromatin and heterochromatin. Cell division. Cell cycle and its regulation: CDC mutants, protein kinases, cyclins.

UNIT 3 DNA structure and Replication 10 hours

DNA structure and topology. Enzymology and mechanism of replication in prokaryotes and eukaryotes. Models of replication. Transposons. Molecular mechanism of recombination. Molecular basis of mutations, DNA repair mechanisms. Molecular mechanisms for epigenetics.

UNIT 4 Principles of transcription and regulation of gene expression 9 hours

Principles of transcription: Structure and function of prokaryotic RNA polymerase, mechanism of transcription in prokaryotes and eukaryotes, post transcriptional processing. Operon concept, regulation of gene expression in E.coli. Biochemical control of gene expression in eukaryotes.

UNIT 5 General features of genetic code and protein targeting and processing 9 hours

General features of genetic code, structure and function of translation machinery in prokaryotic and eukaryotic systems, protein targeting and processing. Signal sequences, signal receptor protein and signal hypothesis.

Text Books :

1. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine and R. Losick,'Molecular Biology of the Gene',7,Pearson,USA,2014,978-0-321-76243-6,Unit-3, 4, 5

2.Robert Brooker, ‘Genetics: Analysis and Principles',6,McGraw-Hill,USA,2017,1259921654,Unit-1

References:

1. B. Alberts, A. Johnson, J. Lewis, D. Morgan, M. Raff, K. Roberts and P. Walter, ,'Molecular Biology of the Cell',6,Garland Publishers,United states,2014,978-0815345244,Unit-2, 3

2. EDP De Robertis,'Cell and Molecular Biology',8,Lippincott, Williams and Wilkins,United states,2011,0781734932,Unit-2, 3,4,5

3. Harvey Lodish, Arnold Berk, Chris Kaiser, Monty Krieger, Anthony Bretscher, HiddePloegh, Kelsey Martin, Michael Yaffe, Angelika Amon, ‘Molecular Cell Biology',9,W.H.Freeman,USA,2021,1319365485,Unit-2,3,4,5

Course Outcomes:

1 Explain the concepts of gene structure and its function

2 Summarize the inheritance of characters by mendelian and non-mendelian genetics.

3 Explain the molecular basis of mutations and DNA repair

4 Explain the mechanism of gene regulation

5 Summarize the importance of genetic code and central dogma

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement: 4
Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG Justification:
This course is designed to introduce students to genetics

<table>
<tr><td rowspan="2">BTEN2041</td><td rowspan="2">FLUID MECHANICS AND MECHANICAL OPERATIONS</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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>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:

Fluid mechanics explains the relationships between force, pressure and fluid movement. Fluid mechanics can be used to understand the flow of fluids in pipes and mixing in bioreactors. Mechanical operations are applied in down-stream processing. This course introduces the principles of fluid mechanics and mechanical operations that are relevant for industrial biotechnology. The instruments used for measurement and control of fluid flow are also described..

Course Educational Objectives:

- explain basic concepts of fluid flow
- Describe the devices for measurement of fluid flow
- Discuss the application of fluid mechanics to bioprocess industries
- Explain principles of mechanical operations
- Discuss construction and working of equipment for mechanical operations.

UNIT 1 **10 hours**

Units and dimensions, types of fluids, hydrostatic pressure, pressure distribution in static fluids, pressure measuring devices, introduction to fluids in motion, concept of stream lines, stream tubes, viscosity, rheological properties of fluids.

UNIT 2 **10 hours**

Boundary layer formation and growth in tubes and on plates, Boundary layer separation and wake formation; Basic equations of fluid flow: continuity equation, and mechanical energy equation (Bernoulli equation).

UNIT 3 **Flow of incompressible fluids in pipes** **9 hours**

relation between skin friction and wall shear, laminar flow in pipes: Hagen-Poiseulle equation, friction factor, friction from changes in velocity or direction. Drag, drag coefficient, flow through beds of solids, fluidization, mechanism of fluidization, applications of fluidization.

UNIT 4 **Transportation and metering of fluids** **8 hours**

reciprocating, rotary, peristaltic and centrifugal pumps; flow measuring devices: venturi meter, orifice meter, rotameter, and pitot tube. Mechanical Separations: Screening, differential and cumulative screen analysis, capacity and effectiveness of screens; screening equipment: grizzly, gyratory and vibratory screens.

UNIT 5 Characteristics of solid particles, principles of comminution 8 hours
laws of crushing (Rittinger's, Bond's, Kick's laws); description and working of size reduction equipment: jaw, gyratory crusher, roll crushers, ball mill, hammer mill, and fluid energy mill.

List of experiments

1. Calibration of Rotameter.
2. Determination of orifice coefficient.
3. Determination of venturi coefficient.
4. Verification of Bernoulli's equation.
5. Friction losses in fluid flow in pipes
6. Determination of pressure drops in a packed bed for different fluid velocities.
7. Determination of pressure drop and void fraction in a fluidized bed.
8. Determination of centrifugal pump efficiency
9. Sampling of materials (Riffle sampling and cone quartering sampling).
10. Determination of energy consumption in size reduction using roll crusher.
11. Determination of energy consumption in size reduction using ball mill.
12. Determination of effectiveness of a given screen.

Text Books :

1. W.L. McCabe, J.C. Smith, and P. Harriot, Unit Operations of Chemical Engineering, 7/e, McGraw-Hill International Edition, 2017.

References:

1. J.M. Coulson, and J.F. Richardson, Chemical Engineering-Volume One, 6/e, The English Language Book Society and Permagon Press,1999.

2. G.G. Brown, Unit Operations, CBS Publishers,2005.

Course Outcomes:

After the completion of the course the student should be able to

1. Identify the types of non-Newtonian fluids
2. Characterize and describe fluid-particle systems in terms of their basic physical properties.
3. Impart the f concepts of fluid statics, pressure distribution and dimensional analysis
4. Learn basic principles of particle preparation and their characterization
5. Study and understand the principles of various size reduction

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement: 6
Ensure availability and sustainable management of water and sanitation for all
SDG Justification:
This is course will introduce the principles of fluid mechanics

BTEN2051	BIOCHEMICAL THERMODYNAMICS	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Thermodynamics is useful to understand the factors that affect the stability of a system at equilibrium. This course explains the fundamental laws of thermodynamics and introduces the concepts necessary to predict the feasibility of a process. These concepts are applied to explain conformational equilibria of biomolecules and energy storage & utilization in biological systems.

Course Educational Objectives:

- Explain thermodynamic properties and laws
- Estimate free energies of various biochemical reactions
- Derive fundamental property relations using state variables
- Explain phase equilibrium and chemical reaction equilibrium
- Apply laws of thermodynamics to biological systems

UNIT 1 **10 hours**

Zeroth law of thermodynamics, The first law of thermodynamics and other basic concepts: Joule's experiments, internal energy, the first law of thermodynamics, energy balance for closed systems, thermodynamic state and state functions, equilibrium, the phase rule, the reversible process, constant volume and constant pressure processes, enthalpy, heat capacity.

UNIT 2 **The second law of thermodynamics** **10 hours**

Statement of the second law, heat engines, thermodynamic temperature scales, entropy, entropy changes of an ideal gas, mathematical statement of the second law. The third law of thermodynamics.

UNIT 3 **Thermodynamic properties** **9 hours**

PVT behavior of pure substances, thermodynamic property relations for homogeneous phases. Solution thermodynamics: fundamental property relation, chemical potential and phase equilibria, fugacity and fugacity coefficient.

UNIT 4 **Chemical reaction equilibria** **8 hours**

The reaction coordinate, application of equilibrium criteria to chemical reactions, the standard Gibbs energy change and the equilibrium constant, effect of temperature on the equilibrium constant, relation of equilibrium constants to composition, phase rule and Duhem's theorem for reacting systems.

UNIT 5 Biochemical applications of thermodynamics 8 hours

Factors affecting stability of double stranded DNA, statistical thermodynamics of monomer-dimer equilibrium for DNA. The helix-coil transition in polypeptides, ligand-receptor binding equilibria. ATP-ADP energy storage and utilization.

Text Books :

1. JM. Smith, HC Van Ness, MM Abbott, Chemical Engineering Thermodynamics, 6/e, Tata McGra-Hill Edition, 2008.

2. I Tinoco, K Sauer, J C Wang, J D Puglisi, G. Harbison and D Rovnyak, Physical Chemistry: Principles and Applications in Biological Sciences, Pearson, 2013.

References:

1. S.I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, 5/e, Wiley, 2017.

2. K. Dill and S Bromberg, Molecular driving forces: statistical thermodynamics in biology, chemistry, physics and nanoscience, 2/e Garland science, 2012

3. J.M. Smith, H.C. van Ness, and M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 6/e, McGraw-Hill, 2003.

Course Outcomes:

After the completion of the course the student should be able to

1. Apply the fundamental concepts of thermodynamics to engineering applications
2. Estimate thermodynamic properties of substances in gas and liquid states.
3. Determine thermodynamic efficiency of a process.
4. Analyze chemical reaction equilibrium data
5. Comprehend the thermodynamic basis of biological phenomena

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement: 7
Ensure access to affordable, reliable, sustainable and modern energy for all
SDG Justification:
This is course will introduce the principles of thermodynamics for modern energy

BTEN3001	BIOCHEMICAL REACTION ENGINEERING	L	T	P	J	S	C
		2	0	2	0	0	3
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

Course Description:

All biochemical reactions occur at finite rates. Estimation of the time required for a process to yield the required amount of product is essential for design of any process. Product yield is a function of the reaction conditions as well as the type of reactor. Models of ideal reactors provide quantitative information regarding yield and process efficiency. This course is an introduction to the models of reactors.

Course Educational Objectives:

- Describe kinetics of homogeneous and heterogeneous reactions
- Explore the design of batch reactors and homogeneous flow reactors
- Introduce the techniques used for designing non isothermal reactors.
- Introduce different models to interpret non ideal flow in reactors

UNIT 1 **Kinetics** 8 hours

Kinetics of homogeneous reactions, elementary and non elementary reactions; collision theory and transition state theory, Arrhenius' relation, Monod kinetics. Kinetics of heterogeneous reactions: immobilized enzyme kinetics, effects of mass transfer on immobilized enzyme kinetics.

UNIT 2 **8 hours**

Introduction to types of reactors and bioreactors, analysis of batch reactor data, isothermal batch reactor design, batch reactor design for autocatalytic reactions, Design of fermenter, Design of enzyme reactor

UNIT 3 **Homogeneous flow reactors** **8 hours**

Design equation for plug flow reactor (PFR) and continuous stirred tank reactor (CSTR), design of PFR and CSTR for single reactions. Cascade of CSTRs and combination of PFR and CSTR Design for autocatalytic reactions, Stirred tank fermenter, multiple fermenters connected in series

UNIT 4 **Non-isothermal design** **8 hours**

Energy balance equations for batch, PFR and CSTR under non-isothermal conditions. Equilibrium conversion under adiabatic conditions. Design of the homogeneous reactors under adiabatic conditions. Sterilization kinetics, Batch & Continuous sterilization

UNIT 5 Non-ideal flow 8 hours

Residence time distribution curves E, F and C; interpretation of the response data for the dispersion and tanks -in-series models (omit multi parameter models).

List of Experiments:

1. Determination of the order of a reaction using a batch reactor and analysing the data by a) differential method and b) integral method.
2. Determination of the activation energy of a reaction using a batch reactor.
3. To determine the specific reaction rate constant of a reaction of known order using a batch reactor
4. To determine the order of the reaction and the rate constant using a tubular reactor.
5. To determine the order of the reaction and the rate constant using a CSTR
6. Determination of RTD and dispersion number in a tubular reactor using a tracer..
7. Axial mixing in a packed bed. Determination of RTD and the dispersion number for a packed-bed using tracer.
8. Determination of RTD and dispersion number in CSTR
9. Performance of reactors in series:

   i. plug-flow reactor followed by a CSTR ii .CSTR followed by Plug flow reactor
10. Determination of RTD and dispersion number forCSTRs in series

Text Books :

1. Octave Levenspiel, Chemical Reaction Engineering, 3/e, John Wiley, 2010.

2. J.M. Smith, Chemical Engineering Kinetics, 3/e, McGraw Hill, 1981.

References:

1. J.M. Coulson, and J.F. Richardson, Chemical Engineering-Volume One, 6/e, The English Language Book Society and Permagon Press, 1999.

2. G.G. Brown, Unit Operations, CBS Publishers, 2005.

Course Outcomes:

After the completion of the course the student should be able to

1. Design of batch reactor using rate law and its parameters
2. Design of flow reactors and fermentors
3. Select reactor and conditions to minimize unwanted products
4. Design of reactors based on energy balance.
5. Identify problems in real reactors

CO-PO Mapping:

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

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

APPROVED IN:

BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement: 7

Ensure access to affordable, reliable, sustainable and modern energy for all

SDG Justification:

This is course will introduce the applictation of biochemical reaction engineering for modern energy

<table>
<tr><td rowspan="2">BTEN3011</td><td rowspan="2">Fundamentals of Heat and Mass Transfer</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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">None</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

Course Description:

Many industrial processes in biotechnology involve heating and cooling. Although thermodynamics determines the direction of heat flow, knowledge of the modes of heat transfer enables us to estimate the time required for achieving the target temperature. The orientation of this course is to deal with certain unit operations. This course is a prerequisite for Fluid Mechanics, Stoichiometry, and Process Calculations.

Course Educational Objectives:

- To understand the fundamental concepts of conduction.
- To understand the principles of Convection.
- To understand the basic fundamental concepts of molecular diffusion.
- To understand the basic principles and equipment of distillation.
- To understand principles and equipment for liquid-liquid extraction.

UNIT 1 Introduction 8 hours

Modes of heat transfer, basic laws of heat transfer. Conduction: The Fourier heat conduction equation. One dimensional Steady state heat conduction through plane wall, cylindrical wall, spherical wall and composite structures. Heat transfer from extended surfaces.

UNIT 2 Convection 8 hours

The convective heat transfer coefficient. Dimensionless numbers in heat transfer and their significance. Application of Dimensional Analysis to heat transfer by convection. Empirical equations for calculation of heat transfer coefficients in laminar, turbulent and transition region in forced convection. Flow arrangements in heat exchangers, plate and frame heat exchanger, shell and tube heat exchanger.

UNIT 3 Introduction 8 hours

Mass transfer operations, molecular diffusion in fluids, binary solutions, Fick's law, equation of continuity, Molecular Diffusion in Gases, Stefan's diffusion, estimation of diffusivity of gases and liquids, theories of mass transfer. Interphase mass transfer: concept of equilibrium, diffusion between phases, material balances in steady state co-current and counter-current stage processes.

UNIT 4 Distillation 8 hours

Principles of VLE for binary systems, phase diagrams, relative volatility, ideal solutions, enthalpy concentration diagrams, flash vaporization, differential distillation (Rayleigh equation), steam distillation, continuous distillation, McCabe-Thiele method.

UNIT 5 Liquid-liquid Extraction 8 hours

Liquid-liquid equilibria, choice of solvent for extraction, analytical and graphical solutions for single and multistage operations, continuous counter current operation. Equipment: Mixer settler cascades, Rotating disc contactor, Scheibel extractor, Pulsed column, Centrifugal extractor.

List of Experiments:

PART A

1. Determination of Thermal conductivity of metal rod (steady state conduction).

2. Calculation of thermal conductance in a unsteady state heat exchange unit.

3. Calculation of film and overall heat transfer coefficients in double pipe heat exchanger

4. Calculation of film and overall heat transfer coefficients in shell and tube heat exchanger

5. Heat transfer through composite walls

6. Unsteady state heat transfer unit

PART-B

7. Ternary liquid –liquid system

6. Liquid-liquid equilibrium system

7. Vapor-Liquid Equilibrium experiment

8. Steam distillation

9. Differential distillation

10 Arnolds cell

11. Liquid-liquid diffusion

12. Solid Liquid equilibrium experiment

Text Books :

1. B.K. Dutta, Heat Transfer: Principles and Applications, Prentice Hall of India, 2000.

2. R.E. Treybal, Mass Transfer Operations, 3/e, McGraw Hill International Editions, 1981.

References:

1. Warren L. McCabe, Julian C.Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7/e, McGraw Hill, 2005.

2. B.K. Dutta, Principles of Mass Transfer and Separation Processes, Prentice Hall of India, 2007.

Course Outcomes:

After the completion of the course the student should be able to

1. Understand modes of heat transfer, basic laws of heat transfer and steady state heat transfer
2. Understand heat transfer by forced and free convection
3. Analyze mass transfer operations, molecular diffusion in fluids and interphase mass transfer.
4. Analyze continuous steady state distillation processes
5. Understand the concept about single and multistage operations and different types of equipments used in extraction

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement: 7
Ensure access to affordable, reliable, sustainable and modern energy for all
SDG Justification:
This is course will introduce the applications of heat and mass transfer for modern energy

BTEN3021	GENETIC ENGINEERING AND ITS APPLICATIONS	L	T	P	J	S	C
		3	0	2	0	0	4
Pre-requisite	BTEN2001, BTEN2011, BTEN2031, BTEN2031						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Genetic engineering consists of a set of techniques for manipulating the genes, which constitute the basis of inheritance. The basic paradigm of genetic engineering namely recombinant DNA technology involves cutting segments of DNA from one organism and pasting it into a vector, which is then transferred to the organism to be modified. This process enables transfer of genes and traits from one organism to another. Genetic engineering is applicable to microbes as well as higher level organisms such as plants, animals and human beings. The principles and techniques of genetic engineering as well as applications of genetic engineering in agriculture, medicine and industry are described in this course.

Course Educational Objectives:

- Explain principles of recombinant DNA technology
- Discuss the methods, tools and techniques for gene cloning and genome analysis.
- Describe methods for production of recombinant proteins.
- Describe the molecular techniques and their applications.
- List applications of rDNA technology in medicine, agriculture, industry and animal husbandry

UNIT 1 Basics of rDNA technology 8 hours

Isolation and purification of nucleic acids. Manipulation of DNA – Restriction and modification enzymes (nucleases, polymerases, ligasesandtoPo isomerases). Characteristics of cloning and expression vectors, vectors based on plasmids, lambda phage, Cosmides and artificial chromosomes BACs and YACs. Vectors for plant, yeast, and mammalian systems. Restriction mapping.

UNIT 2 Prokaryotic and expression host systems 8 hours

Prokaryotic and expression host systems. Cloning strategies: construction of recombinant vectors. Introduction DNA into host systems (gene transfer methods for bacteria, plants and animals). Molecular techniques in volved in study of expression of genes: Southern, Northern, Western, Dot andSlot blots, In-situ hybridization.

UNIT 3 Construction of genomic and cDNA libraries 8 hours

Construction of genomic and cDNA libraries. Screening of DNA libraries using probes and antisera. Preparation of labelled probes and primers. Maxam Gilbert, Sanger Coulson's, automated methods of DNA sequencing and Next Generation sequencing methods.

UNIT 4 Techniques for nucleic acid amplification and analysis 8 hours

Techniques for nucleic acid amplification and analysis: PCR, Nested PCR, inverse PCR, RT-PCR, Hot start PCR, Real time PCR, qPCR, Molecular beacons, DNA finger printing, RAPD, RFLP and AFLP. Site directed mutagenesis.

UNIT 5 RNA silencing: 8 hours

RNA silencing: design and applications of siRNA and anti-sense RNA. Applications of genetic engineering in medicine, agriculture, animal husbandry, environmental management and industry. Achievements, limitations and negative aspects of genetic engineering.

At least 10 of the following experiments:

Expt.1. Isolation of genomic DNA from plants

Expt.2. Determination of plant genomic DNA concentration and purity

Expt.3. Separation of plant genomic DNA on agarose gel electrophoresis

Expt.4. Isolation of plasmid DNA from E.coli culture

Expt.5. Separation of plasmid DNA on agarose gel electrophoresis

Expt.6. Restriction digestion of λ phage DNA

Expt.7. Ligation of the DNA digested by restriction endonucleases

Expt.8. Preparation of competent E.coli cells

Expt.9. Transformation of competent E.coli cells with ligated plasmid and selection of positive colonies through Blue-white screening method

Expt.10. Studying the expression of cloned genes (GFP)

Expt.11. PCR amplification of DNA using gene specific primers

Expt.12. Southern blotting of plant genomic DNA

Expt.13. DNA finger printing through RFLP and RAPD

Expt.14. Regulation of gene expression

Text Books :

1. T.A. Brown, Gene cloning and DNA analysis: an introduction, 6/e, Wiley- Blackwell, 2010.
2. D. S.T. Nicholl, An introduction to genetic engineering, 3/e, Cambridge University press, 2008.

References:

1. J.D. Watson, R.M. Meyers, A.A. Caudy and J.A. Witkowski, Recombinant DNA: genes and genomes - A short course, 3/e, W.H. Freeman and Co, 2007.

2. S.B. Primrose, R. Twyman, B. Old, Principles of gene manipulation, 6/e, Wiley-Blackwell, 2001.

Course Outcomes:

After the completion of the course the student should be able to

1. Summarize the common methods of isolation of nucleic acids and enzymes used in molecular biology.
2. Explain the applications of genome sequencing methods.
3. Select best biological hosts for optimum production of a protein.
4. Explain the principles of modern gene therapy.
5. Describe the applications of rDNA technology

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement: 2

End hunger, achieve food security and improved nutrition and promote sustainable agriculture

SDG Justification:

This course has been designed to apply genetic engineering principles to genetically engineered organisms for improving human living standards

BTEN3031	BIOPROCESS ENGINEERING	L	T	P	J	S	C
		3	0	2	0	0	4
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Industrial scale production of bioproducts involves optimization of media, operational conditions, selection of bioreactor type and method for control of operational parameters at the optimum values. Models of microbial growth are utilized to estimate the time requirements and process efficiency. This course describes the methods for optimization of media, aeration rate, process parameters and bioreactor type.

Course Educational Objectives:

- Identify differences between chemical processes and bioprocesses
- Explain principles of media design and optimization
- Explain principles of microbial growth kinetics
- Describe selection and operation of bioreactors
- Describe fermenter design

UNIT 1 **8 hours**

Definition and scope of bioprocess engineering. Bioprocess verses chemical processing: advantages and disadvantages. Substrates for bioconversions. Choice of microbes. Media design and optimization.

UNIT 2 **Aeration and agitation in bioreactors** 8 hours

Oxygen transfer in microbial systems, oxygen demand mass transfer theories, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth. Measurement of volumetric mass transfer coefficient, power requirement in gassed and unpassed bioreactors, mixing and heat transfer in dispersed systems, biorheology.

UNIT 3 **8 hours**

Kinetics for batch growth- unstructured non- segregated models, models for transient behavior in batch reactor. Batch and continuous bioreactors, growth in ideal chemostat, chemostat with recycle, multistage chemostat, fed-batch growth. Immobilized cell systems.

UNIT 4 **8 hours**

Selectionandoperationofbioreactors.Bioreactorinstrumentationandcontrol, Scale-up of bioreactors: Introduction, criteria of scale-up, similarity criteria, scale-up methods.

UNIT 5 **Design of a fermenter** **8 hours**

Basic functions of a fermenter for microbial or animal cell culture. Aseptic operation and containment, body construction: construction material, temperature control, aeration and agitation, foam control system, factors affecting antifoam requirements, antifoam addition system. Regulatory constraints

Bioprocess Engineering Laboratory

At least 10 of the following experiments are required:

1. Insitu sterilization and sterile operation of large reactors
2. Substrate processing – Pretreatment
3. Media optimization by a) Plackett and Burman method b) Response surface methodology for media design.
4. .
5. Microbial growth and product formation kinetics
6. Measurement of Volumetric Oxygen transfer coefficient (KLa) by: a) Sodium sulphite method b) Dynamic gassing method
7. Batch, Fed batch and continuous bioreactors for Biotech products
8. Residence time distribution in CSTR
9. Solid state fermentation
10. Production of citric acid by solid state fermentation
11. Production and recovery of Penicillin
12. Production and recovery of Vitamin B12
13. Optimization of parameters for Amylase production
14. Bulk production of tailored organisms

Text Books :

1. M. L. Shuler, F. Kargi, Bioprocess Engineering Basic Concepts, 2/e, Prentice Hall, 2002

References:

1. Pauline M Doran, Bioprocess Engineering Principles, Elsevier, 2005.

2. P.F.A. Stanbury, A. Whitaker, S.J. Hall, Principles of Fermentation Technology, 2/e, Pergamon,1995.

Course Outcomes:

After the completion of the course the student should be able to

1. Explain requirements for design of a bioreactor (L2)
2. Calculate power requirements of a bioreactor (L3)
3. Explain kinetics of microbial growth (L2)
4. Explain control of operating conditions in a fermenter (L2)
5. Describe regulatory constraints (L1)

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement: 6
Ensure availability and sustainable management of water and sanitation for all

SDG Justification:
This is course will introduce the applications of bioprocess engineering for improvement of water management and sanitation

<table>
<tr><td rowspan="2">BTEN3041</td><td rowspan="2">IMMUNOTECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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>Pre-requisite</td><td colspan="7">BTEN2001 BTEN2011</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 immune system is designed to prevent foreign organisms from causing harm to the body. Immunotechnology utilizes the components of the immune system for therapeutic and analytical applications. This course describes the components of the immune system, the mechanisms of immune response and application of this knowledge for selection of transplants and to produce vaccines.

Course Educational Objectives:

- Introduce the concepts of immunology
- Describe the structure and functions of immunoglobulins and complement proteins
- Introduce various immunological techniques
- Introduce hypersensitivity reactions and transplantation immunology.
- Describe models of immune deficiency

UNIT 1 **History of immunology** **8 hours**

Types of immunity: Innate and adaptive. Cells of the immune system, T and B lymphocytes – Origin, activation, differentiation, characteristics and functions. Nature of T and B cell surface receptors. Macrophages phagocytosis, Primary and secondary lymphoid organs: Structure and function. Antigens, immunogen, Hapten, Adjuvant, Epitope. Super antigens. Major Histocompatibility Complex, Human Leukocyte antigens (HLA), Antigen presenting cells, Processing and presentation of antigens. Necrosis & Apoptosis.

UNIT 2 **8 hours**

Structure of immunoglobulin, Immunoglobulin classes and biological activities. Isotypes, Allotypes, Idiotypes. Immunoglobulin genes and antibody diversity, Class switching, Humoral and cell-mediated immune responses, Cytokines-Interleukins, Interferons, TNF. The Complement, pathways and consequences of complement activation.Tumor immunology: Definition, tumor antigens, immune response to cancer.

UNIT 3 **Antigen-antibody interactions** **8 hours**

Antibody affinity and avidity, Precipitation reactions –Immunodiffusion, Radial immunodiffusion, double immunodiffusion, immunoelectrophoretic, Rocket immunoelectrophoretic, Agglutination reactions- Hemagglutination and complement fixation, Immunofluorescence, RIA, ELISA, Immunoblotting, Flow Cytometry and Fluorescence, Hybridoma technology - Production of monoclonal antibodies and their applications. Catalytic antibodies.

UNIT 4 **8 hours**

Hypersensitivity: Immediate (type I, type II, type III) and delayed hypersensitivity reactions, Autoimmunity - organ specific (Hashimoto's thyroiditis) and systemic (Rheumatoid arthritis) diseases. Transplantation Immunology- auto, allow, iso and xenograft, Bone marrow and Kidney transplants, Graft rejection (Graft versus host rejection and host versus graft rejection mechanisms), Co stimulatory pathways, Immuno suppressive agents. Immunodeficiencies - SCID and AIDS.

UNIT 5 **Vaccines** **8 hours**

Types of vaccines, Development, Production of peptide and DNA vaccines, Knockout mice, Transgenic mice as models of immune system diseases-Nude mice and SCID mice.

List of Experiments:

1. Differential count of White blood cells by haemocytometer
2. Estimation of haemoglobin by Sahli's method
3. Widal test for identification of Salmonella Typhi
4. Identification of blood group antigens
5. Agglutination inhibition test to detect pregnancy
6. Antigen/ antibody detection by Enzyme linked immune sorbent assay
7. Detection of antigen / antibody by Immuno Diffusion test
8. Immunoelectrophoretic
9. Protein immunoblotting (Western blotting) technique
10. Flow cytometry

Text Books :

1. Thomas J. Kindt, Barbara, A. Osbarne, Richard A. Goldsby, Kuby Immunology, 8th Edition, W.H Freeman, 2018.

2. P.M. Lydyard, A. Whelan & M.W Fanger, Instant notes in Immunology, 1st Edition, Viva publishers, 2008.

References:

1. William E. Paul, Fundamentals of Immunology, 7th Edition, Lippincott and Wilkins, 2012.

2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roit, Roitt's Essential Immunology, 12thedition, Wiley Black well, 2011.

Course Outcomes:

After the completion of the course the student should be able to

1. Describe the molecular basis of the immune response
2. Understand the basics of transplantation immunology.
3. Describe immunosuppressive drugs and immunodeficiency disorders
4. Outline the principles of vaccine development.
5. Explain the potential of transgenic mice

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG3 : Ensure healthy lives and promote well-being for all at all ages
SDG Justification:
This course is designed to introduce students to the tissues, cells and molecules involved in host defence mechanisms.

BTEN3051	**PRINCIPLES OF BIOINFORMATICS**	**L**	**T**	**P**	**J**	**S**	**C**
		3	**0**	**0**	**0**	**0**	**3**
Pre-requisite	BTEN2001 BTEN2031 BTEN3021						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Modern high throughput methods generate vast amounts of biological data. Bioinformatics enables us to validate, store, retrieve and analyze these data sets. This course introduces the data structures and algorithms that enable us to compare, classify and predict the function of biological sequences.

Course Educational Objectives:

- Describe nature and type of information available in biological databases (L1)
- Explain the principles of sequence alignment (L2)
- Analyze the algorithms for phylogenetic analysis (L3)
- Explain the principles of protein structure prediction (L2)
- Explain the principles of structural and functional genomics (L2)

UNIT 1 **8 hours**

Introduction to Biological data types and databases. Brief introduction to information available in the following databases (details to be covered in practicals): NCBI-Genebank, PIR, PFAM, PDB, GOLD. Sequence analysis: introduction. Similarity matrices – PAM and BLOSUM. BLAST Tool for searching sequence databases. Description of the BLAST algorithm

UNIT 2 **8 hours**

Pairwise sequence alignment using dynamic programming. Needleman & Wunsch algorithm for global alignment. Smith-Waterman algorithm for local alignment. Dynamic programming for sequence alignment with affine gap penalties. Searching for repeats and partial overlaps using dynamic programming.

UNIT 3 **Phylogenetic analysis. Distance based methods** **8 hours**

UPGMA and Neighbor joining. Classical parsimony and weighted parsimony methods. Branch and bound.

Multiple sequence alignment. Multidimensional dynamic programming. Progressive alignment and profile alignment. Sankoff and Cedergren method for Simultaneous alignment and phylogeny.

UNIT 4 **8 hours**

Prediction of transmembrane helices. Prediction of secondary structure from protein sequence – Chou-Fasman rules, neural networks. Prediction of protein conformation from protein sequence - Information theoretical methods: Homology and threading. Prediction using Force fields (Basic concepts only, regarding Energy minimization, molecular dynamics and simulated annealing). Forces involved in protein-protein, protein-DNA, protein-ligand and DNA-DNA interactions.

UNIT 5 **8 hours**

Computational problems in genome sequencing (concepts). Graph theoretical formulation of the fragment assembly problem. Hamiltonian path and Eulerian path based algorithms. Gene prediction - statistical and similarity based approaches. Overview (concepts only) of methods for gene annotation. K-means and SOM algorithms for analysis of gene expression data.

Text Books :

1. R. Durbin, S. Eddy, A. Krogh, G. Mitchison, Biological sequence analysis: Probabilistic models of proteins and nucleic acids, Cambridge University Press. 1998.

2. P. Pevzner and R. Shamir. Bioinformatics for Biologists. Cambridge University Press. 2011.

References:

1. A. Leach, Molecular modeling: principles and applications, 2/e, Pearson, 2009.

2. Teresa K. Attwood, Stephen R. Pettifer, David Thorne. Bioinformatics Challenges at the Interface of Biology and Computer Science: Mind the Gap. John Wiley & Sons, 2016. 047003548X, 9780470035481.

3. D. Mount, Bioinformatics: Sequence and Genome analysis, 2/e. CBS publishers. 2005.

4. T. Schlick, Molecular modeling and simulation, Springer-Verlag, 2002.

Course Outcomes:

After the completion of the course the student should be able to

1. List biological databases related to biochemicals, proteins and nucleic acids
2. Assess similarity of biological sequences
3. Solve problems in phylogenetic analysis
4. Predict protein structure based on sequence information and structure of homologs
5. Construct genomic sequences from fragments

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG4 : Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG Justification:
This course is designed to introduce students to the fundamentals and applications of information technology and it will provide foundations for current and future applications

<table>
<tr><td rowspan="2">BTEN4001</td><td rowspan="2">PLANT BIOTECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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>Pre-requisite</td><td colspan="7">BTEN1001, BTEN1021, BTEN2011, BTEN2031, BTEN3021</td></tr>
<tr><td>Co-requisite</td><td colspan="7">BTEN2031, BTEN3021</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

Course Description:

The plant biotechnology course is an essential component of biotechnology program. The course enables students to explore the skills of basic operations such as media preparation, plantlet regeneration and acclimatization. The technique expose student for large scale propagation of plants, their adaptations to climatic changes as well as selection and genetic modifications for disease resistance, herbicide tolerance, abiotic stress tolerance.

Course Educational Objectives:

- Introduce the concepts of screening, isolation and maintenance of industrially important microorganisms.
- Describe the production of organic acids and fermented beverages
- Describe the applications of secondary metabolites, antibiotics and enzymes.
- Introduce the commercial aspects of fermented foods.
- Describe the application of recombinant DNA technology for production of therapeutics

UNIT 1 Plant tissue culture and biotechnology 8 hours

Introduction, significance, history, plant tissue culture media, plant growth regulators, Principle and pathways of in vitro plant regeneration- totipotency, cell differentiation, callogenesis, rhizogenesis, organogenesis, somatic embryogenesis, Clonal (Micro) propagation- business and opportunity.

UNIT 2 Applications of plant tissue culture technique 8 hours

Haploid plant production, Protoplast technology- isolation, culture, somatic hybrids and cybrids production, Germplasms conservation- cryopreservation, Gene banks, Synthetic seeds technology, Somaclonal variations- origin, cause and in vitro selection, Virus indexing.

UNIT 3 Scale-up propagation 8 hours

Callus and cell culture system- isolation, culture, growth, viability and applications, Secondary metabolite production, biotransformation, Bioreactor- design and models for mass cultivation of plant cells, Hairy root bioreactor for secondary metabolite production, Automation in plant tissue culture.

UNIT 4 Genetic Transformation-basic principles and applications 8 hours

Plant genetic transformation technology: chimeric gene construction, Methods of gene transfer, Vectors of genetic transformation- Ti based vectors, T-DNA, mechanism of Agrobacterium gene transfer, , viral vectors, Chloroplast transformation, Gene Silencing-RNA editing, Field techniques for transgenic plants.

UNIT 5 Transgenic plants status 8 hours

Delayed ripening, Disease resistance-fungal, bacterial, viral, Herbicide resistance, Stress tolerance, Enhanced nutritional properties- Iron and Vit-A (Golden Rice), Plantibody, Plant cell chemical factory, Current global status and limitations of transgenic crops, Ethical and legal issues related to GM crops, Regulation of GM crops in India.

Plant Biotechnology Laboratory

1. Preparation of stock solution for Murashige& Skoog's (1962) (MS) medium.
2. Establishment of seed culture.
3. Induction and establishment of callus culture.
4. Haploids from anther culture.
5. Storage organ culture.
6. Axillary bud culture.
7. Leaf disc culture.
8. Subculture and multiplication of callus.
9. Shoot tip culture.
10. Zygotic embryo culture and somatic embryogenesis.
11. Artificial seeds production and plantlets regeneration.
12. Cell suspension culture.
13. Isolation and culture of protoplasts.
14. Agrobacterium mediated genetic transformation and hairy root culture.
15. In vitro rooting/ germination of somatic embryo and regeneration of complete plant.
16. Soil transfer, hardening and acclimatization of plantlets

Text Books :

1. H. S. Chawla, Introduction to Plant Biotechnology, 3/e, CRC Press, 2009.

2.A. Slater, N. Scott, M. Fowler, Plant Biotechnology: The Genetic Manipulation of Plants, 2/e, Oxford University Press, India, 2008.

3.Purohit S.D, Introduction to Plant Cell, Tissue and Organ CulturePaperback– 2012.

References:

1. L. Pena, (Editor), Trangenic Plant: Methods and Protocols (Methods in Molecular Biology Series Vol. 286)", HanumanaPressTotowa, New Jersey, USD, 2005.

2.Agnès E Ricroch, Surinder Chopra, Shelby Fleischer. Plant Biotechnology: Experience and Future Prospects. Springer International Publishing, pp.XIII, 291, 2014, 978-3-319-06891-6.

3.Functions and Biotechnology of Plant Secondary Metabolites 2nd ed (2010). Wink, M. Wiley-Blackwell

Course Outcomes:

After the completion of the course the student should be able to

1. Apply fundamental knowledge of in vitro plant propagation in laboratory and industry
2. Develop protocols for large scale micropropagation system, germplasm conservation, virus elimination
3. Explain screening and selection of haploids, somatic hybrids, and other variants for biotic and abiotic resistance
4. Improvise secondary metabolites through selection and genetic transformation
5. Calculate the cost of tissue cultured plant and the enterprises

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG2 : End hunger, achieve food security and improved nutrition and promote sustainable agriculture
SDG Justification:
This course will introduce plant biotechnology that has potential to end world hunger

.

BTEN4011	PROCESS DYNAMICS AND CONTROL	L	T	P	J	S	C
		2	0	2	0	0	3
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Bioprocesses are extremely sensitive to variations in temperature, oxygenation level, pH, ionic strength and shear. The response of a system to changes in external variables is time dependent. Hence the current state of the system has to be evaluated and the changes required to restore the system to the desired state have to be calculated. This course describes the dynamic models and control methods used for maintenance of reaction conditions.

Course Educational Objectives:

- Operate a process at the desired operating conditions, safely and efficiently, while satisfying environmental and product quality requirements.
- Develop models of important physical process systems.
- Design various control systems.
- Apply the control systems in various chemical and biochemical processes

UNIT 1 Linear Open-loop Systems 8 hours

Response of First-Order Systems, Physical examples of First-Order systems, Response of First-Order Systems in series, Second-Order Systems, Transportation Lag.

UNIT 2 Linear Closed-Loop Systems 8 hours

The control system, Controllers and Final Control elements, Closed-Loop transfer functions, Routh Stability, Root Locus.

UNIT 3 Frequency Response 8 hours

Introduction to frequency response. Control system design by frequency response.

UNIT 4 Process Applications 8 hours

Cascade control, Feed forward control, Ratio control, Selective Controllers, Split Range Controller, Controller tuning, Control valves.

UNIT 5 Applications of controllers in Bioprocesses 8 hours

Measurement and control of biochemical process variables pH, dissolved oxygen, viscosity, temperature, NADH, agitation rate and foam. Data logging, analysis and computer control of bioreactors.

Process Dynamics and Control Laboratory

List of Experiments:

1. Calibration of thermocouples.
2. Calibration of rotameter with compressible fluid.
3. Response of resistance thermometer
4. Response of bare mercury in glass thermometer.
5. Response of bare mercury in glass thermometer with thermal well.
6. Response of U-tube manometer.
7. Response of single-tank liquid-level system
8. Response of two-tank interacting liquid-level system.
9. Response of two-tank non-interacting liquid-level system.
10. Study of ON-OFF control action.

Text Books :

1. Process Systems Analysis and Control, 3rd Edn. S. E. Leblanc, Donald R.Coughanowr, McGraw-Hill Inc., 2009.

2.Stanbury, P.F.A., Whitaker & Hall, Principles of Fermentation Technology, 3/e Elsevier, 2017

References:

1. Seborg, Edgar, Millichamp, Doyle Process dynamics and control, 3/e John Wiley & Sons, 2010

2. Biochemical engineering fundamentals, Bailey and Ollis. 2nd Ed. 1986. McGrawHill.

Course Outcomes:

After the completion of the course the student should be able to

1. Analyse process controls and their applications
2. Assess the dynamics of first and higher order systems.
3. Evaluate the stability of controllers used in process industry
4. Understand the functioning of different controllers.
5. Apply control systems for bioreactor operation

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:

SDG7 : Ensure access to affordable, reliable, sustainable and modern energy for all

SDG Justification:

This is course will introduce the applications of process dynamics and control for improvement of water management and sanitation

<table>
<tr><td rowspan="2">BTEN4021</td><td rowspan="2">BIO SEPARATION TECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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>Pre-requisite</td><td colspan="7">BTEN2031</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:

Products of interest have to be separated from biomass and remaining constituents of the media at the end of fermentation. The separation of the desired products is a challenging task that often accounts for a major part of the cost of an industrial bioprocess. This course describes the techniques and processes used for separation and purification of bioproducts.

Course Educational Objectives:

- Introduce the methods for the separation of bioproducts
- Describe the various methods for the purification of recombinant proteins.
- Explain the mechanism of membrane fouling.
- Create process flow sheet using the unit procedure concept.
- Explain nucleation and growth of crystals

UNIT 1 Overview of bio separation, classification of bioproducts 10 hours

Recovery of intracellular products: Cell disruption methods: physical methods (osmotic shock, grinding with abrasives, solid shear, liquid shear), chemical methods (alkali, detergents), enzymatic methods. Extracellular Products.

UNIT 2 Separation of cells and other insolubles from fermented broth 8 hours

Sedimentation, filtration (pretreatment, filtration theory, continuous rotary filters), microfiltration, ultrafiltration, centrifugation (batch, continuous and basket), Precipitation.

UNIT 3 Extraction, Adsorption and Chromatography 8 hours

Extraction: Phase separation and partioning equilibria, liquid-liquid extraction methods, reciprocating-plate column, centrifugal extractor.

Adsorption: Theory of adsorption, adsorption isotherms, industrial adsorbents, adsorption types.

Chromatography: ion-exchange, column chromatography.

UNIT 4 Crystallization: 8 hours

Crystallization theory, rate of nucleation and rate of crystal growth, particle size distribution of crystals, batch crystallizer, model for Mixed-Suspension-Mixed-Product -Removal (MSMPR) crystallizer.

Drying of bioproducts, methods of drying, equipment for drying, equilibrium moisture content of bioproducts, rate of drying curves, constant rate drying period, falling rate drying period, freeze drying.

UNIT 5 **Product recovery** **8 hours**

Ethanol, Citric acid, Penicillin, Enzyme, Insulin.
Economics of Bioproducts.

Bio separation Technology Lab

1. Cell disruption by chemical method.
2. Cell disruption by mechanical method.
3. Product recovery by membrane filtration.
4. Separation of product using rotary vacuum Evaporation
5. Separation of bioproduct using adsorption.
6. Biomass removal by flocculation / Centrifugation method.
7. Purification of ethanol using distillation method.
8. Dehydration and estimation of drying time of a sample using tray dryer.
9. Purification of antibiotic using liquid-liquid extraction.
10. Enzyme Purification using Dialysis method / Salting out method.

Text Books :

1. P.A. Belter, E.L. Cussler & Wei-Shou Hu, Bioseparations: Downstream Processing for Biotechnology, Wiley-Interscience. 2012.

References:

1. R.G. Harrison, P. Todd & S.R. Rudge, Bioseparation Science and Engineering, Oxford University Press, 2006.

2.McCabe, Smith & Harriot, Unit Operations of Chemical Engineering, 7th edition McGraw Hill book company, 2014.

3. J.A. Asenjo. Separation Processes in Biotechnology, CRC Press, 1990.

Course Outcomes:

After the completion of the course the student should be able to

1. Describe the various methods for the purification of recombinant proteins.
2. List unit operations for biochemical product recovery.
3. Design equipment for the separation and purification of bioproducts
4. Create process flow sheet
5. Estimate the cost requirements of downstream processing

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG9 : Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

SDG Justification:
This course is designed to introduce students the Innovation and technological progress of both economic and environmental challenges,such as increased resource and energy-efficiency and also to Facilitate sustainable infrastructure development & enhance research

<table>
<tr><td rowspan="2">BTEN4031</td><td rowspan="2">ANIMAL BIOTECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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">BTEN2031</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 investigations and interpretations in animal biotechnology had contributed to countless impact to the world. This course provides an introduction to basic techniques of cell, tissue and organ culture, isolation and Application of stem cells in medicine, cell culture reactors. This course is prerequisite for organ culture and tissue engineering, production of transgenic Animals.

Course Educational Objectives:

- Introduce the Basic techniques of cell, tissue and organ culture.
- Impart knowledge of stem cells
- Summarize cell culture reactors
- Explain the organ culture and tissue engineering
- Discuss the production of transgenic animals

UNIT 1 **8 hours**

Basic techniques of cell, tissue and organ culture, Primary culture and subculture of cells. kinetics of cell growth, Properties of normal and transformed cells, Role of carbon-dioxide, serum and other supplements in cell culture, Different types of culture media- natural media, BSS, MEM, serum free media, Different methods for the estimation of cell viability and cytotoxicity, Applications of cell culture.

UNIT 2 **8 hours**

Stem cells – Embryonic and adult stem cells, Isolation and culture of stem cells, Induced pluripotency of stem cells, Stem cell markers, Stem cell plasticity and differentiation, Application of stem cells in medicine, Apoptosis- mechanism and significance with reference to degenerative diseases – Parkinson’s disease, stroke and diabetes.

UNIT 3 **8 hours**

Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration; Rotating chambers; Perfused suspension cultures; Fluidized bed reactors for suspension culture; Scale-up in monolayers; Multisource propagators; Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures.

UNIT 4 **Organ culture and tissue engineering** **8 hours**

Organ cultures, histotypic cultures, three dimensional cultures, organotypic cultures. Production of bio-artificial skin, liver and pancreas, Tissue engineering- cell source and culture, culture of cells, design engineering of tissues, tissue modelling, Embryonic stem cell engineering.

UNIT 5 **8 hours**

Production of Transgenic Animals -Mouse, cattle and fish by microinjection, retroviral vector method and embryonic stem cell method. Animal cloning-Somatic cell nuclear transfer and embryonic stem cell nuclear transfer methods. Biopharming and gene knockout technologies

Text Books:

1. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002

2.Ramadass P, Meera Rani S. Text Book of Animal Biotechnology. Akshara Printers, 1997.

References:

1. Freshney, R.I., “Culture of Animal Cells: A Manual of Basic Techniques and Specialized Applications”, 6th Edition, John Wiley & Sons, 2010.

2.Portner, R., “Animal Cell Biotechnology: Methods and Protocols”, 2nd Edition, Humana Press, 2007.

3.Masters J.R.W. Animal Cell Culture: Practical Approach. Oxford University Press.2000.

Course Outcomes:

After the completion of the course the student should be able to

1. Llearn Basic techniques of cell, tissue and organ culture.
2. Outline cell culture reactors
3. Explain the organ culture and tissue engineering
4. Discuss the production of transgenic animals
5. Explain the production various transgenic animals

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG3 : Ensure healthy lives and promote well-being for all at all ages

SDG Justification:
This course has been designed to apply genetic engineering principles to genetically engineered organisms for human benefit

Program Elective

BTEN3062	ADVANCED CELL BIOLOGY	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	BTEN1001 BTEN1021 BTEN2001						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Cells are the basic units of all higher level living organisms. This course describes the basis of cellular organization, cell-cell communication mechanisms and the molecular basis of cellular response to environmental signals. This course is useful to pursue advanced research in the fields of immunology and cancer biology.

Course Educational Objectives:

- Provide a perspective on recent advances in cell biology
- Familiarize the different approaches of cell biology
- Impart the concept of cell signalling cascades
- Introduce the mechanism of cell – cell communication
- Explore the models and case-studies of signal transduction

UNIT 1 6 hours

Introduction to cellular organization and metabolism: Energy trading within the cell: Cellular energy currencies: reduced nicotinamide adenine dinucleotide, nucleoside triphosphates, hydrogen ion gradient across the mitochondrial membrane, sodium gradient across the plasma membrane, inter-convertible mechanisms of energy currencies, feedback and feed-forward control of energy production.

UNIT 2 Ions and Voltages, Properties of carriers and Action potential 6 hours

Ions and Voltages: Potassium gradient and the resting voltage, Chloride gradient. Properties of carriers: sodium–calcium exchanger, calcium ATPase pump.
Action potential: calcium action potential in sea urchin eggs, voltage-gated sodium channel in nerve cells.

UNIT 3 Intracellular signalling 6 hours

Calcium, cyclic Adenosine Mono-Phosphate, cyclic Guanosine Mono-Phosphate, Receptor Tyrosine Kinases and the MAP kinase cascade, Protein Kinase B and the glucose transporter: working principle of insulin. Crosstalk between signalling pathways.

UNIT 4 Intercellular Communication and Synapses between neurons 6 hours

Intercellular Communication: Classifying transmitters and receptors, Intercellular communication in action: case study of gastrocnemius muscular action. Nitric oxide signaling. Synapses between neurons: spatial summation, temporal summation, case study of gamma-amino butyric acid (GABA) neuro-transmitter.

UNIT 5 Cytoskeletal molecules: 6 hours

Cytoskeletal molecules: Microtubules, Microfilaments, Intermediate filaments, Cell-Cell junctions, Chemo and durataxis, Cell locomotion, cell migration and homing.

Advanced Cell Biology Lab

1	Introduction to biological safety cabinets and CO2 incubators
2	Aseptic techniques for cell culture
3	Principle and operation of an Inverted Microscope
4	Low Speed Centrifugation for separation of Cells from Whole blood
5	Isolation of Chloroplasts
6	Isolation of Mitochondria
7	Harvesting and Counting of cultured mammalian cells
8	Cryopreservation of Cells
9	Assessment of cell viability
10	Preparation of whole cell extracts
11	Western blot
12	Flow cytometry
13	Cell separation with magnetic beads

Text Books :

1. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter, Molecular Biology of the Cell, 6th Edition, 2014

2.Geoffrey M. Cooper, The Cell: A Molecular Approach 7th Edition, Oxford University Press; 2015.

References:

1. Francisco V. Sepiilveda and Francisco Bezanilla, Pumps, Transporters, and Ion Channels Studies on Their Structure, Function, and Cell Biology, Kluwer Academic /Plenum Publishers, 2005.

2.P.S. Verma, Cell Biology, Genetics, Molecular Biology: Evolution and Ecology, Chand (S.) & Co Ltd, India 2004.

Course Outcomes:

After the completion of the course the student should be able to

1. Understand the energetics of cell metabolism
2. Understand the concepts of Ion gradients and Voltages in cells
3. Impart knowledge of inter and intracellular communications
4. Apply thermodynamic principles to biological systems.
5. Appreciate the potential of recombinant DNA technology.

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG4 : Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG Justification:
This course is designed to introduce students to molecular components in cells, their structure and functions

BTEN3072	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Measurement of human induced changes to the environment and their remediation are essential for long term sustenance. Biotechnology based methods are useful for monitoring pollution and environmental remediation. This course describes the applications of biotechnology for pollution monitoring, methods for waste treatment and the applications of genetically engineered microbes for bioremediation.

Course Educational Objectives:

- Describe the relation between biodiversity and environmental pollution
- Describe sources of pollution
- Describe methods for biomonitoring of pollution
- Describe applications of biotechnology for environmental remediation
- Explain potential of genetically engineering microbes for bioremediation

UNIT 1 Issues and Scope of Environmental Biotechnology 6 hours

Introduction to Biodiversity, environmental pollution, chemical pesticides and their effects, metal pollution, bioaccumulation of toxicants, Biotechnological methods for measurement of pollution. Biomonitoring of air and water pollution, remediation of pollutants.

UNIT 2 Biological Treatment of waste water 6 hours

Aerobic suspended and attached growth system- activated sludge process, trickling filters, Rotating biological contractors (RBC). Anaerobic suspended and attached growth systems- anaerobic digestion, anaerobic filter process, UASB. removal of biological nitrogen and phosphorus.

UNIT 3 Treatment of waste water of food processing industries 6 hours

Starch, Dairy, Fruit &Vegetable, Confectionary, Beverages, meat and vegetable oil .

UNIT 4 6 hours

Solid waste management- Sources, preliminary operations, sludge thickening, sludge stabilization, conditioning of sludge, dewatering, heat drying, disposal of sludge, Composting, Vermicomposting, Biofertilizers.

UNIT 5 6 hours

Biodegradation and bioremediation- In situ and ex situ bioremediation, biodegradation of hydrocarbons, pesticides, herbicides and xenobiotics. Bioremediation of contaminated soil, Genetically engineered microorganisms in bioremediation. Phytoremediation.

Text Books :

1. M.H. Fulekhar, Environmental biotechnology,2017, CRC publishers
2. U. Satyanarayana, Biotechnology, 1st Edition, Books and Allied (P) Ltd, 2005

References:

1. Bruce E. Rittmann and Perry L. Mc Carty, Environmental Biotechnology: Principles and applications, Mc Graw Hill Company, 2012.
2. Martin Alexander, Biodegradation & Bioremediation, 2nd Edition, Academic press, 2012

List of suggested experiments/field trips/tutorials

Any five of the following:

1. Assessment of microbes in air
2. Assessment of biological oxygen demand in Wastewater
3. Demonstration of Activated sludge process for Wastewater treatment
4. Demonstration of Anaerobic digestion for Wastewater treatment
5. Composting
6. Production of biofertilizer
7. Biodegradation of plastics
8. Estimation of heavy metals in water
9. Environmental impact assessment of Fermentation Unit

Course Outcomes:

After the completion of the course the student should be able to:

1. Describe methods for biomonitoring of pollution
2. Describe principles and methods for biological treatment of wastewater
3. Describe methods for solid waste management
4. Describe principles and applications of biodegradation and bioremediation
5. Explain potential of genetically engineering microbes for bioremediation

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG15 : Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

SDG Justification:

<table>
<tr><td rowspan="2">BTEN3081</td><td rowspan="2">BIOPROCESS TECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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:

Fermentation is the process that started the era of industrial biotechnology. This technology can be utilized to produce biochemicals, fuel and medicines. This course introduces the procedures involved in fermentation.

Course Educational Objectives:

- Introduce the concepts of screening, isolation and maintenance of industrially important microorganisms.
- Describe the production of organic acids and fermented beverages
- Describe the applications of secondary metabolites, antibiotics and enzymes.
- Introduce the commercial aspects of fermented foods.
- Describe the application of recombinant DNA technology for production of therapeutics

UNIT 1 Introduction to Industrial Fermentations 9 hours

Screening, isolation and maintenance of industrially important microorganisms. Types of fermentation processes, carbon and nitrogen sources, conventional and non- conventional raw materials and microbial metabolism.

UNIT 2 Production of primary metabolites 9 hours

Production of organic acids: citric acid, acetic acid and lactic acid. Production of amino acids: L-glutamic acid and Lysine. Production industrial solvents and fermented beverages: ethanol, beer and wine.

UNIT 3 Production of secondary metabolites 9 hours

Production of antibiotics: penicillin and streptomycin. Production of industrial enzymes: amylases, proteases and pectinases.

UNIT 4 Food fermentation 9 hours

Fermented milk foods: cheese. Fermented vegetable foods: Sauerkraut and soya sauce.Production of food and fodder yeast: Baker's yeast, food and fodder yeast.

UNIT 5 Production of recombinant products 9 hours

Production of recombinant biopolymers. Recombinant therapeutics: Production human insulin by bacterial and yeast expression systems. Production of human growth hormone by bacterial expression system.

Text Books :

1. 1. A. H. Patel, Industrial Microbiology, 2/e, MacMillan Publishers, 2012.
2. N. Okafor, Modern Industrial Microbiology and Biotechnology, Science Publishers, 2007.

References:

1. E. M. T. El Mansi, C. F. A. Bryce, A. L. Demain, A. R. Allaman, Fermentation Microbiology and Biotechnology, 3/e, Taylor and Francis, 2011.
2. W. C. Frazier, D. C. Westhoff and N. M. Vanitha, Food Microbiology, 4/e, McGraw Hill, 2014.
3. A. N. Glazer and H. Nikaido, Microbial Biotechnology: Fundamentals of Applied Microbiology, 2/e, Cambridge University Press, 2007.
4. G. Reed, Presscott and Dunn's Industrial Microbiology, 4/e, CBS Publishers and Distributors, 2004.
5. W. Cruger and A. Cruger, Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation, 2003.

Course Outcomes:

After the completion of the course the student should be able to:

1. Understand the scope and importance of fermentation technology
2. Distinguish between methods for production of primary and secondary metabolites
3. Describe applications of recombinant DNA technology for pharmaceutical production

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG6 : Ensure availability and sustainable management of water and sanitation for all
SDG Justification:
This is course will introduce the bioprocess technology for improvement of water management and sanitation

BTEN3092	SEA & DAIRY FOOD PROCESSING	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

Course Description:

The sea and dairy food are major components of the food processing industry with specialized requirements. This course describes the methods used for food processing and food quality assessment applicable to sea and dairy foods.

Course Educational Objectives:

- Describe the scope and importance of sea and dairy food processing.
- Describe milk processing technology
- Introduce unit operations in sea and dairy food processing
- Describe the processing technology for production of butter and cheese
- Describe the regulations pertinent to the sea and dairy food industries

UNIT 1 Seafood Processing 6 hours

Principles of preservation and processing ; chilling and freezing methods, cold storage, phenomena of rigor mortis, spoilage changes and causative factors. Drying; conventional methods, salt curing, pickling and smoking. Canning and hurdle technology in food preservation. Role of preservatives in processing. Fishery by-products.

UNIT 2 Milk processing and Common dairy processes 6 hours

Milk processing: Fluid milk processing, packaging and distribution. Common dairy processes: cream separation (standardization), pasteurization, sterilization and homogenisation. UHT processing of milk. Process technology for manufacture of evaporated milk, condensed milk, dried milk, malted milk, reconstituted/rehydrated milk, recombined milk, toned milk and fermented milk.

UNIT 3 Dairy and food processing operations 1 6 hours

Overview of thermal operations carried out in dairy processing. Role of water and water activity in foods. Crystallization and freezing. Estimation of freezing time of foods. Concentration of liquid foods in batch, continuous type and multiple effect evaporators with mechanical and thermal vapour compression. Mechanism of moisture removal in solid and liquid foods during drying. Spray, freeze, roller tray and through-flow drying operations.

UNIT 4 Dairy and food processing operations 2 6 hours

Overview of mechanical operations carried out in dairy processing. Particle size separation in spray dryer and gravity separator. Filtration of food. Slurry filter medium and cake resistances. Size separation through sieving. Particle movement in sediment and centrifugal settling tank. Solid bowl and disc bowl centrifuges. Operation of cyclone separator and self cleaning centrifuge. Agitation and mixing of liquid foods, powders and pastes.

UNIT 5 Butter 6 hours

Composition, flow diagram of production, yield, fat loss in butter making. Continuous butter making, grading of table butter, defects in butter; causes and prevention. Cheese: Flow diagram of production. Cheddar cheese, mozzarella cheese and processed cheese manufacturing. Curing and storage of cheese. Defects causes, prevention and quality control. Ice Cream: Composition and flow diagram of production. Infant, baby foods and indigenous dairy products. Laws and standards in Fishery Industry: Quality control with reference to sea food. Novel product development, nutrition promotion, consumer studies, marketing and sea food export. MPEDA, government policies, export finance, economic importance.

Sea And Dairy Food Processing Laboratory

Minimum of 8 experiments from the following:

1. Drying of fish
2. Production of marine algal foods
3. Production of cheese
4. Production of yoghurt
5. Production of buttermilk
6. Production of butter
7. Evaluation of cheese
8. Evaluation of yoghurt
9. Pasteurization of milk
10. Evaluation of milk

Text Books :

1. A. Tufail, Dairy Plant Engineering and Management, Kitab Mahal Distributors, 2014.

2. P. Sinha, Fish processing and preservation, APH Publishing, 2011.

References:

1. A.W. Farrall, Engineering for Dairy and Food Products, John Wiley and Sons, New York, 1963.

2. R. P. Aneja, B. N. Mathur, R. C. Chandan and A. K. Banerjee, Technology of Indian Milk Products: Handbook on Process Technology, Modernization for Professionals, Entrepreneurs and Scientists. A Dairy India Publication, 2002.

Course Outcomes:

After the completion of the course the student should be able to

1. Understand the scope and importance of sea and dairy food processing.
2. Understand the application of milk processing technology
3. Optimize unit operations in sea and dairy food processing
4. Describe the processing technology for production of butter and cheese
5. Describe the regulations pertinent to the sea and dairy food industries

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG2 : End hunger, achieve food security and improved nutrition and promote sustainable agriculture

SDG Justification:
This course will introduce food technology to improve utilization of food

<table>
<tr><td rowspan="2">BTEN3101</td><td rowspan="2">CONCEPTS IN BIOPHYSICS</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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">BTEN2001 BTEN2031</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:

Biological organisms utilize energy from external sources to drive non-equilibrium processes that are utilized for the benefit of the organism and its progeny. Biophysical models can be used to explain the interactions of forces, fields and biological molecules that produce complex behaviour in biological systems. Noninvasive biophysical imaging methods can provide detailed structural information that is useful for diagnosis and quality control. This course introduces the biophysical principles and methods useful for understanding the structure and function of biological organisms.

Course Educational Objectives:

- Explain the physics of energy transfer and molecular interactions in biological systems
- Explain the physical basis of human vision and hearing
- Describe the physiology of biological information processing and response
- Explain the mechanics of locomotion
- Describe the methods for biomedical imaging

UNIT 1 Bioenergetics 10 hours

Energy transfer mechanisms. Photo physics of chlorophylls and carotenoids: MO model for the electronic states. Huckel approximation. Energy transfer in photosynthetic systems. Role of electron transfer in biological systems. Mechanisms of electron transfer. Proton transfer in bacteriorhodopsin. Molecular basis of human photoreception and Mechano-electrical transduction.

UNIT 2 Molecular biophysics 10 hours

Introduction to molecular mechanics. Role of hydrogen bond in biological systems. Models of allosteric interactions. Thermal stability of double stranded DNA. Transport of oxygen in humans. Self-assembly of micelles and lipid bilayers. Membrane potential. Measurement of transmembrane ionic current. Transmembrane transport mechanisms.

UNIT 3 Neurobiophysics 8 hours

Conduction of an action potential. Transmission of a nerve impulse across a synapse. Molecular mechanism of memory formation. Experimental measurement of brain activity. Mechanism of activation of muscles by nerve signals. Introduction to cybernetics and coordinated control of movement.

UNIT 4 Biomechanics 9 hours

Molecular motor models. Measurement of force generated by molecular motors. Propulsion by cilia and flagella. Models of Bacterial chemotaxis. Biofluid mechanics. Scaling laws applicable to biomechanics of locomotion. Energetic cost of locomotion. Terrestrial locomotion gaits. Froude number and dynamic similarity.

UNIT 5 Biomedical imaging 8 hours

Principles of following non-invasive imaging techniques: CT, PET, ultrasonography and MRI. Application of magnetic resonance for non-invasive imaging. Encoding of spatial information by using magnetic field gradients. MRI for non-invasive pharmacokinetic studies and medical diagnostics. Superparamagnetic iron oxide nanoparticles and their theranostic applications.

Text Books :

1. W. Hoppe, W. Lohmann, H. Markl, H. Ziegler. Biophysics. Springer. 2012.
2. Andrew W Wood. Physiology, Biophysics, and Biomedical Engineering. CRC Press. 2012.

References:

1. Andrew A. Biewener and Sheila Patek. Animal Locomotion. 2nd Edition. OUP Oxford, 2018.
2. Susan Hall. Basic biomechanics. 8th edition. McGraw Hill. 2019.
3. Robert W. Brown, Y.-C. Norman Cheng, E. Mark Haacke, Norman Cheng, Michael R. Thompson, Ramesh Venkatesan. Magnetic Resonance Imaging: Physical Principles and Sequence Design. John Wiley & Sons, 2014

Journal(s)

1. K J Breslauer, R Frank, H Blöcker, and L A Marky, PNAS June 1, 1986 83 (11) 3746-3750,Unit-2
2. Journal of Neurochemistry, 2006, 97, 1520–1533. Barco, Bailey and Kandel
3. Wadhams, G., Armitage, J. Making sense of it all: bacterial chemotaxis. Nat Rev Mol Cell Biol 5, 1024–1037 (2004)

Website(s)

NPTEL: Physics of Biological Systems

Course Outcomes:

1. Describe models of energy transfer in photosynthesis
2. Analyze the control systems and mechanics of motion in biological systems
3. Apply scaling laws for biological locomotion
4. Calculate energy requirements for motion in biological systems
5. Compare the advantages and disadvantages of biomedical imaging techniques

CO-PO Mapping:

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

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

APPROVED IN:

BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:

SDG4 : Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG Justification:

This course is designed to introduce students to the fundamentals of biological processes that will provide foundations for current and future technologies

<table>
<tr><td rowspan="2">BTEN3111</td><td rowspan="2">FOOD HANDLING, PACKAGING & STORAGE</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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:

In our healthy life, selection of types of foods or its products play important role with awareness of types of foods. And modern era, our customers are more sincere about selection of foods which could be safe, nutritious and least processed in nature. Most of our food processing industries are developing the more variety of foods for our people. But they are sensitive about processing conditions with maintenance of food standards as well ensuring of food safety for their products.

Course Educational Objectives:

- Acquire knowledge of various type of material handling and the type of equipment utilized
- Understand to designing food packaging materials depends the variety of food products
- Select the packaging materials and types depending upon the properties and sources of food.
- ensure the self-life of the packaged food product and adapt appropriate storage condition
- Describe the national and international acts and rules about food packaging

UNIT 1 **9 hours**

Material Handling: Solids and granular materials handling: elevators, conveyors; Pumps: centrifugal and positive displacement; Liquid filling machines: open vent, closed vent and piston fillers.

UNIT 2 **Packaging Materials** **9 hours**

Polymer films, metal containers, flexible packages, special packing.

UNIT 3 **Food Packaging** **9 hours**

Requirements for cereals, meat, poultry, fish, milk, vegetables, fruits, plantation crop-based products and carbonated beverages.

UNIT 4 **Storage Principle and Practice** **9 hours**

Storage Principle and Practice: Storage losses and their estimation: Modified and control atmosphere storage: Binandsilo storage force reals and pulses.

UNIT 5 **Loss in cereal quality** **9 hours**

insect and pest control. Design of storage structures and facilities including cold storage.

Textbooks:

1. M.J. Kirwan, McDowell, R.Coles, Food packaging technology. Wiley- Blackwell,2010.

References:

1. S. Stanley, C.G. Roger, Food Packaging, AVI Publications, 1970.
2. S. Sacharow, R.C. Griffin, Principles of Food Packaging, AVI Publication, 1980.
3. F.A. Painy, A handbook of Food Packaging, App. Sci. Publishers, 1980.

Course Outcomes:

After the completion of the course the student should be able to

1. Designing various food packaging materials and the equipment's used in processing of materials
2. Select the packaging materials based on their properties and usage.
3. Apply principles of food processing for efficient packaging with enhanced self-life with implementation of various acts and rules
4. Specialised and sustainable (environmentally) packaging for end user satisfaction.

CO-PO Mapping:

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

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

APPROVED IN:	
BOS : 24-12-2020	**ACADEMIC COUNCIL: 01/04/2022**
SDG No. & Statement:	
SDG2 : End hunger, achieve food security and improved nutrition and promote sustainable agriculture	
SDG Justification:	
This course will introduce food technology to improve utilization of food	

<table>
<tr><td rowspan="2">BTEN3121</td><td rowspan="2">ESSENTIALS OF MARINE BIOTECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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">BTEN2011, BTEN2031</td></tr>
<tr><td>Co-requisite</td><td colspan="7">Environmental Science</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

Course Description:

Marine ecosystems are a major source of food, oxygen and play a vital role in biogeochemical cycles. This course describes the natural products obtainable from marine resources and the application of biotechnology for diagnosis of diseases prevalent in commercially important marine organisms such as fish.

Course Educational Objectives:

- Provide the basis for evaluation and conservation of marine biodiversity.
- Describe the resources from marine environment.
- Introduce the different aspects of aquaculture.
- Describe the applications of marine biotechnology

UNIT 1 **9 hours**

Overview of the present status of marine biotechnology, Marine ecosystems – intertidal zone, inhabitants and ecology of estuaries, salt marshes, mangrove swamps, coral reefs and the deep sea, Plankton, nekton and benthos.

UNIT 2 **9 hours**

Introduction to tides and waves. Water currents and winds. Major and minor elements in the sea water and their importance, dissolved oxygen. Biogeochemical cycles (Carbon, Nitrogen, Sulphur and Phosphorus) in the ocean. Global climatic change and potential effects on coral bleaching, eutrophication.

UNIT 3 **9 hours**

Applications from both the biology and policy perspectives (e.g. endangered species, captive breeding, habitat fragmentation, ecosystem restoration, rehabilitation. Marine food web dynamics - primary, secondary and tertiary production.

UNIT 4 **9 hours**

Marine natural products, aquaculture, valuable chemicals, bioactive compounds from micro-algae, macro-algae and other marine organisms. Important enzymes from marine microorganisms and their applications: Xylanases, proteases, chitinases.

UNIT 5 **9 hours**

Marine biotechnology for economic development and environmental problem solving. Aquaculture- fish, shrimp and pearl oyster culture. Transgenic marine organisms. Biofouling and prevention. Bioremediation. Probiotic bacteria and their importance in aquaculture. PCR, molecular and immunological techniques for determination and identification of bacterial and viral pathogens in aquaculture. Vaccines for aquaculture.

Text Books :

1. Text book of Marine Ecology. (1989). Nair N.B. &Thampy, D.M.
2. Recent Advances in Marine Biotechnology. Vol.2 (1998) Fingerman, M., Nagabushanam, R., Thompson, M.

References:

1. Biological Oceanography. (1999). Lilly, C.M.
2. Ecology of Coastal water. (1988). Mann, K.H.
3. An introduction to Marine Sciences. (1988). Meadows, P.S. & Campbell J.J.
4. General Oceanography–An introduction (1980).Dietrich,G.,Kalle,K, Krauss,W&Siedler, G.
5. Biotechnology in the marine sciences: Proceedings of the first annual MIT Sea grant lecture & seminar. (1984). Colwell, R.D.(Ed)

Course Outcomes:

After the completion of the course the student should be able to

1. Explain physicochemical aspects of marine environment
2. Summarize applications of marine natural products
3. Apply biotechnological interventions to economic and environmental issues
4. Appreciate the importance of marine biotechnology.

CO-PO Mapping:

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

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

APPROVED IN:

BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:

SDG2 : End hunger, achieve food security and improved nutrition and promote sustainable agriculture, SDG14 : Conserve and sustainably use the oceans, seas and marine resources for sustainable development

SDG Justification:

This course has been designed to understand marine environment, apply genetic engineering principles to genetically engineered marine organisms for increase in aquaculture and other purposes

<table>
<tr><td rowspan="2">BTEN3131</td><td rowspan="2">PHARMACEUTICAL BIOTECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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">BTEN2001, BTEN2011, BTEN3031, BTEN3081 1. Biochemistry 2. Human physiology 3. Chemistry, 4. upstream and downstream processing 5. bioinformatics,</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 science of pharmaceutical biotechnology is a dynamic science aimed at focusing the attention of students on the manufacture and recovery of biopharmaceuticals and other biological products, basic knowledge about biological techniques used in production of some biological drugs and some basic principles and definitions related to pharmaceutical biotechnology. Dosage forms, pharmacokinetics, dynamics and Clinical Trials, case studies on biopharmaceutical product development which would broaden the knowledgebase of the students.

Course Educational Objectives:

- Introduce the drug discovery, development, regulatory aspects of drugs and cosmetics act.
- Impart knowledge of drug dosage forms Pharmacokinetics and dynamics.
- Summarize bulk drug production and a case study.
- Explain pharmacology principles, classification of drugs and mechanisms.
- Discuss case studies on biopharmaceutical product development

UNIT 1 Introduction 8 hours

History of pharmaceutical industry, drug discovery and development phases; Introduction to pharmacokinetics and pharmacodynamics (factors affecting drug metabolism (ADME)), Dose effect relationship, adverse drug reactions (ADR), the role of patents in the drug industry.

UNIT 2 Dosage form 8 hours

Drug screening principles; definition of dosage forms, classification of dosage forms (solid unit dosages – Tablets, capsules; liquids – solutions, lotions, suspension etc; semi-solid – ointments; Parenteral)

UNIT 3 Bulk drug manufacturing 8 hours

Bulk drug manufacturing: Types of reactions in bulk manufacture and processing. Special requirements for bulk drug manufacture.
Case study: Unit process and unit operations of inulin production, purification, formulation, and packaging.

UNIT 4 Generics **6 hours**

Generics and its advantages; bio-generics and biosimilar, protein-based biopharmaceuticals; Marine natural products, bioactive compounds from micro-algae, macro-algae, and other marine organisms.

UNIT 5 **Quality control** **6 hours**

GMP, GLP, Purity determination as per ICH guidelines, FSSA guidelines, use of biochemical and molecular techniques in quality evaluation. Drugs and Cosmetics Act and regulatory aspects.

Textbooks:

1. D.M. Brahmankar and Sunil B. Jaiswal 2019 Biopharmacuitics and pharmacokinetics - A Treatise 3/e Vallabhaprakashan new edition. 9788185731933.
2. Ghangas Jyoti, A. N. Nagappa, A. Kaushik, G. Agarwal 2022 Biopharmaceutics and Pharmacokinetics, 1/e, CBS Publishers & Distributors
3. Fingerman, M., Nagabushanam, R., Thompson, M. 1998. Recent Advances in Marine Biotechnology. Vol.2

References:

1. R.K. Khar, S. P. Vyas, F J Ahmad G.K. Jain 2020. Lachman/Lieberman’s, The Theory And Practice Of Industrial Pharmacy, CBS publishers and Distributors 4/e.
2. Biotechnology in the marine sciences: Proceedings of the first annual MIT Sea grant lecture & seminar (1984), Colwell, R.D. (Ed)

Course Outcomes:

After the completion of the course the student should be able to

1. Explain drug development, pharmacokinetics and pharmacodynamics
2. Summarize dosage forms in drug delivery
3. Explain the various process involved in bulk production with a case study
4. Summarize drug screening method and applications of marine natural products
5. Apply GMP and ICH guidelines in purification of drug
6. Appreciate the importance of regulatory aspects of drug production

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG3 : Ensure healthy lives and promote well-being for all at all ages

SDG Justification:
This course is designed to apply the process of production of biopharmaceuticals & regulatory issues and drug discovery.

BTEN3142	ARTIFICIAL NEURAL NETWORKS AND DEEP LEARNING	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Neural Networks can assist in the analysis, interpretation and utilization of large amounts of highly complex structured and unstructured data. Neural Network based decision support systems have been deployed in agricultural, biomedical, biometric, economic and legal applications. Neural Networks can be utilized as components of advanced robots and control systems for industrial automation. Neural Networks can also be utilized in engineering design.

Course Educational Objectives:

- Introduce a variety of Neural Network architectures
- Evaluate merits and demerits of learning models used by Artificial Neural Networks
- Describe the algorithms for training of Neural Networks
- Explain the effect of choice of parameters on training efficiency
- Exemplify the relation between problem type and Neural Network type

UNIT 1 6 hours

Introduction to Neural Networks: Architecture based classification of Neural Networks. Classification of Neural Networks based on learning methods. Activation functions and Loss functions. Factors to be considered for choice of type of Neural Network. Introduction to hardware requirements for implementation of Neural Networks.

UNIT 2 6 hours

Rosenblatt's perceptron model. Rosenblatt's perceptron convergence theorem. Back Propagation Method. Back propagation learning algorithm for multilayer feed forward Neural Network. Factors affecting back propagation based training of a Neural Network.

UNIT 3 6 hours

Radial basis function networks. Generalized regularization theory. Neural Network models with Hebbian learning. Introduction to Hopfield networks. Recurrent Neural Network models. Universal approximation theorem. Backpropagation through time. Real time recurrent learning. Long short term memory.

UNIT 4 6 hours

Convolutional Neural Networks. Variants of the basic convolution function. Convolution algorithms. Recursive Neural Networks. Greedy layer-wise pretraining. Transfer learning. Structured probabilistic models for deep learning. Convolutional boltzmann machines.

UNIT 5 6 hours

Model based calculation of reward in Reinforcement learning. Markov decision process. Bellman's optimality criteria. Policy iteration. Value iteration. Q-learning. Model free Reinforcement learning. Deep reinforcement learning. Generative adversarial networks

Artificial Neural Networks and Deep Learning Laboratory

At least five of the following experiments:

1. Software installation for Artificial Neural Networks
2. Training of an Artificial Neural Network
3. Testing of a trained Artificial Neural Network
4. Application of an Artificial Neural Network for secondary structure prediction
5. Application of an Artificial Neural Network for protein-ligand binding study
6. Application of an Artificial Neural Network for promoter identification
7. Application of an Artificial Neural Network for identification of genes in a genome
8. Application of an Artificial Neural Network for image recognition

Textbooks:

1. S.J.RussellandP.Norvig.ArtificialIntelligence:AModernApproach. 4thEd.Pearson.2020.9781292401133.

References:

1. S.O.Haykin.NeuralNetworks&LearningMachines.3rdEd.Pearson.2019.0131471392.

Course Outcomes:

After completing this unit, the student will be able to

1. Describe different types of artificial neural networks
2. Justify the back propagation algorithm
3. Understand different types of learning mechanisms
4. Understand the principles of deep learning and convolutional neural networks
5. Understand the principles of reinforcement learning

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG3 : Ensure healthy lives and promote well-being for all at all ages

SDG Justification:
This course will introduce technology for improving health

<table>
<tr><td rowspan="2">BTEN3152</td><td rowspan="2">MACHINE LEARNING IN BIOTECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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:

Machine Learning can assist in the analysis, interpretation and utilization of large amounts of highly complex structured and unstructured data.

Course Educational Objectives:

- Introduce a variety of machine learning methods
- Evaluate merits and demerits of machine learning models
- Describe the algorithms for machine learning
- Explain the effect of choice of parameters on efficiency of machine learning
- Exemplify the relation between problem type and machine learning methodology

UNIT 1 Introduction to Machine Learning 8 hours

Definition of learning. Representation and prior knowledge. Types of learning. Logical formulation of learning. Knowledge in learning. Explanation based learning. Learning using relevance information. Inductive logic programming.

UNIT 2 8 hours

Learning decision trees. Decision tree representation. Inducing decision trees from examples. Evaluating and choosing the best hypothesis. Model selection. Regularization.

UNIT 3 8 hours

Learning association, classification, and regression. Nonparametric models. Nearest neighbour models. Find nearest neighbours with k-d trees. Nonparametric regression. Principal component analysis. Support vector machines. Unsupervised clustering. Self-organizing maps

UNIT 4 Statistical learning and Bayesian parameter learning 8 hours

Statistical learning. Maximum likelihood parameter learning. Naive Bayes models. Bayesian parameter learning. Learning with hidden variables. The expectation-maximization algorithm. Learning Hidden Markov Models.

UNIT 5 8 hours

Probabilistic models of evolution. Machine learning methods for gene finding. Machine learning methods for gene function prediction. Hidden Markov Models of protein sequence families.

Machine Learning in Biotechnology Laboratory

At least five of the following experiments

1. Software installation for Machine Learning
2. Regression analysis for studies of chemical activity
3. Application of Principal Component Analysis for drug activity studies
4. Application of Support Vector Machines for classification of coding & non-coding sequences
5. Application of clustering for classification of gene sequences
6. Application of Hidden Markov Models for sequence analysis

Textbooks:

1. P.Baldi, S.Brunak, F.Bach. Bioinformatics: The Machine Learning Approach. 2001. MIT Press.
2. E. Alpaydin. Introduction to Machine Learning. 3Rd edition. 2014. MITPress.

References:

1. S.J.Russell and P. Norvig. Artificial Intelligence: A Modern Approach. 3rd Ed. Pearson. 2016.
2. S.O.Haykin. Neural Networks & Learning Machines. 3rd Ed. Pearson.2019

Course Outcomes:

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

1. Describe major types of machine learning methods
2. Classify available machine learning methods
3. Apply machine learning to solve simple problems
4. Analyze a problem and identify optimal machine learning for its solution
5 Evaluate a problem description and predict optimal parameters for its solution

CO-PO Mapping:

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

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

APPROVED IN:

BOS: 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:

SDG3 : Ensure healthy lives and promote well-being for all at all ages

SDG Justification:

This course will introduce technology for improving health

<table>
<tr><td rowspan="2">BTEN3162</td><td rowspan="2">METABOLOMICS AND METABOLIC ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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">BTEN2001, BTEN2011, BTEN3031, BTEN3081, BTEN3101 1. Biochemistry 2. process calculations 3. Bioanalytical techniques 4. bioprocess engineering,</td></tr>
<tr><td>Co-requisite</td><td colspan="7">Enzymology</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

Course Description:

Metabolomic studies are used to characterize the complete set of metabolites in a cell, tissue, organ or organism. Comparative metabolomic studies are useful for identification of biomarkers for diagnostic applications, for elucidation of metabolic pathways and to identify targets for drug design. Metabolic engineering can be utilized for optimizing the yield of desired metabolites in industrial biotechnology. This course introduces the methods for characterization of the metabolome and the methods and applications of metabolic engineering.

Course Educational Objectives:

- Provide information regarding databases of metabolomic data
- Describe methods useful for obtaining metabolomic data
- Introduce methods for analysis of metabolomic data
- Describe the principles of metabolic engineering
- Describe the applications of metabolic engineering

UNIT 1 — Introduction to metabolomics — 6 hours

Introduction to metabolomics. Metabolite identification and quantification by mass spectrometry and NMR spectroscopy. Mass spectral databases. Metabolic flux determination by time dependent changes in concentration. Metabolic flux determination by isotope labeling: Analysis of mass spectral data. Analysis of NMR spectral data.

UNIT 2 — 8 hours

Stoichiometry of cellular reactions, mathematical formulation of rate laws. Metabolic network reconstruction. Introduction to Metabolic flux analysis. Steady state analysis and sensitivity analysis (Linear systems only).

UNIT 3 — Metabolic control analysis — 6 hours

Metabolic control analysis: Fundamentals of metabolic control analysis, control coefficients and the summation theorems, determination of flux control coefficients. MCA of linear and branched pathways. Case studies.

UNIT 4 — 6 hours

Metabolic engineering and metabolic pathway engineering. Regulation of metabolic pathways. Regulation of metabolic networks. Metabolic engineering by gene amplification, gene disruption, and strain improvement. Synthetic biology for metabolic engineering.

UNIT 5 **6 hours**

Calculation of theoretical yield. Amino acid production by glutamic acid bacteria, metabolic engineering of lactic acid bacteria, riboflavin production by Bacillus subtilis, metabolic engineering of Saccharomyces cerevisiae.

Metabolomics and Metabolic Engineering Laboratory

Minimum of 5 experiments from the following:

1. Estimation of km of an enzyme
2. Estimation of Vmax of an enzyme
3. Effects of enzyme inhibitors on enzyme kinetics: Competitive inhibition
4. Effects of enzyme inhibitors on enzyme kinetics: Irreversible inhibition
5. Metabolite identification from Mass Spectral data
6. Metabolite identification from NMR spectral data
7. Metabolic pathways models
8. Optimization of flux in a metabolic pathway

Text Books :

1. 1. Eberhard Voit. A First Course in Systems Biology. Edition 2. Garland Science, 2017.
2. G.N. Stephanopoulos, A.A. Aristidou, J. Neilsen, Metabolic engineering. Principles and Methodologies, Academic Press, Elsevier, 1998.

References:

1. C .Wittman, S.Y.Lee (ed.), Systems metabolic engineering, Springer, 2012.
2. B.N. Kholodenko, H.V. Westerhoff (ed.), Metabolic engineering in the post-genomic era, Horizon bioscience, 2004.

Course Outcomes:

After the completion of the course the student should be able to

1. Describe methods for identification and quantification of metabolites
2. Summarize methods for control of metabolic pathways
3. Calculate flux control coefficients and theoretical yeilds
4. Explain the principles of metabolic engineering
5. Describe the applications of metabolic engineering

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG7 : Ensure access to affordable, reliable, sustainable and modern energy for all
SDG Justification:
This course is designed to apply the mathematical and design principales to metabolic process for better yeild of metabolic products.

<table>
<tr><td rowspan="2">BTEN3172</td><td rowspan="2">PROTEOMICS AND PROTEIN ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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">BTEN2001 BTEN2031 BTEN3021</td></tr>
<tr><td>Co-requisite</td><td colspan="7">BTEN3051</td></tr>
<tr><td>Preferable exposure</td><td colspan="7">None</td></tr>
</table>

Course Description:

Proteomic studies are used to characterize the complete set of proteins in a cell, tissue, organ or organism. Comparative proteomic studies are useful for identification of biomarkers for diagnostic applications, for elucidation of the function of proteins and to identify targets for drug design. Stability and enzyme activity can be improved by protein engineering. This course introduces the methods for characterization of the proteome and the methods and applications of protein engineering.

Course Educational Objectives:

- Describe potential applications of proteomics
- Describe databases related to proteomics
- Describe the methods for proteomics studies
- Describe the methods of protein engineering
- Describethe applications of protein engineering

UNIT 1 Expression Proteomics 6 hours

Expression Proteomics: Proteome characterization by DIGE, Mass spectrometry and High throughput protein sequencing. Protein chips.
Structural Proteomics: Comparative modeling, Molecular Replacement for X-ray diffraction, NMR spectroscopy.

UNIT 2 Interaction proteomics 10 hours

Interaction proteomics: Phage display, yeast two hybrid and mass spectroscopy.
Functional proteomics: Predicting function from sequence, structure and interaction data.

UNIT 3 Proteomics databases 8 hours

Proteomics databases: protein sequence identification, protein expression data, protein structures, protein-protein interactions, protein function.
Applications of proteomics: Biomarkers for diagnosis. Target identification in drug development.

UNIT 4 8 hours

Objectives of protein engineering. Reaction environment engineering. Chemical modification of proteins. Principles of directed evolution for protein engineering. Methods for library design and high throughput screening. Semirational and Rational design for protein engineering. Characterization of engineered enzymes.

UNIT 5 6 hours

Engineering of DNA polymerase for PCR applications. Engineering of lipases and cellulases for biofuel production. Antibody engineering. Enzyme engineering for production of antibiotics. Enzyme engineering for degradation of xenobiotics. Protein engineering for biosensors.

Proteomics and Protein Engineering Lab

Session	Description of Experiments
1	Isolation of total Protein from bacteria or plants or blood
2	Estimation of total protein concentration using Lowry's method
3	Estimation of total protein concentration using Bradford's method
4	Estimation of total protein by using BCA method
5	SDS-PAGE: Application
6	Western blotting: application (Virtual) and data analysis
7	2D-PAGE: application (Virtual) and data analysis
8	MALDI-TOF MS: application (Virtual) and data analysis

Text Books :

1. R. Twyman. Principles of proteomics. 2nd edition. Garland Science. 2013.
2. A.ReesM.J.E.Sternberg and R.Wetzel. Protein Engineering. Oxford University Press. 1993.

References:

1. S.R.Pennington and M.J.Dunn. Proteomics: From Protein Sequence to Function. Garland Science. 2001.
2. Stefan Lutz, Uwe Theo Bornscheuer. Protein Engineering Handbook. Vol. 3. Wiley. 2013
3. Uwe Theo Bornscheuer and Mathias Hohen. Protein Engineering. Humana Press. 2018.

Course Outcomes:

After the completion of the course the student should be able to

1. Describe methods for obtaining proteomic data (L1)
2. List applications of proteomics (L1)
3. Summarize the methods used for engineering of proteins (L2)
4. Describe applications of protein engineering (L1)

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG3 : Ensure healthy lives and promote well-being for all at all ages
SDG Justification:
This course will introduce technology for improving health

BTEN3181	APPLIED BIOCATALYSIS AND BIOTRANSFORMATION	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Biocatalysts have the potential to catalyse a wide variety of reactions of industrial, pharmaceutical, agricultural, and medical significance. They have the potential to enhance reaction rates in mild conditions at low cost using sources that are environmentally friendly. This course provides an overview of the different types of bio transformations, the sources the the biocatalysts as well as their current and potential applications.

Course Educational Objectives:

- To describe different types of biocatalysts and their applications
- To classify reaction types of microbial transformations
- To describe redesign of biocatalysts
- To describe commercial lipases and their applications
- To describe the biosynthesis and transformation of alkaloids

UNIT 1 **9 hours**

General usage of biocatalysts, fermentation and applied Biocatalysis. Types of bioconversion reactions, proceduresforbiotransformations, useofcells and enzymes for biotransformation, genetic manipulations of organisms for biotransformation, Application of bioconversions.

UNIT 2 **9 hours**

Reaction types for microbial transformations of steroids, microbial breakdown of sterol side chain. L-Ascorbic acid, Dihydroxyacetone from glycerol, Prostaglandins, Hydantoins, Carbamylates, catalytic antibodies, Acylases and peptidases, reaction of penicillin and cephalosporin in substrates, protection of amino groups, accumulation of pesticides ,pesticides ascarbonsource,conjugateformation.

UNIT 3 **9 hours**

Nitrile hydratases and nitriles, biotechnology of nitrile transformations, regional stereo selective biotransformation of nitriles, commercial processes, search for novel nitrile bio transforming activities, redesign of existing enzyme by protein engineering, metabolic engineering by multistep biotransformation, cyanide biotransformation.

UNIT 4 **9 hours**

Commercial lipases, properties and application of lipases, lipidorsurfactant coated lipases, inter-esterification of fats and oils, enantioselective esterification by lipase, commercial application (food ingredients and enantiomerically pure chemical and pharmaceutical intermediates)

UNIT 5 **9 hours**

Tropane alkaloid biosynthesis, microbial metabolism tropane alkaloids, morphine alkaloid biosynthesis, transformation of morphine alkaloid by PseudomonasputidaM10, microbialtransformationofheroin.

Text Books :

1. 1.A.J.J. Straathof, P Adlercreutz (Eds.), Applied catalysis, 2/e, Hardwood academicpublishers,TaylorandFrancis,2005

Course Outcomes:

At the end of this course the student should be able to

1. Understand the significance of biocatalysts
2. Classify reaction types of microbial transformations
3. Discussthe engineering of biocatalysts
4. List commercial lipases and their applications
5. Describe the biosynthesis and transformation of alkaloids

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG7 : Ensure access to affordable, reliable, sustainable and modern energy for all
SDG Justification:
This is course will introduce the enzyme technology for improvement of water management and sanitation

		L	T	P	J	S	C

BTEN3191	NANO BIOTECHNOLOGY	3	0	0	0	0	3
Pre-requisite	BTEN2001 BTEN2031						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Nanomaterials are materials that are restricted to nanoscale size in at least one dimension.

Nanoscience is the study of nanomaterials that have unique physical, chemical or biological properties due to their size. Nanobiotechnology utilizes the unique properties of nanomaterials for applications in medicine, agriculture and industry. This course is an introduction to the fabrication, characterization and biological applications of nanomaterials.

Course Educational Objectives:

- Describe the unique properties of nanomaterials
- Describe the methods for synthesis and fabrication of nanomaterials
- Describe the methods for characterization of nanomaterials
- Create awareness of applications of nanotechnology
- Describe the application of nanomaterials in novel biomedical devices and components

UNIT 1 **9 hours**

Structure and properties of C60, carbon nanotubes and graphene.
Size dependent properties: Size dependence of sedimentation rate, adsorption effects, scattering of light, absorption of electromagnetic radiation, magnetic and electrical properties. Cooperative transitions in biological systems: Zimm-Bragg theory for helix-coil transition in polypeptides

UNIT 2 **9 hours**

Production of nanomaterials: Top down &bottom up strategies. Green synthesis of nanoparticles. Self-assembly: Langmuir-Blodgett films. DNA origami.

UNIT 3 **9 hours**

Bionanomaterial characterization: Electron microscopy. Scanning probe microscopy. Light Scattering. Optical tweezers. Surface plasmon resonance. Light scattering. X-ray diffraction.

UNIT 4 **9 hours**

Vectors for drug delivery: Liposomes, Micelles and viral capsids.
Targeted drug delivery – Nano bioconjugates for receptor targeting and magnetic guidance. Controlled drug release. Nanomaterials for Biomedical imaging: Quantum dots, SPIONs Theragnostic.

UNIT 5 **9 hours**

Diagnostics and Prognostics: Principles and applications of Nanoarrays and Nanofluidic. Nanopore sequencing of DNA. BioNanomechanics: NanoBiomotors. Mechanics of cilia and flagella. Nanobioelectronic: Nanowires based on DNA. Molecular transistors. Voltage gated ion channels.

Text Books :

1. 1. C. M. Niemeyer and C. A. Mirkin. Nanobiotechnology: Concepts, applications and perspectives. Wiley, 2006.
2. C. A. Mirkin and C. M. Niemeyer, Nanobiotechnology II: More concepts and applications, Wiley-VCH, 2007

References:

1. T.Vo-Dinh, Nanobiotechnology in biology and medicine: methods, devices and applications, CRC, 2007.
2. Y Xie, The nanobiotechnology handbook, CRC, 2012
3. https://nptel.ac.in/courses/118107015

Course Outcomes:

After completing this unit, the student will be able to:

1. Understand and explain the unique properties of nanomaterials
2. Compare the methods for fabrication of nanomaterials
3. Select optimum methods for nanomaterial characterization
4. Compare drug delivery vectors
5. Describe the applications of nanobioelectronic

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:

SDG3 : Ensure healthy lives and promote well-being for all at all ages

SDG Justification:

This course is designed to introduce students to the applications of nanobiotechnology with potential for improvement of health and environment

<table>
<tr><td rowspan="2">BTEN3201</td><td rowspan="2">STEM CELLS AND TISSUE ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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">BTEN3021</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:

Stem cells play crucial roles in tissue regeneration and understanding their properties is necessary for tissue engineering applications.

Course Educational Objectives:

- Introduce the concepts of self renewal and differentiation of cells
- Describe the role of the extra cellular matrix
- Describe the biomaterials for cell culture
- Introduce the concepts of scaffold design and fabrication
- Describe the bioreactors for tissue engineering

UNIT 1 Basic biology of stem cells 9 hours

Basic biology of stem cells: Types and sources of stem cells with characteristics: embryonic, adult, cancer stem cells, induced pluripotent stem cells; signalling mechanisms of stem cell self-renewal and differentiation.

UNIT 2 9 hours

History and scope of tissue engineering. Organization of cells into higher ordered structures. Composition and diversity of extracellular matrix, receptors for ECM molecules. Matrix molecules and their ligands. Preparation of ECM, biologic activities of ECM, scaffolds. Commercially available scaffolds composed of extracellular matrix. Cell differentiation and migration.

UNIT 3 Biomaterials in cell culture 9 hours

Biomaterials in cell culture: harvest, selection, expansion, and differentiation, cell nutrition, natural polymers in tissue engineering applications, biomaterial scaffold properties. Models as precursors for prosthetic devices, quantitative aspects, cell tissue mechanics. Mechano-chemical control of cell fate switching.

UNIT 4 Scaffold design and fabrication 9 hours

Scaffold design and fabrication: degradable polymers and bioceramics for tissue engineering. Principles of scaffold design. Scaffold fabrication technologies: foaming, sintered microspheres, solvent casting, phase separation,electro-spinning.Textiletechnologiesforfibreandfabrics.Solid free form fabrication.

UNIT 5 Bioreactors for tissue engineering 9 hours

Bioreactors for tissue engineering: 2D and 3D cell culture. Key functions of bioreactors in tissue engineering. Bioreactor design and development. Bioreactorsas3Dinvitromodel systems, bioreactor sin clinical applications, tissue engineering of skin,bone,cartilage,nervoussystem,lung,liverand pancreas.

Text Books :

1. C.A.van Blitterswijk andP. Thomsen, Tissue engineering, Academic Press series in biomedical engineering,2008.
2. R.P. Lanza, R. Langer, W.L. Chick, Principles of tissue engineering, 3/e, Elsevier Publishers,2007.

References:

1. Donglu Shi, Biomaterials and Tissue Engineering, Springerpublishers,2003.
2. PeterC. Johnsonand Antonios G.Mikos, Advances in Tissue Engineering, Mary Ann Liebert publishers,2012.

Course Outcomes:

After completion of the course the student should be able to:

1. Describe the concepts of self-renewal and differentiation of cells
2. Describe the role of the extra cellular matrix
3. Describe the biomaterials for cell culture
4. Understand the concepts of scaffold design and fabrication
5. Design bioreactors for tissue engineering

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:

SDG3 : Ensure healthy lives and promote well-being for all at all ages

SDG Justification:

This course is designed to introduce students to the conept of tissue engineering as a treatment approach for certain diseases and conditions

<table>
<tr><td rowspan="2">BTEN3212</td><td rowspan="2">FOOD PROCESSING TECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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 shelf life, texture and taste of most food materials can be improved by application of food processing technology. This course describes the methods used for food processing and food quality assessment.

Course Educational Objectives:

- Describe the scope and importance of food processing (L2)
- Describe the application of membrane technology (Lf2)
- Demonstrate design of filter module (L5)
- Describe principles of formulation of food products (L3)
- Describe the benefits of nutraceuticals (L2)

UNIT 1 **6 hours**

Properties and processing theory of foods, Size reduction theory, Material transfer phenomena of foods, Effects of processing on nutritional properties and sensory characteristics, Food additives and its impacts on food safety, Principles of food processing, Processing of Food Commodities for high, medium and low moistures food, Theory and equipment of membrane technology for food, Microfiltration for food components separation and clarification, Ultrafiltration for protein concentration, Reverse osmosis processes for water quality.

UNIT 2 **Thermal food processing** **6 hours**

Thermal food processing: Concepts and mechanisms of heat transfer, Sources of heat and methods of application to foods, concept of sterilization, blanching, pasteurization on reduction of pathogens, concept and principles of microwave and radio frequency heating, Infra- Red (IR), Ohmic and Inductive heating. Effect of heat on nutritional and sensory characteristics, mechanism of microbial inactivation by thermal processing techniques.

UNIT 3 **Non-thermal food processing** **6 hours**

Non-thermal food processing: Concept and principles of non-thermal food processing, Hurdle technology for food preservation and processing Theory, equipment and application of High pressure processing (HP) and ultrasonic processing.

Preservation of foods by pulsed light technology.

Food Irradiation, technology of food irradiation, and effect of irradiation on food borne microbial pathogens. Ionizing Radiation sources. Mechanism of microbial inactivation.

UNIT 4 **6 hours**

Food safety and good manufacturing practice, , Contaminants and Food Safety, Quality controls and its detection in foods products: Methods of quality assessment, Export Quality Control and Inspection Systems, Concept and application of Codex Alimentarious, HACCP, and ISO 9000; Package principles, Controlled-or-modified-atmosphere storage and packaging, Deteriorative changes in foodstuff in packed food, Packaging methods for protection from deterioration, Approaches for enhancing. Shelf life of packaged foodstuff.

UNIT 5 Nutraceuticals and functional foods 6 hours

Definition, Classification of nutraceuticals, health benefits of nutraceuticals, Spirulina, Ginseng , Lycopene, Microbes as nutraceuticals, Probiotics, Prebiotics. Functional foods, Different cereal products.

Food Processing Technology Laboratory

Minimum of 8 experiments from the following:

Experiment- 1-: Crude Protein- Kjeldahl Method

Experiment- 2-: Moisture Content- Lab Oven Method

Experiment-3-: Crude Fat- Soxhlet Apparatus Method

Experiment- 4-: Detection of adulterants in different food products

Experiment- 5-: Crude Fiber Objective

Experiment- 6-: Cut out test for Canned Fishery Products

Experiment- 7-: Determination of total carbohydrate of a food sample

Experiment- 8-: Microbiological analysis of fruits and vegetables

Experiment- 9-: Microbial analysis of ice cream and soft drink

Experiment- 10: Good Manufacturing Practices for foods

Experiment- 11: Food Preservation Techniques

Experiment- 12: Control drying of fruits and vegetable by microwave heating.

Text Books :

1. Zeki Berk, 2009, Food Process Engineering and Technology, International Series. Series Editor: Steve L. Taylor, First edition,
2. P. Fellows, 2000, Food Processing Technology: Principles and Practice, Woodhead Publishing Limited, Cambridge CB1 6AH, England
3. Carl J Schaschke, 2011, Food Processing, Carl J. Schaschke&Ventus Publishing ApS

References:

1. Fellows, P. & Ellis H.1990 Food Processing Technology. Principles and practice; Newyork
2. Macrae R, Roloson R &Sadlu MJ. 1994. Encyclopedia of Food Science & Technology & Nutrition. VolXVI. Academic Press.
3. Nesser JR & German BJ.2004. Bioprocesses and Biotechnology for Nutraceuticals. Chapman & Hall.
4. Shi J. (Ed) 2006. Functional Food Ingredients and Nutraceuticals: Processing Technologies. CRC.
5. Barbosa-Canovas, G.V.,Maria Tapia and M. Pilar Cano, eds. 2005. Novel Food processing Technologies. Boca Raton, FL: CRC Press.
6. Rajesh K. Srivastava, Food processing, quality analysis and quality assurance, 2018, Shree publishers and contributions, Delhi
7. Perkins Muredzi, 2013, Food is Medicine – An Introduction to Nutraceuticals, LAP LAMBERT Academic Publishing, pp.276

Course Outcomes:

After the completion of the course the student should be able to

1. Understand the scope and importance of food processing.
2. Understand the application of membrane technology
3. Design the filter module for long stability of filtration process
4. Formulate food products based on modern customer demand.
5. Understand the benefits of nutraceuticals

CO-PO Mapping:

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

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

APPROVED IN:

BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:

SDG2 : End hunger, achieve food security and improved nutrition and promote sustainable agriculture

SDG Justification:

This course will introduce food technology to improve utilization of food

<table>
<tr><td rowspan="2">BTEN4041</td><td rowspan="2">FOOD SAFETY AND QUALITY MANAGEMENT</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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:

In our healthy life, selection of types of foods or its products play important role with awareness of types of foods. And modern era, our customers are more sincere about selection of foods which could be safe, nutritious and least processed in nature. Most of our food processing industries are developing the more variety of foods for our people. But they are sensitive about processing conditions with maintenance of food standards as well ensuring of food safety for their products. A lot of international or national food safety guideline has been provided to maintain our products in safety nature.

Course Educational Objectives:

- To understand the values of hygienic conditions for our food products
- To understand the guidelines for food safety issues to be maintained
- To understand the food borne disease from food safety failure
- To understand the food processing condition changes during transformation of foods
- To optimize processing conditions for more safe food products

UNIT 1 Characterization of food safety 9 hours

Food Safety definition and principles, characterization of food hazards, risk analysis for chemical and microbial hazards, exposure assessment of microbial food hazards, chemical risk assessment in foods

UNIT 2 9 hours

Food hazards from biological agents, prevalence of food-borne pathogens, physiology and survival of food-borne pathogens in various food systems, characteristics of biological hazards in foods

UNIT 3 9 hours

Chemical and physical nature of food hazards, hazards from natural origins, chemical and physical hazards produced during food processing, storage, and preparation, hazards associated with nutrient fortification, monitoring chemical hazards: regulatory information

UNIT 4 9 hours

Food quality and food standard, Codex Alimentarius as FAO/WHO food standards program Implementation of FSLS regulatory programs for pathogen reduction, advances in food sanitation: use of intervention strategies, use of surveillance networks, hazard analysis critical control point (HACCP)

UNIT 5 **9 hours**

Food plant sanitation, food safety control systems in food processing, food safety and innovative food packaging, safe handling of fresh-cut produce and salads, good manufacturing practices, prerequisites for food safety, the principles of modern food hygiene

Textbooks:

1. Ronald H. Schmidt and Gary E. Rodrick, 2003, Food Safety Handbook. A John Wiley & Sons Publication

References:

1. A. K. Singh P. N. Raju & A. Jana. Food Technology-I, www.agrimoon.com
2. R. Paul Singh and Dennis R. Heldman. 2009. Introduction to Food Engineering Fourth Edition, Academic Press is an imprint of Elsevier

Course Outcomes:

After the completion of the course the student should be able to

1. People can purchase of more variety of food via ensuring the food safety issues
2. Processed foods can create more marketing opportunity for different food once consumer will secure about food safety issue and quality or food standards
3. Safe food can enhance the shelf-life of many foods
4. Processed foods can help to gain more opportunity for investment with foreign currency gain with proving of food safety and hygienic processing conditions
5. Processed foods can maintain the sensory quality and nutrient contents for customers for long periods

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG2 : End hunger, achieve food security and improved nutrition and promote sustainable agriculture

SDG Justification:
This course will introduce food technology to improve utilization of food

<table>
<tr><td rowspan="2">BTEN4052</td><td rowspan="2">BIOPROCESS PLANT DESIGN</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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>

UNIT 1 **6 hours**

General design information; Material and energy balance calculations; Process flowsheeting.

UNIT 2 **Scale up issues and Scale up of downstream processes** **6 hours**

Scale up issues: Effect of oxygenation, mixing, sterilization, pH, temperature, inoculums and nutrient availability; Bioreactor scale-up based on constant power consumption per unit volume, mixing time, impeller tip speed (shear), mass transfer coefficients.

Scale up of downstream processes: Adsorption (LUB method); Chromatography (constant resolution); Filtration (constant resistance); Centrifugation (equivalent times); Extractors (geometry-based rules).

UNIT 3 **6 hours**

Selection of bioprocess equipment (upstream and downstream); Specifications and Mechanical design of reactors, heat transfer and mass transfer equipment; Design considerations for maintaining sterility of process streams and process equipment.

UNIT 4 **Facility design** **6 hours**

Facility design: Utility supply; Equipment cleaning; Cell culture banks; cGMP guidelines; Validation; Safety.

UNIT 5 **Pilot plant design** **6 hours**

Fermenter design calculations (simulations), downstream processing calculations, environmental and economic considerations.

Bioprocess Plant Design Laboratory

Minimum of 8 experiments from the following:

1. Selection of equipment for production of alcohol by fermentation
2. Plant layout for production of alcohol by fermentation
3. Process flowsheet for production of alcohol by fermentation
4. Material & Energy balance for production of alcohol by fermentation
5. Material and Energy balance for distillation

6. Design of a unit for distillation of alcohol
7. Material and Energy balance for pasteurization of milk
8. Selection of equipment for pasteurization and packaging of milk
9. Design of a unit for pasteurization of milk
10. Plant layout for pasteurization and packaging of milk

Text Books :

1. M.V. Joshi and V.V. Mahajani, Process Equipment Design, 3/e, Macmillan India,2008.

2. J.M. Coulson, J.F. Richardson (Eds.) and R.K. Sinnott, Chemical Engineering Volume 6: An introduction to Chemical Engineering Design, 2/e, Butterworth- Heinemann, 1996.

References:

1. M. Shuler and F. Kargi, Bioprocess Engineering Basic Concepts, 2 /e, Prentice Hall, 2002.

2. M. S. Peters and K. D. Timmerhaus, Plant Design and Economics for Chemical Engineers, 3/e, McGrawHill, 2003.

3.R. H. Perry and D. W. Green (eds.), Perry's Chemical Engineers' Handbook, 8/e, McGraw Hill, 2007.

Course Outcomes:

At the end of the course, students are able to

1. Apply engineering principles to design unit operations in bioprocess plant.
2. Design and evaluate a suitable unit operation and equipment in a bioprocess plant.
3. Apply modern simulation software to solve unit operations.
4. Design process flow diagram (PFD) for bioprocess plant.

CO-PO Mapping:

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

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

APPROVED IN:

BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:

SDG8 : Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

SDG Justification:

This is course will introduce the applications of plant design for improvement of water management and sanitation

<table>
<tr><td rowspan="2">BTEN4062</td><td rowspan="2">MODELLING AND SIMULATION IN BIOPROCESSES</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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:

Bioprocess mathematical modeling involves the modeling of the dynamic changes of the metabolic rates and their distribution inside the cells with the changes of time and cultivation conditions, as well as the modeling of the dynamic changes of the reaction rates and mass transfer rates as well as the cultivation conditions inside the cell. This course focuses on the principles of process design and analysis of biochemical reactors. These designed reactors are applicable in the production lines of pharmaceutical, biotech and chemical industries.

Course Educational Objectives:

- To study the modeling& simulation techniques of biochemical processes and to gain skills in using process simulators.
- Analysis and interpretation of data
- Use research-based knowledge and research methods including design of experiments
- To know the requirements for real time process analytics at the bioreactor
- Parameters involved in the bioprocess
- Simulation of bioprocess

UNIT 1 Modeling of biological systems 6 hours

Modeling of biological systems: Modeling principles, significance of modeling and simulation, model development from first principles. ModelingapproachesforBiologicalsystems-structuredandunstructured systems; Compartment models (two and four); Deterministic and stochastic, segregatedandunsegregatedapproachesformodelingstructuredsystems. kinetic models on different approaches; product formation model; genetically structured models, modeling of extra cellular enzyme production.

UNIT 2 Modeling of diffusion 6 hours

Modeling of diffusion: Bioprocess modeling: Modeling of continuous sterilization of medium; Models for external mass transfer, internal diffusion and reaction with in biocatalysts, model for SCP production from spent sulphite liquor, model for antibiotic formation; modeling of therapeutic protein production with recombinant cells. Modeling of activated sludge process with a control system; model for anaerobic digestion.

UNIT 3 Bio reactor modeling 6 hours

Bioreactor modeling: Ideal and non-ideal bioreactors; stirred tank models; characterization of mass and energy transfer distributions in stirred tanks, tower reactor model; flow modeling, bubble column flow models, mass transfer modeling, structured models for mass transfer in tower reactors, process models in tower reactors, airlift models, modeling of non-ideal behaviour in bioreactors-tanks-in-series and dispersion models.

UNIT 4 Linear system analysis 6 hours

Linear system analysis: Study of linear systems, linearization of non-linear systems; Software based simulation of linear models; Parameter estimation and sensitivity analysis; Steady state and unsteady state systems; stability analysis; Case study of recombinant protein production (Insulin). Simulation techniques (Software): continuous system simulators; dynamic process simulators; steady state material and energy balance programs.

UNIT 5 Hybrid and other modeling techniques 6 hours

Hybrid and other modeling techniques: Simulation techniques (numerical methods): Programs based on numerical methods like algebraic equations, Newton_ Raphson method for algebraic convergence, interpolation arbitrary function generation. Programs based on solution of differential equations: Euler method for 1st and 2nd order integration; Fourth order Runga -Kutta method: stability of numerical integration, variable slip size method. Case studies, numerical problems. Advanced modeling techniques such as fuzzy logic, neural network, hybrid systems and fuzzy logic systems; case studies.

Modelling and Simulation in Bioprocesses Laboratory

At least five of the following experiments:

1. Bioreactor model to demonstrate effect of stirring speed
2. Bioreactor model to demonstrate effect of aeration rate
3. Modeling of Bioreactor tanks-in-series
4. Structured model for a tower reactor
5. Simulation of population growth in bacteria
6. Model of pharmacokinetics of a drug

Text Books:

1. B.W.Bequette, Process Dynamics: Modeling, Analysis and Simulation, Prentice-Hall, 1998.
2. Said S.E.H. Elnashaie, P. Garhyan, Conservation Equations and Modeling of Chemical and Biochemical Processes, Marcel Dekker, Inc., 2003.

References:

1. I.J. Dunn, Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples, Wiley-VCH, 2003

Course Outcomes:

After the completion of the course the student should be able to

1. Understand the kinetics of enzymatic reactions
2. Assess / Evaluate the tools and techniques for design of bioprocesses
3. Apply basic programming tools for the modeling of enzymatic/microbial phenomena
4. Analyze biochemical processes
5. Visualize results obtained through modeling
6. Model a bioreactor

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG15 : Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

SDG Justification:
This is course will introduce modeling and simulation for improvement of water management and sanitation

<table>
<tr><td rowspan="2">BTEN4072</td><td rowspan="2">MOLECULAR DIAGNOSTICS AND ITS APPLICATIONS</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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">BTEN2031</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:

Molecular diagnostics is a dynamic and transformative area of diagnostics, leading to insights in research and treatment in many disease states that are revolutionizing healthcare. This course describes the methods to detect and measure the presence of genetic material or proteins associated with a specific health condition or disease, helping to uncover the underlying mechanisms of disease. Students aspiring to continue higher education and research in medical biotechnology will have a solid footing in this course

Course Educational Objectives:

- To learn methods for isolation and sequencing of nucleic acids
- To learn molecular techniques useful for molecular diagnosis and prognosis
- To learn methods for molecular diagnosis of common genetic disorders
- To learn methods for molecular diagnosis of cancer and infectious diseases
- To learn quality control and quality assurance for molecular diagnosis

UNIT 1 **6 hours**

Isolation of DNA from Buccal swabs, Blood, Urine and Hair. Methods for DNA and cDNA amplification. Next generation DNA sequencing technology. Lab-on-a-chip approach to molecular diagnostics.

UNIT 2 **Molecular techniques** **6 hours**

Biomarkers. Primer design and primer selection for selected diseases. PCR-RFLP, Real time PCR, Reverse Transcription-PCR, multiplex-PCR, SSCP, CSGE, DGGE.

UNIT 3 **6 hours**

Genetic Disorders and classification of genetic disorders, single gene disorders (Cystic Fibrosis, Marfan's syndrome), multifactorial disorders (Diabetes, Atherosclerosis, Schizophrenia). Tumor profiling. Molecular diagnosis for cervical cancer. Molecular diagnostics for hematopoietic disorders (sickle cell anaemia, thalassemia).

UNIT 4 **Disease identification and genetic tests for following disorders** **6 hours**

Thrombofilia, cystic fibrosis, Huntington disease, fragile-X syndrome, thalassemia, sickle cell anemia, Alzheimer's disease, Huntington's disease, hepatitis C virus, cytomegalovirus. Molecular diagnostics for streptococcus and tuberculosis. Molecular diagnosis for HLA typing.

UNIT 5 **Quality control and quality assurance** **6 hours**

identification and standards for molecular diagnosis. Regulatory issues in molecular diagnostics. Ethical considerations in molecular diagnostics.

Practicals for Molecular Diagnostics And Its Applications

Demonstrate At least five of the following experiments:

1. Demonstration of Polymerase Chain Reaction
2. Demonstration reverse transcriptase Polymerase Chain Reaction
3. HLA typing (Virtual)
4. Molecular diagnostics for detection of HPV infection in cervical cancer
5. Detection of Mycobacterium tuberculosis infection
6. Molecular Diagnosis of Cystic fibrosis (Virtual)

Text Books :

1. C.A. Burtis, D.E. Bruns Tietz, Fundamentals of clinical chemistry and molecular diagnostics, 7/e, Saunders, 2014.

2. L. Buckingham, Molecular Diagnostics: fundamentals, methods and clinical applications, F.A. Davis Company, 2011.

References:

1. G.P. Patrinos, W.J. Ansorge, Molecular Diagnostics, 2/e, Elsevier publications,2010.

2. W.W. Grody, R.M. Nakamura, F.L. Kiechle, C. Storm, Molecular diagnostics: techniques and applications for the clinical laboratory, 1/e, Academic press,2009.

3. D.E. Bruns, E.R. Ashwood, C.A. Burtis, Fundamentals of molecular diagnostics, Elsevier-Saunders.2007.

4. C.A.Burtis,D.E.Bruns,eds.TietzFundamentalof clinicalchemistryand molecular diagnostics, 7/e, Saunders-Elsevier,2015.

Course Outcomes:

1. Describe techniques useful for molecular diagnostics
2. Describe the molecular basis for genetic disorders
3. Describe molecular methods for testing of genetic diseases
4. Describe molecular methods for diagnosis of infectious diseases
5. Describe molecular methods to assist diagnosis of cancer, diabetes and cardiovascular disorders

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG3 : Ensure healthy lives and promote well-being for all at all ages

SDG Justification:
This course is designed to introduce students to the fundamentals of molecular basis of diagnosis and application to develop diagnostic methods for infectious and genetic diseases

BTEN4082	Molecular Modeling and Drug Design	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	BTEN3051						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Quantum mechanics is the foundation for prediction of the stability of molecules. Molecular mechanics enables us to evaluate the relative energies of different conformations of a molecule. Molecular mechanics and knowledge-based methods can be used to predict the mode of binding and stability of protein-ligand complexes. This knowledge can be used to design drugs that bind to selected molecular targets. This course is an introduction to the principles and algorithms applicable for design of drugs.

Course Educational Objectives:

- Introduce the principles of quantum mechanical methods of molecular modeling
- Introduce the principles of classical mechanical methods of molecular modeling
- Introduce the principles of knowledge-based methods of molecular modelling
- Introduce the principles of conformational analysis of biomolecules
- Describe the benefits and limitations in the application of molecular modeling for drug design.

UNIT 1 Quantum chemistry for Modeling of small molecules and Abinitio methods for molecules 7 hours

Quantum chemistry for Modeling of small molecules: Postulates of Quantum Mechanics. Variation method and Time independent Perturbation theory.

Abinitio methods for molecules: Hartree-Fock SCF method. Common basis sets. Semi-empirical methods. Huckel's molecular orbital theory.

UNIT 2 Stability of biomolecular systems and Force fields for molecular modeling 6 hours

Stability of biomolecular systems: The hydrogen bond. Hydrophobic effect. Solvation energy.

Force fields for molecular modeling: Functional form of a type one force field. Parametrization of a force field. Anharmonicity. Potentials of mean force. Common force fields for biomolecules.

UNIT 3 Conformational analysis and Conformational analysis of polypeptides 6 hours

Conformational analysis: Geometry optimization using steepest descent and conjugate gradients. Molecular dynamics. Simulated annealing.
Conformational analysis of polypeptides: Ramachandran map and rotamer libraries. Comparative modeling of protein structure. De novo Protein structure prediction.
Conformation and stability of polynucleotides.

UNIT 4 5 hours

Target identification for drug design. Desired properties of small molecule drugs. Molecular descriptors. Distance and similarity of molecules. Quantitative structure property relationships. Introduction to databases for drug design and development.

UNIT 5 Ligand based drug design, Receptor based drug design and Case study 6 hours

Ligand based drug design: Quantitative Structure Activity Relationships (QSAR). Pharmacophore analysis.
Receptor based drug design: Principles of receptor based de novo ligand design.
Rigid body molecular Docking. Flexible docking.
Scoring functions for predicting ligand-receptor binding.
Case study: Structure based design of non-peptide inhibitors specific for HIV1 protease.

Molecular Modeling and Drug Design Laboratory

- Introduce the concepts of forcefields.
- Introduce examples of structure optimization
- Demonstrate utilization of QSAR for predicting properties of molecules
- Demonstrate the application of docking for estimating binding constants
- Demonstrate the applications of molecular graphics
- Molecular graphics for virtual manipulation of molecules
- Molecular graphics for visualization of protein-ligand interactions
- Calculation of potential energy of a molecule
- Structure optimization of a molecule
- Generating 3D representations from 2D descriptions of small molecules
- QSAR calculations
- Molecular editor for ligand design
- Comparative modeling of proteins
- Rigid body docking
- Flexibile docking

Text Books :

1. Andrew Leach. Molecular modeling: principles and applications. 2nd ed. Pearson Education. 2001.
2. Atkins and Friedman. Molecular quantum mechanics. Oxford University Press. 5th ed. 2011.

References:

1. Tamar Schlick. Molecular modeling and simulation: An interdisciplinary guide. 2nd Edition. Springer. 2010.
2. Jan H. Jensen. Molecular modeling basics. CRC press. 2010.

Course Outcomes:

After the completion of the course the student should be able to

1. Recall principles of quantum mechanics and molecular mechanics
2. Utilize computational methods to model molecules
3. Select optimum computational method for binding site prediction
4. Apply computational methods for predicting stability of protein-ligand complex
5. Design drugs

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG3 : Ensure healthy lives and promote well-being for all at all ages

SDG Justification:
This course is designed to introduce students to the fundamentals and applications of molecular modeling and drug design and it will enable design of novel drugs to reduce the global burden of disease

BTEN4091	SYSTEMS BIOLOGY	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	BTEN3051						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Descriptions of biological systems generally begin with a description of the components of the system followed by details of interactions of each component with other components of the system. However, this bottom-up view cannot provide a complete perspective of complex systems such as cells and organisms. Systems biology provides a top-down perspective of the control mechanisms that are utilized in living beings for maintenance of homeostasis, development and complex responses to external stimuli.

Course Educational Objectives:

The objectives of the course are to

- Introduce concepts of network motifs observable in biological systems
- Explain feed forward loops and their relevance for optimal gene circuit design
- Explore temporal expression programs by feed forward loops and study of network motifs in sensory transcription networks
- Integrate motifs in signal transduction networks and developmental transcription networks
- Introduce the principles of robustness in biological systems

UNIT 1 **10 hours**

Overview of control mechanisms at transcriptional, translational and enzyme level. Representation of biological networks. Network modeling tools. Modeling and analysis of metabolic networks. Constraint based modeling of metabolic networks. Flux balance analysis. Metabolic flux analysis.

UNIT 2 **Basic concepts of transcription networks and Optimal gene circuit design** **10 hours**

Basic concepts of transcription networks: input functions - logic input function, multidimensional input functions. Dynamics and response time of simple gene regulation. Optimal gene circuit design: fitness function and optimal expression level under constant conditions, optimal regulation under variable conditions.

UNIT 3 **Network motifs and Feed forward loop network motif** **8 hours**

Network motifs: negative auto regulation, positive auto regulation.

Feed forward loop network motif: structure of the feed forward loop gene circuit. Dynamics of Coherent type-1 feed forward loop and Incoherent type-1 feed forward loop. Biological relevance of feed forward loop types. Selection of the feed forward loop network motif.

UNIT 4 **8 hours**

Single input Unit network motif. Generation of temporal expression programs by single input Units. FIFO temporal order by multi output feed forward loop. Network motifs in sensory transcription networks. Network motifs in developmental transcription networks: two node positive feedback loops for decision making. Network motifs in signal transduction networks.

UNIT 5 **8 hours**

The robustness principle. Robust patterning in development. Self-enhanced morphogen degradation. Adaptation in bacterial chemotaxis. Models for exact adaptation. Information processing using multi-layer perceptron's. Network motifs in the neuronal network of C. elegans.

Text Books:

1. Uri Alon, An introduction to systems biology. Design principles of biological circuits, CRC Press, 2006.
2. Markus W. Covert. Fundamentals of systems biology. CRC Press, 2015.

References:

1. Eberhard Voit. A First Course in Systems Biology. 2nd Edition. Garland Science, 2017.
2. Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald. Systems Biology: A Textbook. Edition 2. John Wiley & Sons, 2016.
3. C. J. Meyers, Engineering genetic circuits, CRC Press, 2009.
4. M. Ptashne, A genetic switch: phage [lambda] and higher organisms, Cell Press, 1992.

Course Outcomes:

After the completion of the course the student should be able to

1. Recall concepts of network based modeling of biological phenomena
2. Illustrate the types and properties of motifs in transcription networks
3. Define the principles of gene circuit design
4. Identify properties that lead to robust systems
5. Describe examples of adaptive networks

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG4 : Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG Justification:
This course is designed to introduce students to concepts related to systems and where the interactions between relatively simple components of a system can give rise to complex behaviour.

BTEN4091	SYNTHETIC BIOLOGY	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	BTEN3051						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Synthetic Biology is the design and production of novel sub-systems or entire organisms from biological or bioengineered components. It may involve metabolic engineering or genetic engineering to optimize existing biological systems. Or novel biological systems may be designed and created.

Course Educational Objectives:

- Describe the genetic code and its variations
- Describe model systems for Synthetic Biology
- Explain the principles of genome design
- Explain the strategies for genome synthesis
- Describe the potential applications of Synthetic Biology

UNIT 1 **Introduction to Synthetic Biology** **9hours**

Basic concepts of synthetic biology. Self-replicating systems. RNA dependent RNA polymerase. Synthetic genetic code. Minimal genetic code. Extended genetic code. Non-native nucleic bases. Non-native backbone.

UNIT 2 **9 hours**

Minimal nucleic acid polymerases. Minimal ribosome. Minimal genome. Minimal cell. Minimal microbes (specific example E.coli and Mycobacteria). Targeted deletion methods. Semi-synthetic systems. Semi-synthetic microbes.

UNIT 3 **9 hours**

Genome design. Building blocks and structures. Temporal and spatial engineering. Design tools for synthetic biology. OPEN and CoDA selection systems.

UNIT 4 **9 hours**

Genome synthesis strategies. Genome editing tools - Zinc finger nucleases, TALENs, CRISPR-Cas9. Genome assembly methods. Genome sequencing. Measurement of genetic output.

UNIT 5 **9 hours**

Microbial cell factories. Potential applications of synthetic biology for production of biomaterials, biofuels and drugs. Potential applications of synthetic biology in medicine, food production and bioremediation. Regulation of synthetic biology for safety. Intellectual property rights for synthetic organisms.

Text Books :

1. C. Smolke, S.Y.Lee, J.Nielsen, G. Stephanopoulos. Synthetic Biology: Parts, Devices and Applications. (2018). Wiley-VCH.
2. D.N.Nesbeth. Synthetic biology handbook. (2016). CRC Press.

References:

1. Church, G and Regis, E. (2012). Regenesis: How Synthetic Biology will Reinvent Nature and Ourselves. Basic Books.
2. Pier Luigi Luisi, Cristiano Chiarabelli. Chemical Synthetic Biology. (2011) Wiley & Sons.
3. Gibson, D.G., 2014. Programming biological operating systems: genome design, assembly and activation. Nature methods, 11(5), pp.521-526.

Course Outcomes:

After completion of the course, the student should be able to:

1. Describe the genetic code and its variations
2. Explain the importance of model systems for Synthetic Biology
3. Understand the principles of genome design
4. Describe the strategies for genome synthesis
5. Describe the potential applications of Synthetic Biology

CO-PO Mapping:

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

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

APPROVED IN:

BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:

SDG4 : Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG Justification:

This course is designed to introduce students to concepts related to systems and where the interactions between relatively simple components of a system can give rise to complex behaviour.

BTEN4101	GENOMICS AND GENOME ENGINEERING	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	BTEN2001 BTEN2031 BTEN3021						
Co-requisite	BTEN3051						
Preferable exposure	None						

Course Description:

Genomic studies are used to characterize the nucleotide sequences that encode the genetic information of an organism. Comparative genomic studies are useful for identification of biomarkers for diagnostic applications, for elucidation of the function of genes and to identify targets for drug design. This course introduces the methods for characterization of the genome and the methods and applications of genome engineering.

Course Educational Objectives:

- To learn the concepts related to genome organization, epigenomics and comparative genomics
- To learn the genomic organization and sequencing strategies of model organisms
- To learn techniques for genome editing
- To learn methods for molecular cell imaging and transcriptomics
- To understand the concepts of metabolomics

UNIT 1 **9 hours**

Organization of genomes. Genome maps. Data mining and sequence acquisition. Polymorphism and structural variations. Genome wide association studies (GWAS). Epigenomics and comparative genomics. Genome dynamics and cytogenomics.

UNIT 2 **9 hours**

Genome sequence determination and genome analysis of E. coli, Saccharomyces cerevisiae, C. elegans, Drosophila melanogaster, Arabidopsis thaliana and Homo sapiens. Applications of genomics in predictive medicine and forensics.

UNIT 3 **9 hours**

Introduction to Genome Editing, DNA repair mechanisms, Methods used in genome editing technology ZFNs, TALENs, Introduction to CRISPR/ CAS technology and its applications, Transfection optimization for efficient gene editing

UNIT 4 **9 hours**

Fluorescent tagging of fixed and live cells, CRISPR-based DNA tagging, Quantitative and high-throughput single-cell image analysis, Chip-seq, RNA-seq, single-cell transcriptomics, guide RNA.

UNIT 5 **9 hours**

Applications of genome engineering in therapy, synthetic, developmental biology, human genetics and disease phenotyping, Ethical aspects and safety of genome engineering technology.

Text Books :

1. S.B. Primrose and R.M. Twyman, Principles of gene manipulations and genomics,7/e, Blackwell publishing, Oxford, U.K. 2006.

References:

1. T.A. Brown, Genomes, 3/e, Garland Science, 2006.

2. A.M. Campbell and L.J. Heyer, Discovering Genomic, Proteomics and Bioinformatics, 2/e, Benjamin Cummings, 2006.

Course Outcomes:

After the completion of the course the student should be able to

1. Be familiar with concepts of genomics and genomic engineering
2. Be familiar with the techniques that are available for the genome engineering
3. Design CRISPR based editing tools for the target gene of interest

CO-PO Mapping:

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

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

APPROVED IN:

BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:

SDG1 : End poverty in all its forms everywhere

SDG Justification:

This course will introduce technology for improving health and food availability

BTEN4111	SYNTHETIC BIOLOGY	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	BTEN4101						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Synthetic Biology is the design and production of novel sub-systems or entire organisms from biological or bio engineered components. It may involve metabolic engineering or genetic engineering to optimize existing biological systems. Ornovel biological systems may be designed and created.

Course Educational Objectives:

- Describe the genetic code and its variations
- Describe model systems for Synthetic Biology
- Explain the principles of genome design
- Explain the strategies for genome synthesis
- Describe the potential applications of Synthetic Biology

UNIT 1 **9 hours**

Introduction to Synthetic Biology: Basic concepts of synthetic biology. Self-replicating systems. Independent RNA polymerase. Synthetic genetic code. Minimal genetic code. Extended genetic code. Non-native nucleic bases. Non-native back bone.

UNIT 2 **9 hours**

Minimal nucleic acid polymerases. Minimal ribosome. Minimal genome. Minimal cell. Minimal microbes(specific example E.coliand My cobacteria).Targeted deletionmethods. Semi-synthetic systems. Semi-synthetic microbes.

UNIT 3 **9 hours**

Genome design. Building blocks and structures. Temporal and spatial engineering. Design tools for syntheticbiology. OPEN and CoDA selection systems.

UNIT 4 **9 hours**

Genome synthesis strategies. Genome editing tools - Zinc finger nucleases, TALENs, CRISPR-Cas9.Genomeassemblymethods. Genomesequencing.Measurementofgeneticoutput.

UNIT 5 **9 hours**

Microbial cell factories. Potential applications of synthetic biology for production of biomaterials, biofuels and drugs. Potential applications of synthetic biology in medicine, food production and bioremediation. Regulation of synthetic biology for safety. Intellectual property rights for synthetic organisms.

Text Books :

1. C. Smolke, S.Y.Lee, J.Nielsen, G. Stephanopoulos. Synthetic Biology: Parts, Devices and Applications.(2018).Wiley-VCH.
2. D.N.Nesbeth. Synthetic biology handbook.(2016).CRCPress.

References:

1. Church, G and Regis, E. (2012). Regenesis: How Synthetic Biology will Reinvent Nature and Ourselves.Basic Books.
2. PierLuigiLuisi,Cristiano Chiarabelli. Chemical Synthetic Biology.(2011)Wiley&Sons.
3. Gibson, D.G., 2014. Programming biological operating systems: genome design, assembly andactivation.Naturemethods, 11(5), pp.521-526.

Course Outcomes:

After the completion of the course the student should be able to

1. Describe the genetic code and its variations
2. Explain the importance of model systems for Synthetic Biology
3. Understand the principles of genome design
4. Describe the strategies for genome synthesis
5. Describe the potential applications of Synthetic Biology

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG4 : Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG Justification:
This course will introduce technology for improving health and food availability

BTEN4121	BIOMEDICAL ENGINEERING	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	BTEN3101						
Co-requisite	None						
Preferable exposure	None						

Course Description:

Biomedical Engineering is the application of engineering principles, practices, and technologies to the field of medicine. Models of physiological systems assist in obtaining insights regarding their function and provide information for potential remedial action. A wide variety of instruments assist the medical practitioners in the acquisition of the data required for diagnosis. Methods developed in Information Technology and Computer Science are being adopted for development of Clinical Decision Support systems.

Course Educational Objectives:

- Describe the physical and engineering properties of materials relevant for biocompatibility
- Explain the concepts of stress and strain required for understanding the musculoskeletal system
- Describe the rheological properties of the cardiovascular system
- Introduce the principles of biomedical sensors and signal processing
- Describe Datatypes and Databases for clinical decision support systems

UNIT 1 Biomaterials 9 hours

Tissue-implant interactions for ceramics, metals and polymers. Biodegradable materials. Smart biomaterials.
Tissue engineering: Transformed human cell lines and their applications. Embryonic stem cells and adult stem cells; therapeutic applications of stem cells. Organ culture of skin.

UNIT 2 Biomechanics 9 hours

Relationship between stress and strain. Local balance of mass, momentum and energy. One dimensional model of a skeletal muscle. Viscoelastic properties of muscles.

UNIT 3 Biological transport phenomena 9 hours

Rheology of blood and the Casson equation. The Fahraeus effect. Molecular and macroscopic level control of blood oxygenation level: Hill equation, Oxygen transport in the Krogh tissue cylinder. Single compartment model of urea hemodialysis. Two compartment model for drug absorption.

UNIT 4 Biomedical Instrumentation 9 hours

Biomedical sensors – physical measurements, biopotential measurements, blood gas sensors. Introduction to Bioinstrumentation design. Time varying signals. Active Analog filters. Biomedical signal processing. Biomedical Imaging.

UNIT 5 Biomedical Informatics 9 hours

Data types used in computer aided diagnosis: physical examination, historical, in-vitro diagnostic, histopathological, genetic, nucleotide sequence and image data. Medical image databases and PACS. SNP and genomic databases. Genomic and SNP data for prognosis. Clinical decision support systems.

Text Books :

1. M. Saltzmann. Biomedical Engineering. 2nd Edition. Cambridge University Press. 2015. ISBN-978-1107037199

2. J.Enderle, J. Bronzino. Introduction to Biomedical Engineering. 3rd Edition. Academic Press. 2011. ISBN-978-0123749796

References:

1. C. Oomens, M. Berkelmans, S. Loerakker, F. Baaijens. Biomechanics. 2nd Edition. Cambridge University Press. 2018

2. R. L. Fourneir. Basic Transport Phenomena in Biomedical Engineering. CRC Press. 2018

3. Medical Informatics: Knowledge Management and Data Mining in Biomedicine. Volume 8 of Integrated Series in Information Systems. Ed. Hsinchun Chen, Sherrilynne S. Fuller, Carol Friedman, William Hersh. Springer Science & Business Media, 2006

4. Medical Informatics: Computer Applications in Health Care and Biomedicine. Ed. Edward H. Shortliffe, Leslie E. Perreault. 2nd Edition. Springer Science & Business Media, 2013

Course Outcomes:

1. Compare the physical and engineering properties of materials relevant for biocompatibility
2. Explain the rheological properties of the cardiovascular system
3. Analyze stress and strain relationships in the musculoskeletal system
4. Describe the properties of biomedical sensors
5. List Datatypes and Databases for clinical decision support systems

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG3 : Ensure healthy lives and promote well-being for all at all ages
SDG Justification:
This course will introduce technology for improving health

<table>
<tr><td rowspan="2">BTEN4131</td><td rowspan="2">AI AND ML FOR BIO ENGINEERS</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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">BTEN3051</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 progress of modern biology and medicine is closely linked to acquisition and analysis of massive amounts of data. Machine learning and Artificial Intelligence have proven their ability to utilize available biological data to facilitate inferential studies. In addition, the tools of Machine Learning and Artificial Intelligence have the potential to assist in the design and synthesis of complex biomolecules, pathways, gene circuits and even entire organisms. This course starts with a review of the fundamentals of AI and ML and provides an insightful overview of the diverse applications of AI and ML in Bioengineering.

Course Educational Objectives:

- Explain the concepts of automated reasoning and planning
- Compare methods for machine learning
- Describe applications of AI & ML in biomedicine
- Explain the utility of AI & ML for protein structure prediction & drug design
- Describe potential applications of AI & ML for the synthesis of drugs and the design of living organisms

UNIT 1 Artificial Intelligence for disease diagnosis 8 hours

Intelligent agents and Expert systems. Knowledge representation. Automated Reasoning. Perception and Action. Planning.

Propositional logic. First order logic. Fuzzy sets, Fuzzy logic and Fuzzy inference. Fuzzy relations. Fuzzy relations between symptoms and diseases.

UNIT 2 Biomedical Applications 8 hours

Application of AI & ML for biomedical image recognition and classification. Clinical Decision Support systems for cancer.

UNIT 3 Applications of AI & ML in Drug Design & Development 8 hours

Application of neural networks for Quantitative Structure Activity Relationships. Application of neural networks for prediction of drug-target interaction. Application of neural networks for toxicity prediction. AI & ML for computer aided synthesis of drugs.

UNIT 4 Applications of Neural Networks in Bioinformatics 8 hours

Application of Artificial Neural Networks for transmembrane helix prediction. Application of Artificial Neural Networks for Secondary structure prediction. Artificial Neural Networks for Protein function prediction, Artificial neural networks for Protein structure prediction. Applications of AI & ML in protein engineering.

UNIT 5 Machine Learning for Bioprocess optimization 8 hours

AI & ML for bioprocess optimization. Artificial Neural Networks for selection and optimization of process variables in bioreactor operation. Machine learning for bioprocess control.

Text Books :

1. S.J.RussellandP.Norvig.ArtificialIntelligence:AModernApproach. 4thEd.Pearson.2020.9781292401133.
2. W.R.Hersh,R.E.Hoyt.HealthInformatics:PracticalGuide.SeventhEdition.2018.1387642413.

References:

1. S.O.Haykin.NeuralNetworks&LearningMachines.3rdEd.Pearson.2019.0131471392.
2. Data Analytics in Bioinformatics: Machine Learning Perspective.EditedbyR.Satpathyetal.Wiley.2021.978-1-119-78560-6.

Course Outcomes:

1. Understand and apply the concepts of planning, logic and inference
2. Understand and apply the basic concepts of classification and decision theory
3. Describe applications of AI&ML in clinical decision support systems
4. Describe applications of AI&ML in Bioinformatics & Pharmacoinformatic
5. Describe applications of AI & ML in bio process optimization and bio process control

CO-PO Mapping:

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

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

APPROVED IN:

BOS : 24-12-2020 ACADEMIC COUNCIL: 01/04/2022

SDG No. & Statement:

SDG3 : Ensure healthy lives and promote well-being for all at all ages

SDG Justification:

This course will introduce technology for improving health

BTEN2061	LIFE SCIENCES FOR ENGINEERS	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

Course Educational Objectives:

- Introduce the molecular basis of life.
- Provide the basis for classification of living organisms.
- Describe the transfer of genetic information.
- Introduce the techniques used for modification of living organisms.
- Describe the applications of biomaterials

UNIT 1 **10 hours**

Comparison of biological organisms with manmade systems, Classification of living organisms, Cellular basis of life, differences between prokaryotes and eukaryotes, classification on the basis of carbon and energy sources, molecular taxonomy.
Tutorial/Lab Experiments (Virtual or Field Experiments): Microscopy, Nitrogen cycle, Species interactions, Bacterial population growth

UNIT 2 **8 hours**

Water, Biomolecules, structure and functions of proteins and nucleic acids, hemoglobin, antibodies and enzymes, Industrial applications of enzymes, Fermentation and its industrial applications

UNIT 3 **Bioenergetics, Respiration** **8 hours**

Glycolysis and TCA cycle, Electron transport chain and oxidative phosphorylation, Mechanism of photosynthesis, Human physiology, neurons, synaptic and neuromuscular junctions

UNIT 4 **10 hours**

Mendel's laws, gene mapping, Mitosis and Meiosis, single gene disorders in humans, Genetic code, DNA replication, Transcription, Translation
Tutorial/Lab Experiments (Virtual or Field Experiments): Mendel's laws, mapping, genetic interactions, Bacterial population growth

UNIT 5 **Recombinant DNA Technology** **8 hours**

recombinant vaccines, transgenic microbes, plants and animals, animal cloning, biosensors, biochips.

Text Books :

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. T. Chakraborty & N. Akhtar. Biology for Engineers, PHI, 2022.

References:

1. Arthur T Johnson, Biology for Engineers, CRC press, 2011
2. Alberts Et. Al. The molecular biology of the cell, 6/e, Garland Science, 2014
3. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, “Outlines of Biochemistry”, John Wiley and Sons, 2009.
4. John Enderle and Joseph Bronzino Introduction to Biomedical Engineering, 3/e, 2012

Course Outcomes:

After studying the course, the student will be able to:

1. Explain catalytic properties of enzymes.
2. Summarize application of enzymes and fermentation in industry.
3. Identify DNA as a genetic material in the molecular basis of information transfer.
4. Apply thermodynamic principles to biological systems.
5. Analyze biological processes at the reductionistic level.
6. Appreciate the potential of recombinant DNA technology.

CO-PO Mapping:

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

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

APPROVED IN:

BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:

SDG8 : Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

SDG Justification:

This course has been designed to provide fundamental understanding about biological process and systems that can be utilized to solve problems with food security and improved nutrition

<table>
<tr><td rowspan="2">BTEN2071</td><td rowspan="2">BIOTECHNOLOGY FOR SOCIETY</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</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 Educational Objectives:

- Introduce the tools of techniques of molecular biotechnology
- Discuss the risks and benefits of biotechnology
- Describe the principles of medical biotechnology.
- Discuss concepts and implications of personalized medicine
- Describe the relevance of biotechnology for agriculture and medicine

UNIT 1 **8 hours**

History of Biotechnology, Genes (basic concepts) Genetic Engineering Invention, Genetic engineering, Tools for manipulation of genes (introduction to recombinant DNA technology) Vectors and expression systems (introduction).

UNIT 2 **8 hours**

Intellectual property rights (concepts related to drugs, genes and genomes) Recombinant DNA Debates, Biotechnology and Business, Patenting Life, Genetically Modified Foods: Risk and Regulation

UNIT 3 **8 hours**

Freezing, Banking, Crossing, Eugenics, The Human Genome Project, Genetic Testing, Disability, and Discrimination, Bioethics and Medicine, From the Pill to IVF, Cloning, Stem Cells, Designer Babies.

UNIT 4 **Biotechnology and Diversity** **8 hours**

Personal Genomics, Biotechnology and Race, Drugs and designer bodies. Bioprospecting and Bio colonialism

UNIT 5 **8 hours**

Vaccines, Gene therapy, Clinical trials, Synthetic Biology and Bioterrorism, Use of biofertilizers and biopesticides for organic forming

Text Books :

1. Biotechnology and Society: An introduction. Hallam Stevens. University of Chicago Press. 2016. ISBN 022604615X, 9780226046150

References:

1. W. Godbey, An Introduction to Biotechnology, The Science, Technology and Medical Applications, 1/e, Woodhead Publishing, 2014.
2. J.M. Walker and R. Rapley, Molecular Biology and Biotechnology, 5/e, Royal society of chemistry, 2009.
3. B.R. Glick, J.J.Pasternak, C.L.Patten. Molecular Biotechnology.ASM Press. 2009. ISBN-10: 1555814980, ISBN-13: 978-1555814984

Course Outcomes:

After studying the course, the student will be able to:

1. Summarize the principles and tools of biotechnology
2. Assess the risks and benefits of biotechnology
3. Identify techniques used in biotechnology
4. Understand the potential of biotechnology for exploration
5. Appreciate the potential of recombinant DNA technology.

CO-PO Mapping:

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

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

APPROVED IN:
BOS : 24-12-2020 **ACADEMIC COUNCIL: 01/04/2022**

SDG No. & Statement:
SDG3 : Ensure healthy lives and promote well-being for all at all ages

SDG Justification:
This course has been designed to describe the applications involving biological processes and systems that can be utilized to solve problems with food security, health and environment

BTEN2081	BIOPESTICIDES AND BIOFERTILIZERS	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

This course introduces the student to the effects of pests and soil properties on crops. Different types of biopesticides and biofertilizers that are currently used in crops will be described. Advantages of utilisation of biopesticides and biofertilizers over chemical pesticides and fertilisers will be emphasized. Course prerequisite is 10th class biology.

Course Objectives:

- Introduce pest infestation in crops.
- Describe the fertility of soil.
- Understand different types of biopesticides and biofertilizers used in crops
- Application of biopesticides and biofertilizers
- Understand the advantages and disadvantages of biopesticides and biofertilizers

Unit- I **10 h**

Different type of pest that infest agricultural crops and their control methods. Definition of biopesticides, History and concept of biopesticides. Importance, scope and potential of biopesticide.

Learning Outcomes:

At the end of this unit, the student will be able to

- summarize pest infestation on crops. (L2)
- understand biopesticides (L2)
- outline the history and concept of biopesticides (L2)
- interpret the scope and potential of biopesticides(L2).

Pedagogy tools: Blended learning, Case studies, video lectures, Teaching on board, self-reading

Unit- II **8 h**

Definitions, concepts, and classification of biopesticides viz. pathogen, botanical pesticides, and biorationals. Mass production technology of bio-pesticides.

Learning Outcomes:

At the end of this unit, the student will be able to

- Outline concepts and classification of biopesticides (L2)
- discuss pathogen, botanical biopesticides and biorationals (L3)
- interpret the mass production technology of biopesticides (L2)

Pedagogy tools: Blended learning,Case let, video lectures, self-reading

Unit-III **8 h**

Virulence, pathogenicity, and symptoms of entomopathogenic pathogens and nematodes. Methods of application of biopesticides. Methods of quality control techniques of biopesticides. Impediments and limitation in production and use of biopesticide.

Learning Outcomes:

After completing this unit, the student will be able to

- explain virulence and pathogenicity of entomopathogens (L2)
- explain the virulence and pathogenicity of nematodes (L2)
- explain methods of application of biopesticides (L2)
- understand methods of quality techniques of biopesticides (L3)

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

Unit-IV **10 hrs**

Biofertilizers - Introduction, status, and scope. Structure and characteristic features of bacterial biofertilizers- Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia; Cyanobacterial biofertilizers- Anabaena, Nostoc, Hapalosiphon and fungal biofertilizers- AM mycorrhiza and ectomycorrhiza.

Learning Outcomes:

After completing this unit, the student will be able to

- discuss the scope and status of biofertilizers (L2).
- describe the structure and characteristics of different type of biofertilizers (L2)
- describe the bacterial and fungal based biofertilizers (L2)

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

Unit-V **10 hrs**

Nitrogen fixation -Free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, K solubilization. Production technology: Strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertilizers. FCO specifications and quality control of biofertilizers.

Learning Outcomes:

After completing this unit, the student will be able to Genetics

- understand the basics of free living and symbiotic nitrogen fixation (L3)
- explains phosphate and potassium mobilization (L2)
- understand the FCO specifications and quality control of biofertilizers (L3)

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

Course Outcomes:

After the completion of the course the student should be able to

- explain basics of biopesticides. (L2)
- explain types of biopesticides (L2)
- understand biofertilizers and types of biofertilizers(L2)
- summarize mass production technologies of biopesticides and biofertilizers (L2)

- Applications of quality control methods in biopesticides and biofertilizers (L5)

Text Books:

1. Krishnendu Acharya , Surjit Sen , Manjula Rai Biofertilizers and Biopesticides, 1/e, Techno World; 29 June 2019. Language: English, Country of Origin: India, ISBN-10: 9388347234, ISBN-13 : 978-9388347235
2. H. C. Lakshman, Channabasava A., Biofertilizers and Biopesticides, 1/e, Pointer Publishers, 2014, Language: English, Country of Origin: India, ISBN-9788171327751, 8171327753

References:

1. **A.M. Deshmukh, R.M. Khobragade, P.P. Dixit, Handbook of Biofertilizers and Biopesticides, ABD Publishers, 2007, Language: English, Country of Origin: India, ISBN-10: 8189473158, ISBN-13 : 978-8189473150**

	Programme Objectives (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1										1			3		
CO2											1		2		
CO3		2	2										2		
CO4					3		2							3	
CO5										3	3				3

1-Low, 2- Medium and 3- High Correlation

Specify the importance of starch and cellulose in multicellular organisms

BTEN4141	BIOLOGICAL NMR SPECTROSCOPY	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	Introduction to Nuclear Magnetic Resonance						
Co-requisite	None						
Preferable exposure	None						

Course Description

This course in an introduction to the theory of NMR spectroscopy required for the description of the experiments that are commonly utilized for the study of structure, dynamics and interactions of biomolecules. The set of experiments that are most commonly utilized for biomolecular structure determination are emphasized in this course.

Course objectives:

The objectives of the course are to:

- Review the basic principles of nuclear magnetic resonance (L1)
- Introduce the quantum mechanical basis for description of NMR experiments (L1)
- Describe two dimensional NMR spectroscopic experiments (L1)
- Describe three dimensional NMR spectroscopic experiments (L1)
- Describe the methodology for structure determination of proteins from NMR spectroscopic data (L3)

Unit 1

Review of the principles of magnetic resonance

Nuclear spin angular momentum, Spin angular momentum operators for an isolated spin, Time dependent evolution of an isolated spin in the presence of a magnetic field, Spin magnetic resonance. Spin polarization. Qualitative description of Nuclear spin relaxation and Polarization transfer.

Unit 2

Introduction to product operator theory

Density operator, effect of a radio-frequency pulse on the density operator for uncoupled spins. Product operators for coupled two-spin systems, Addition and Multiplication of Product operators, Evolution of two-spin product operators in the absence of external perturbation, effect of a radio-frequency pulse on the density operator of a two-spin system. Coherence transfer. Qualitative description of decoherence.

Unit 3

Two-dimensional NMR spectroscopy of liquids and solutions

Homouclear two dimensional correlation spectroscopy (2D-COSY). Phase sensitive Double-quantum-filtered correlation spectroscopy. Two dimensional Nuclear Overhauser effect spectroscopy (2D-NOESY). Total correlation spectroscopy (2D-TOCSY). Heteronuclear Single Quantum Coherence NMR spectroscopy. Coherence selection with phase cycling and pulsed magnetic field gradients. Solvent suppression for biomolecular NMR spectra in water. Qualitative description of Broadband decoupling.

Unit 4

3D and higher dimensional NMR spectroscopy of liquids and solutions

Three dimensional homonuclear Hartmann-Hahn Nuclear Overhauser effect spectroscopy (3D HOHAHA-NOESY). Two dimensional heteronuclear single quantum coherence spectroscopy (2D-HSQC). 3D NOESY-HSQC, 3D HOHAHA-HSQC. The triple resonance 3D NMR experiments: HNCA, HN(CO)CA, HNCO, HN(CA)CO, HNHA, HNHB. Introduction to 4D, 5D, 6D and 7D NMR experiments. Introduction to Non-linear sampling.

Unit 5

Application of NMR spectroscopy for studies of Biomolecules

Spin systems of the standard amino acids. Identification of spin system type of amino acids from NMR spectroscopic data. Concepts of sequential resonance assignment. Distance constraints and Nuclear Overhauser effect. Angular constraints and the Karplus relationship. Amide H/D exchange rates and hydrogen bonds. Protein structure determination with NMR spectroscopy derived restraints. Qualitative description of protein dynamics and residual dipolar coupling. Introduction to NMR spectroscopy of Protein-Protein, Protein-DNA and Protein-Ligand interaction studies.

Recommended demonstrations/practicals/assignments:

Sequential resonance assignment of a peptide or small protein

Structure determination of a small protein using NMR derived restraints

Texbook(s)

1. R.V.Hosur and V.M.R. Kakita. A graduate course in NMR spectroscopy. 2022. Springer.
2. J. Keeler. Understanding NMR spectroscopy. 2nd Ed. 2010. Wiley.

Additional Reading(s)

1. J. Cavanaugh, W. J. Fairbrother, A. G. Palmer III, M. Rance, N. J. Skelton. Protein NMR spectroscopy. 2nd Ed. 2007.
2. J.S.Harwood and H. Mo. Practical NMR Spectroscopy Laboratory Guide: Using Bruker Spectrometers. 2015.

Course outcomes:

After completion of the course the student should be able to:

- Understand the basic principles of nuclear magnetic resonance (L1)

- Apply the quantum mechanical density operator theory for description and design of NMR experiments (L5)
- Utilize information from two dimensional NMR spectroscopic experiments (L3)
- Utilize information from three dimensional NMR spectroscopic experiments (L3)
- Utilize data derived from NMR spectroscopy for studies of biomolecular structure and dynamics (L3)

BTEN3221	INTRODUCTION TO NUCLEAR MAGNETIC RESONANCE	L	T	P	J	S	C
		3	0	0	0	0	3
Pre-requisite	None						
Co-requisite	None						
Preferable exposure	None						

Course objectives:

The objectives of the course are to:

- Introduce the basic principles of nuclear magnetic resonance (L1)
- Describe the instrumentation required for Nuclear Magnetic Resonance experiments (L1)
- Introduce the methodology for using NMR spectroscopy for structure determination of small organic molecules (L1)
- Introduce the principles of MRI (L1)
- Provide an overview of the applications of nuclear magnetic resonance (L1)

Unit 1

Principles of nuclear magnetic resonance

Nuclear spin angular momentum. Nuclear spin angular momentum quantum numbers for ^{1}H, ^{2}H, ^{12}C, ^{13}C, ^{14}N, ^{15}N, ^{16}O, ^{17}O, ^{19}F and ^{31}P. Nuclear spin energy states for these nuclei in the presence of a magnetic field. Nuclear magnetic resonance. Effects of magnetic field strength on the S/N.

Unit 2

Instrumentation

Effects of magnetic field homogeneity on the NMR spectrum. Field frequency lock. Continuous wave and pulsed excitation. Shaped pulses. Role of the probe temperature on S/N. Quadrature detection. Frequency filters. Digital fast fourier transform. Effects of sampling rate on analog-to-digital conversion.

Unit 3

Introduction to NMR spectroscopy

Chemical shifts. 1H and 13C chemical shifts for following functional groups: -CH3, -CH=O, -phenyl, -NH-CO-, -CH2-OH, -COOH. J-coupling. Effects of magnetic field strength on the fine structure of NMR spectra. Decoupling. Structure determination of small organic molecules from NMR spectroscopy data. NMR spectral databases. Qualitative description of the of factors affecting line shape.

Unit 4

Introduction to MRI

Encoding of spatial information by using Magnetic field gradients. Spin-echo and gradient echo. Slice selection. Two dimensional imaging with MRI. Three dimensional imaging with MRI. Qualitative descriptions of following: Functional MRI. Diffusion weighted imaging. Diffusion tensor imaging. MR angiography.

Unit 5

Applications of nuclear magnetic resonance

Qualitative description of following applications: Food and beverage quality control, Structure determination of molecules, Drug design and development, Pharmacokinetics, Nanoparticle studies, *in vivo* NMR spectroscopy, MR microscopy, Quantum computing.

Recommended demonstrations/practicals/assignments (any of these may be used):

NMR spectrum of ethanol

NMR spectrum of aspirin

NMR spectrum of a protein/oligonucleotide

NMR spectra of vegetable oils

NMR spectrum of kerosene/petrol/diesel/biodiesel

NMR spectrum of serum

NMR spectrum of suspended bacteria/eukaryotic cells

NMR spectrum of nanoparticles

NMR spectrum of liquid crystals

MRI of human brain

Recommended Textbooks:

1. Joseph B Lambert, Eugene P Mazzola, Clark D. Ridge. Nuclear Magnetic Resonance Spectroscopy: An Introduction to Principles, Applications, and Experimental Methods. 2018. Prentice Hall.

Course outcomes:

After completion of the course the student should be able to:

- Understand the basic principles of nuclear magnetic resonance (L1)
- Understand the role of each component of the instrumentation required for data acquisition (L1)
- Utilize information from NMR spectroscopy for structure determination of small organic molecules (L3)
- Understand the principles of MRI (L1)
- Describe the applications of NMR (L1)

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