GITAM

(DEEMED TO BE UNIVERSITY)

(Estd. u/s 3 of the UGC Act, 1956)

BENGALURU * HYDERABAD * VISAKHAPATNAM

f NAAC Accredited with A+ Grade

REGULATIONS AND SYLLABUS of

Bachelor of Technology

in Mechanical Engineering

(w.e.f 2020-21 admitted batch)

www.gitam.edu

A University Committed to Excellence

B. Tech. in Mechanical Engineering
REGULATIONS
(w.e.f. 2020-21 admitted batches)

1. ADMISSION

1.1 Admission into B. Tech. in Mechanical Engineering program of GITAM (Deemed to be University) is governed by GITAM admission regulations.

2. ELIGIBILITY CRITERIA

2.1 A first class in 10+2 or equivalent examination approved by GITAM (Deemed to be University) with subjects Physics, Chemistry, and Mathematics.

2.2 Admission into B.Tech. will be based on an All-India Entrance Test (GITAM Admission Test - GAT) conducted by GITAM/Specified rank holders of JEE mains/EAMCET (AP & TS) and the rules of reservation of statutory bodies, wherever applicable, will be followed.

3. CHOICE BASED CREDIT SYSTEM

3.1 Choice Based Credit System (CBCS) was introduced with effect from the academic year of 2015-16 admitted batch and repromoted 2019-2020 academic year, based on guidelines of the statutory bodies in order to promote: o Activity based learning.

- o Student-cantered learning o Cafeteria approach
- o Students to choose courses of their choice.
- o Learning at their own pace
- o Interdisciplinary learning

3.2 Course Objectives, Learning Outcomes, and Course Outcomes are specified, focusing on what a student should be able to do at the end of the course and program.

4. STRUCTURE OF THE PROGRAM

4.1 The Program consists of humanities and social sciences, basic sciences, basic engineering, program core, program electives, open electives, interdisciplinary electives, industry internship, laboratory, mandatory courses and project work.

Core Courses	Branch specific	Compulsory
Elective courses	Program Electives	Supportive to the discipline courses with expanded scope in a chosen track of specialization or cross track courses
	Interdisciplinary Electives	Interdisciplinary exposure & nurture the student interests in other department courses.
	Open Electives	Common to all disciplines that helps general interest of a student

4.2 Each course is assigned a certain number of credits depending upon the number of contacts. hours (lectures/tutorials/practical) per week.

4.3 In general, credits are assigned to the courses based on the following contact hours per week per semester.

- One credit for each Lecture/Tutorial hour per week.
- One credit for two hours of Practical's per week.

4.4 The curriculum of the eight semesters B.Tech. program is designed to have a total of 160 credits for the award of B.Tech. degree.

5. MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be English.

6. REGISTRATION

Every student has to register himself/herself for the courses in each semester individually at the time as specified in academic calendar.

7. ATTENDANCE REQUIREMENTS

7.1 A student whose attendance is less than 75% in all the courses put together in any semester will not be permitted to attend the end - semester examination and he/she will not be allowed to register for subsequent semester of study. He/she has to repeat the semester along with his/her juniors.

7.2 However, the Vice-Chancellor on the recommendation of the Principal / Director of the Institute/School may condone the shortage of attendance of the students whose attendance is between 65% and 74% on genuine medical grounds and on payment of prescribed fee.

8. EVALUATION

8.1 The assessment of the candidates' performance in a theory course shall be based on two components: Continuous Evaluation (40 marks) and Semester-end Examination (60 marks).

8.2 A candidate has to secure an aggregate of 40% in the course in the two components put together to be declared to have passed the course, subject to the condition that the candidate must have secured a minimum of 24 marks out of 60 marks (i.e., 40%) in the theory component at the semester-end examination.

8.3 Practical courses are assessed under Continuous Evaluation for a maximum of 100 marks, and a candidate has to obtain a minimum of 40% to secure pass grade.

8.4 The courses having theory and practical combined, 70% of the weightage will be given for theory component and 30% weightage for practical component. The candidate has to acquire 40% in the semester end theory examination. However, candidate must have secured overall 40% (Theory + Practical) to secure pass grade.

8.5 Project Work/ Industrial internship courses are assessed under continuous evaluation for a maximum of 100 marks, and a candidate has to obtain a minimum of 40% to secure pass grade.

8.6 Mandatory Courses are assessed for PASS or FAIL only. No grade will be assigned to these courses. If a candidate secures more than 40 out of 100 marks, he / she will be declared PASS, else FAIL.

8.7 Mandatory courses NSS/NCC/NSO/YOGA are assessed for satisfactory or not satisfactory only. No grade will be assigned. A candidate has to undergo two hours training per week in any one of the above in both 1st and 2nd semesters.

Details of Assessment Procedure are furnished in Table 1.

Table 1: Assessment Procedure

S.No	Component of Assessment	Types of Assessment	Marks Allotted	Scheme of Evaluation
1	Theory courses	Continuous Evaluation	40	(i) Thirty (30) marks for mid-semester examinations. Three mid examinations shall be conducted for 15 marks each; performance in best two shall be taken into consideration. ii) Ten (10) marks for Quizzes, Assignments and Presentations.
		Semester End Examinations	60	Sixty (60) marks for semester-end Examinations.
		Total	100	
2	Practical courses	Continuous Evaluation	100	(i) Fifty (50) Marks for regularity and performance, records and oral presentations in the laboratory. Weightage for each component shall be announced at the beginning of the semester. ii) Ten (10) marks for case studies. iii) Forty (40) marks for two tests of 20 marks each (one at the mid-term and the other towards the end of the semester) conducted by the concerned lab teacher.

3	Theory and Practical combined courses	(a) Theory component: continuous evaluation and semester-end examination. (b) Practical component: continuous evaluation Total	100 100 200	70% of the weightage will be given for theory component. Evaluation for theory component will be same as S. No 1 as above. 30% weightage for practical components. Evaluation for practical component will be same as S. No 2 as above
4	Project work (VII & VIII Semesters)	Continuous Evaluation	100	i) Forty (40) marks for periodic evaluation on originality, innovation, sincerity and progress of the work assessed by the project supervisor. ii) Thirty (30) marks for mid-term evaluation for defending the project before a panel of examiners. iii) Thirty (30) marks for final Report presentation and Viva-voce by a panel of examiners.
5	Industrial Internship (VII Semester)	Continuous Evaluation	100	i) Thirty (30) marks for Project performance, assessed by the Supervisor of the host Industry/ Organization. Submission of a Project Completion Certificate from host organization is mandatory. ii) Forty (40) marks for Report and Seminar presentation on the training, assessed by the Teacher/Coordinator.
				iii) Thirty (30) marks for presentation on the training, before a panel of examiners.

6	Mandatory Courses	Continuous Evaluation	100	(i) Sixty (60) marks for mid semester Examinations. Three mid examinations shall be conductedfor30 marks each; performance in best two shall be taken into consideration. (ii) Forty (40) marks for Quizzes, Assignments and Presentations

9. RETOTALLING & REVALUATION

9.1 Retotalling of the theory answer script of the semester-end examination is permitted on request by the candidate by paying the prescribed fee within one week after the announcement of the results.

9.2 Revaluation of the theory answer scripts of the semester-end examination is permitted on request by the student by paying the prescribed fee within one week after the announcement of the result.

9.3 A candidate who has secured ‘F’ grade in a theory course shall have to reappear at the subsequent examination held in that course. A candidate who has secured ‘F’ grade can improve continuous evaluation marks unto a maximum of 50% by attending special instruction classes held during summer.

9.4 A candidate who has secured ‘F’ grade in a practical course shall have to attend Special Instruction classes held during summer.

9.5 A candidate who has secured ‘F’ grade in a combined (theory and practical) course shall have to reappear for theory component at the subsequent examination held in that course. A candidate who has secured ‘F’ grade can improve continuous evaluation marks up to a maximum of 50% by attending special instruction classes held during summer.

9.6 A candidate who has secured ‘F’ Grade in project work / Industrial Training shall be permitted to submit the report only after satisfactory completion of the work and viva voce examination.

10. PROVISION FOR ANSWER BOOK VERIFICATION AND CHALLENGE EVALUATION

10.1 If a candidate is not satisfied with his/her grade after revaluation, the candidate can apply for, answer book verification on payment of prescribed fee for each course within one week after announcement of revaluation results.

10.2 After verification, if a candidate is not satisfied with revaluation marks/grade awarded, he/she can apply for challenge valuation within one week after announcement of answer book verification result/ two weeks after the announcement of revaluation results, which will be valued by the two examiners i.e., one Internal and one External examiner in the presence of the candidate on payment of prescribed fee. The challenge valuation fee will be returned, if the candidate is succeeded in the appeal with a change for a better grade.

11. SUPPLEMENTARY EXAMINATIONS AND SPECIAL EXAMINATIONS.

11.1 The odd semester supplementary examinations will be conducted on daily basis after conducting regular even semester examinations during April/May.

11.2 The even semester supplementary examinations will be conducted on daily basis after conducting regular odd semester examinations during October/November.

11.3 A candidate who has completed his/her period of study and still has “F” grade in final semester courses is eligible to appear for Special Examination normally held during summer vacation.

12. PROMOTION TO THE NEXT YEAR OF STUDY

12.1 A student shall be promoted to the next academic year only if he/she completes the academic requirements of 60% of the credits till the previous academic year.

12.2 Whenever there is a change in syllabus or curriculum, he/she has to continue the course with new regulations after detention as per the equivalency established by the BoS to continue his/her further studies.

13. MASSIVE OPEN ONLINE COURSES

Greater flexibility to choose variety of courses is provided through Massive Open Online Courses (MOOCs) during the period of study. Students without any backlog courses up to fourth semester are permitted to register for MOOCs from fifth semester onwards up to a maximum of 15 credits from program elective/ interdisciplinary elective/ open elective courses. However, the Departmental Committee (DC) of the respective campuses has to approve the courses under MOOCs. The grade equivalency will be decided by the respective Board of Studies (BoS).

14. BETTERMENT OF GRADES

14.1 A student who has secured only a pass or second class and desires to improve his/her class can appear for betterment examinations only in eight theory courses of any semester of his/her choice, conducted in summer vacation along with the Special Examinations.

14.2 Betterment of Grades is permitted 'only once', immediately after completion of the program of study.

15. HONORS

A student who secured 8 CGPA or above up to IV semester is eligible to register for B. Tech (Honors) degree. The student has to complete additional 20 credits (six theory courses + seminar) as approved by the respective Departmental Committee (DC) to secure B. Tech (Honors). The courses will be approved by DC of respective campuses.

16 GRADING SYSTEM

16.1 Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the correspond e points are as given in Table 2.

Table 2: Grades and Grade Points

S.No.	Grade	Grade Points	Absolute Marks
1	O (Outstanding)	10	90 and above
2	A+ (Excellent)	9	80 to 89
3	A (Very Good)	8	70 to 79
4	B+ (Good)	7	60 to 69
5	B (Above Average)	6	50 to 59
6	C (Average)	5	45 to 49
7	P (Pass)	4	40 to 44
8	F (Fail)	0	Less than 40
9	Ab. (Absent)	0	-

16.2 A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, subject to securing an average GPA of 5.0 (average of all GPAs in all semesters) at the end of the program to declare pass in the program.

17. GRADE POINT AVERAGE

17.1 A Grade Point Average (GPA) for the semester will be calculated according to the formula:

$$GPA = \frac{\Sigma [C^* G]}{\Sigma C}$$

where, C = number of credits for the course.

G =grade points obtained by the student in the course.

17.2 To arrive at Cumulative Grade Point Average (CGPA), a similar formula is used considering the student's performance in all the courses taken, in all the semesters up that particular semester.

17.3 CGPA required for classification of class after the successful completion of the program is shown in Table 3.

Table 3: CGPA required for award of Class.

Class	CGPA Required
First Class with Distinction	>8.0*
First Class	> 6.5
Second Class	> 5.5
Pass Class	> 5.0

* In addition to the required CGPA of 8.0 or more, the student must have necessarily passed all the courses of every semester in first attempt.

18. ELIGIBILITY FOR AWARD OF THE B. Tech. DEGREE

18.1 Duration of the program: A student is ordinarily expected to complete the B.Tech. program in eight semesters of four years. However, a student may complete the program in not more than eight years including a study period.

However, the above regulation may be relaxed by the Vice-Chancellor in individual cases for cogent and sufficient reasons.

18.2 A student shall be eligible for award of the B.Tech. Degree if he/she fulfils all the following conditions:

i) Registered and successfully completed all the courses and projects.

ii) Successfully acquired the minimum required credits as specified in the curriculum in the branch of his/her study within the stipulated time.

iii) Has no dues to the Institute, hostels, Libraries, NCC/NSS etc, and no disciplinary action is pending against him/ her.

19. DISCRETIONARY POWER

Notwithstanding anything contained in the above sections, the Vice-Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

Program Educational Objectives (PEO)

The program educational objectives of the Department of Mechanical Engineering Program are to produce engineers whose attributes several years after graduation are marked by their ability to

PEO1	Thrive as professional engineers in core mechanical engineering and other allied fields.	
PEO2	learn new knowledge and skills through professional development prospects or pursue advanced education	
PEO3	Pursue lifelong learning opportunities to enhance and develop their technical and professional skills	
PEO4	Follow to the highest level of professional code of ethics	

Program Outcomes (PO) & Program specific outcomes

Program outcomes

PO 1	Apply basic knowledge of mathematics and science to design and analyze mechanical engineering systems.
PO 2	Apply recent advances in mechanical engineering to solve industrial problems.
PO 3	Establish the procedures for experimentation using core mechanical engineering knowledge for data collection, simulation and analysis.
PO 4	Implement computer solution methods for design and synthesis of mechanical engineering systems.
PO 5	Assess the influence of global changes on organization for effective decision making.
PO 6	Acquire knowledge of fast changing technologies for solving engineering problems.
PO 7	Exhibit leadership capabilities
PO 8	Perform multi-disciplinary goals as a team member.
PO 9	Communicate effectively in peer and diverse groups.
PO 10	Acquire skills to become an entrepreneur.
PO 11	Engage in a life-long learning environment.
PO 12	Imbibe professional and ethical responsibility towards the society.

Programme Specific Outcomes (PSO)

After the culmination of the course students will be able to acquire:

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

Department of Mechanical Engineering
B.Tech. Mechanical Engineering with Specialization in AI and ML/Electric and hybrid vehicles/ Smart manufacturing
(Common course structure up to 4th semester)

(Effective from the academic year 2020-21 admitted batch)

Semester I

S. No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1.	19EMA101	Engineering Mathematics I (Calculus and Algebra)	BS	3	0	0		3	Common to all except BT
2.	GEL131	Communicative English	HS	2	0	2		3	Common to all
3.	19ECY133/ 19EPH133	Chemistry of materials/ Applied Physics	BS	3	0	3		4.5	Common with CIVIL
4.	19EID131/ 19EEE131	Problem Solving and Programming/ Basic Electrical and Electronics Engineering	ES	3	1	3		5.5	Common to all
5.	19EME121/ 19EME131	Basic Workshop / Engineering Graphics	ES	0/1	0	3		1.5/2.5	Common to all
6.	19EMC181A/ 19EMC181B/ 19EMC181C/ 19EMC181D	National Service Scheme/National Cadet Corps/ National Sports Organization/ Yoga	MC	0	0	2		0	Common to all
Total								**17.5/18.5**	

Semester II

S. No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1.	19EMA102	Engineering Mathematics II (ODE, PDE, and Multivariable Calculus)	BS	3	0	0		3	Common with ECE, EEE & CIVIL
2.	19EPH133/ 19ECY133	Applied Physics/ Chemistry of materials	BS	3	0	3		4.5	Common with CIVIL
3	19EID134/ 19EID132	**AI Tools/Design Thinking**	ES	2	0	2		3	
4.	19EME131/ 19EME121	Engineering Graphics/ Basic Workshop	ES	1/0	0	3		2.5/1.5	Common to all
5.	19EEE131/ 19EID131	Basic Electrical and Electronics Engineering/ Problem Solving and Programming	ES	3	1	3		5.5	Common to all
6	19EME122	Mechanical Engineering Workshop	PC	0	0	3		1.5	Branch Specific
7	19EMC181A/ 19EMC181B/ 19EMC181C/ 19EMC181D	National Service Scheme/National Cadet Corps/ National Sports Organization/ Yoga	MC	0	0	2		0	Common to all
8	19EHS122	Comprehensive Skill Development I	HS	0	0	0	6	1	
9.	VDC111	Venture Discovery	PW	0	0	2	0	2	Common to all
Total								**23/22**	

Semester III

S.No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1.	19EMA201	Engineering Mathematics III (Applications of PDE, Complex Variables and Transform Techniques)	BS	3	0	0		3	Common with CIVIL
2.	19EID132/ 19EID134	Design Thinking /AI Tools	ES	2	0	2		3	Common to all
3	19EME201	Engineering Mechanics	PC	3	0	0		3	Common with CIVIL
4	19EME203	Thermodynamics	PC	2	1	0		3	Branch Specific
5	19EME205	Material Science and Engineering	PC	3	0	0		3	Branch Specific
6	19EME231	Computer-Aided Machine Drawing	PC	1	0	3		2.5	Branch Specific
7	19EMC281/ 19EMC282	Constitution of India/Environmental Sciences	MC	3	0	0		0	Mandatory Course
8	19EHS221	Comprehensive Skill Development II	HS	0	0	0	6	1	
Total								**18.5**	

Semester IV

S.No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1.	19EMA202	Engineering Mathematics IV (Numerical methods, Probability and Statistics)	BS	3	0	0		3	Common with EEE &CIVIL
2.	19EID234 /19EID232	Life Sciences for Engineers/Internet of Things	BS/ES	2	0	2		3	Common to all
3.	19EME202	Strength of Materials	PC	3	1	0		4	Branch Specific
4.	19EME232	Applied Thermodynamics	PC	2	1	3		4.5	Branch Specific
5.	19EME234	Fluid Mechanics	PC	3	1	3		5.5	Branch Specific
6	19EME204	Manufacturing Processes	PC	3	0	0		3	Branch Specific
7	19EMC282 /19EMC281	Environmental Sciences/Constitution of India	MC	3	0	0		0	Mandatory Course
8.	19EME292	Comprehensive Skill Development-III	PW	0	0	0	6	1	
Total								**24**	

Department of Mechanical Engineering
B.Tech. Mechanical Engineering
(Effective from the academic year 2020-21 admitted batch)

Semester V

S. No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1.	19EME331	Manufacturing Technology	PC	3	0	3		4.5	Branch Specific
2.	19EME301	Mechanics of Machinery	PC	3	1	0		4	Branch Specific
3.	19EID232 /19EID234	Internet of Things/ Life Sciences for Engineers	ES/BS	2	0	2		3	Common to all
4.	19EME335	Smart manufacturing systems	PC	3	0	0	0	3	B. Tech (Mechanical engineering)
5.	19EOE3XX/ GEL244/ 19EOE224	Open Elective I	OE	3	0	0		3	Open Elective
6.	19EME332	Heat and Mass Transfer	PC	3	1	3		5.5	Branch Specific
7.	19EME391	Comprehensive Skill Development IV	PW	0	0	0	6	1	
8	HSMCH102	Universal Human Values 2:Understanding Harmony	HS	2	1	0		3	
Total								**27**	

Semester VI

S. No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1.	19EME348	Robotics and automation	PC	3	0	0		3	Common for AIML/SM/Mechanical engineering
2.	19EME302	Design of Machine Elements	PC	3	1	0		4	Branch Specific
3.	19EME3XX	Program Elective I	PE	3	0	0		3	Program Elective
4.	19EME3XX	Program Elective II	PE	3	0	0		3	Program Elective
5.	19EOE3XX	Open Elective II	OE	3	0	0		3	Open Elective
6.	19EHS302	Engineering Economics and Management	HS	3	0	0		3	Humanities
7	19EME431	Measurements and Metrology	PC	3	0	2		4	Branch Specific
8.	19EMC382	Engineering Ethics	MC	3	0	0		0	Mandatory Course
9.	19EME392	Comprehensive Skill Development V	PW	0	0	0	6	1	
Total								24	

Semester-VII

S.No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1	19EME439	Additive manufacturing	PC	3	0	0		3	
2	19EXXXXX	Inter-Disciplinary Elective -I	ID	3	0	0		3	IDE-1
3	19EXXXXX	Program Elective -III	PE	3	0	0		3	Program Elective -III
4	19EXXXXX	Program Elective -IV	PE	3	0	0		3	Program Elective -IV
5	19EHS405	Operations Research	HS	3	0	0		3	Humanities
6	19EME491	Project Phase I	PW	0	0	6		1	
7	19EME493	Internship	PW					1	
8	19EME495	Comprehensive Skill Development VI	PW	0	0	0	6	1	
		total						18	

***** Industrial Training / Research Projects in National Laboratories / Academic Institutions

Semester VIII

S.No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1	19EXX4XX	Inter-Disciplinary Elective II	ID	2	1	0		3	Interdisciplinary Elective
2	19EME4XX	Program Elective V	PE	3	0	0		3	Program Elective
3	19EME492	Project Phase II	PW	0	0	12		6	
4	GSS115	Gandhi for the 21st century	PW				6	1	Online Course
Total								13	

Department of Mechanical Engineering

B.Tech. Mechanical Engineering with Specialization in AI and ML

(Effective from the academic year 2020-21 admitted batch)

Semester V

S. No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1.	19EME331	Manufacturing Technology	PC	3	0	3		4.5	Branch Specific
2.	19EME301	Mechanics of Machinery	PC	3	1	0		4	Branch Specific
3.	19EID232 /19EID234	Internet of Things/ Life Sciences for Engineers	ES/BS	2	0	2		3	Common to all
4.	19ECS344	Introduction to Machine Learning	PC	2	1	0		3	Common to all except CSE
5.	19EOE3XX/ GEL244/ 19EOE224	Open Elective I	OE	3	0	0		3	Open Elective
6.	19EME332	Heat and Mass Transfer	PC	3	1	3		5.5	Branch Specific
7.	19EME391	Comprehensive Skill Development IV	PW	0	0	0	6	1	
8	HSMCH102	Universal Human Values2: Understanding Harmony	HS	2	1	0		3	
Total								**27**	

Semester VI

S. No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1.	19EME348	Robotics and automation	PC	3	0	0		3	Branch Specific
2.	19EME302	Design of Machine Elements	PC	3	1	0		4	Branch Specific
3.	19EME3XX	Program Elective I	PE	3	0	0		3	Program Elective
4.	19EME3XX	Program Elective II	PE	3	0	0		3	Program Elective
5.	19EOE3XX	Open Elective II	OE	3	0	0		3	Open Elective
6.	19EHS302	Engineering Economics and Management	HS	3	0	0		3	Humanities
7	19EME431	Measurements and Metrology	PC	3	0	2		4	Branch Specific
8.	19EMC382	Engineering Ethics	MC	3	0	0		0	Mandatory Course
9.	19EME392	Comprehensive Skill Development V	PW	0	0	0	6	1	
Total								24	

Department of Mechanical Engineering
B.Tech. Mechanical Engineering with Specialization in AI and ML
(Effective from the academic year 2020-21 admitted batch)
Semester-VII

S.No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1	19EME439	Additive manufacturing	PC	3	0	0		3	
2	19EXXXXX	Inter Disciplinary Elective -I	ID	3	0	0		3	IDE-1
3	19EXXXXX	Program Elective -III	PE	3	0	0		3	Program Elective -III
4	19EXXXXX	Program Elective -IV	PE	3	0	0		3	Program Elective -IV
5	19EHS405	Operations Research	HS	3	0	0		3	Humanities
6	19EME491	Project Phase I	PW	0	0	6		1	
7	19EME493	Internship	PW					1	
8	19EME495	Comprehensive Skill Development VI	PW	0	0	0	6	1	
		Total						18	

***** Industrial Training / Research Projects in National Laboratories / Academic Institutions

Semester VIII

S.No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1	19EXX4XX	Inter-Disciplinary Elective II	ID	2	1	0		3	Interdisciplinary Elective
2	19EME4XX	Program Elective V	PE	3	0	0		3	Program Elective
3	19EME492	Project Phase II	PW	0	0	12		6	
4	GSS115	Gandhi for the 21st century	PW				6	1	Online Course
Total								13	

Department of Mechanical Engineering
B.Tech. Mechanical Engineering with Electrical and Hybrid Vehicles
(Effective from the academic year 2020-21 admitted batch)

Semester V

S.No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1.	19EME331	Manufacturing Technology	PC	3	0	3		4.5	Branch Specific
2.	19EME301	Mechanics of Machinery	PC	3	1	0		4	Branch Specific
3.	19EID232 /19EID234	Internet of Things/ Life Sciences for Engineers	ES/BS	2	0	2		3	Common to all
4.	19EME373	Fundamentals of Electric and Hybrid vehicles Technology	PC	3	0	0		3	
5.	19EOE3XX/ GEL244/ 19EOE224	Open Elective I	OE	3	0	0		3	Open Elective
6.	19EME332	Heat and Mass Transfer	PC	3	1	3		5.5	Branch Specific
7.	19EME391	Comprehensive Skill Development IV	PW	0	0	0	6	1	
8	HSMCH102	Universal Human Values 2: Understanding Harmony	HS	2	1	0		3	
Total								**27**	

Semester VI

S. No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1.	19EME304	Vehicle Electrical Power systems	PC	3	0	0		3	Branch Specific
2.	19EME302	Design of Machine Elements	PC	3	1	0		4	Branch Specific
3.	19EME3XX	Program Elective I	PE	3	0	0		3	Program Elective
4.	19EME3XX	Program Elective II	PE	3	0	0		3	Program Elective
5.	19EOE3XX/ 19MOEXX/ 19LOEXX/ GEL3XX	Open Elective II	OE	3	0	0		3	Open Elective
6.	19EHS302	Engineering Economics and Management	HS	3	0	0		3	Humanities
7	19EME431	Measurements and Metrology	PC	3	0	2		4	
8	19EMC382	Engineering Ethics	MC	3	0	0		0	Mandatory Course
9.	19EME392	Comprehensive Skill Development V	PW	0	0	0	6	1	
Total								24	

Semester VII

S.No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1	19EME439	Additive manufacturing	PC	3	0	0		3	
2	19EXXXXX	Inter Disciplinary Elective -I	ID	3	0	0		3	IDE-1
3	19EXXXXX	Program Elective -III	PE	3	0	0		3	Program Elective -III
4	19EXXXXX	Program Elective -IV	PE	3	0	0		3	Program Elective -IV
5	19EHS405	Operations Research	HS	3	0	0		3	Humanities
6	19EME491	Project Phase I	PW	0	0	6		1	
7	19EME493	Internship	PW					1	
8	19EME495	Comprehensive Skill Development VI	PW	0	0	0	6	1	
		Total						18	

***** Industrial Training / Research Projects in National Laboratories / Academic Institutions

Semester VIII

S.No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1	19EXX4XX	Inter-Disciplinary Elective II	ID	2	1	0		3	Interdisciplinary Elective
2	19EME4XX	Program Elective V	PE	3	0	0		3	Program Elective
3	19EME492	Project Phase II	PW	0	0	12		6	
4	GSS115	Gandhi for the 21st century	PW				6	1	Online Course
Total								13	

Department of Mechanical Engineering
B.Tech. Mechanical Engineering with Smart Manufacturing
(Effective from the academic year 2020-21 admitted batch)

Semester V

S.No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1.	19EME331	Manufacturing Technology	PC	3	0	3		4.5	Branch Specific
2.	19EME301	Mechanics of Machinery	PC	3	1	0		4	Branch Specific
3.	19EID232 /19EID234	Internet of Things/ Life Sciences for Engineers	ES	2	0	2		3	Common to all
4.	19EME335	Smart manufacturing systems	PC	3	0	0		3	
5.	19EOE3XX/ GEL244/ 19EOE224	Open Elective I	OE	3	0	0		3	Open Elective
6.	19EME332	Heat and Mass Transfer	PC	3	1	3		5.5	Branch Specific
7.	19EME391	Comprehensive Skill Development IV	PW	0	0	0	6	1	
8	HSMCH102	Universal Human Values 2: Understanding Harmony	HS	2	1	0		3	
			Total					**27**	

Semester VI

S. No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1.	19EME348	Robotics and Automation	PC	3	0	0		3	Branch Specific
2.	19EME302	Design of Machine Elements	PC	3	1	0		4	Branch Specific
3.	19EME3XX	Program Elective I	PE	3	0	0		3	Program Elective
4.	19EME3XX	Program Elective II	PE	3	0	0		3	Program Elective
5.	19EOE3XX/ 19MOEXX/ 19LOEXX/ GEL3XX	Open Elective II	OE	3	0	0		3	Open Elective
6.	19EHS302	Engineering Economics and Management	HS	3	0	0		3	Humanities
7	19EME431	Measurements and Metrology	PC	3	0	2		4	Branch Specific
8.	19EMC382	Engineering Ethics	MC	3	0	0		0	Mandatory Course
9.	19EME392	Comprehensive Skill Development V	PW	0	0	0	6	1	
			Total					24	

Semester-VII

S. No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1	19EME439	Additive manufacturing	PC	3	0	0		3	
2	19EXXXXX	Inter Disciplinary Elective -I	ID	3	0	0		3	IDE-1
3	19EXXXXX	Program Elective -III	PE	3	0	0		3	Program Elective -III
4	19EXXXXX	Program Elective -IV	PE	3	0	0		3	Program Elective -IV
5	19EHS405	Operations Research	HS	3	0	0		3	Humanities
6	19EME491	Project Phase I	PW	0	0	6		1	
7	19EME493	Internship	PW					1	
8	19EME495	Comprehensive Skill Development VI	PW	0	0	0	6	1	
		total						18	

***** Industrial Training / Research Projects in National Laboratories / Academic Institutions

Semester VIII

S.No	Course Code	Course Name	Category	L	T	P	A	C	Remarks
1	19EXX4XX	Inter-Disciplinary Elective II	ID	2	1	0		3	Interdisciplinary Elective
2	19EME4XX	Program Elective V	PE	3	0	0		3	Program Elective
3	19EME492	Project Phase II	PW	0	0	12		6	
4	GSS115	Gandhi for the 21st century	PW				6	1	Online Course
		Total						13	

Total Number of Credits for award of B. Tech degree

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Credits	**17.5/18.5**	**23/22**	**18.5**	**24**	**27**	**24**	**18**	**13**	**165**

Category and Credits

Category	Category Code	Courses	Credits GITAM	Credits proposed by AICTE
Humanities & Social Sciences	HS	Communicative English	**14**	**12**
		HS1 and HS2 (elective)		
		Comprehensive Skill Development I &II		
		Universal Human Values 2: Understanding Harmony		
Basic Sciences	BS	Engineering Physics	**24**	**25**
		Engineering Chemistry		
		Mathematics (4 Courses)		
		Life Sciences for Engineers		
Engineering Sciences	ES	Problem Solving and Programming	**24**	**24**
		Basic Electrical and Electronics Engineering		
		AI Tools		
		Engineering Graphics		
		Workshop		
		Design Thinking		
		Internet of Things		
Open Electives	OE	OE1, OE2	**6**	**18**
Interdisciplinary Electives	ID	ID1, ID2	**6**	
Program Electives	PE	PE1, PE2, PE3, PE4, PE5	**15**	**18**
Program Core	PC	PC1 – PC18	**61**	**48**
Project	PW	Internship	**15**	**15**
		Project Phase I		
		Project Phase II		
		GANDHI for 21st century (GITAM Online)		
		Comprehensive Skill Development III to VI		
		Venture Discovery		
Mandatory	MC	Environmental Science, Constitution of India, Engineering Ethics,	**-**	**-**
Total			**162**	**160**

1st and 2nd Semester Mandatory Course

S. No	Course Code	Course Title	Category	L	T	P	C	Remarks
1.	19EMC181A	National Service Scheme	MC	0	0	2	0	Mandatory Course
2.	19EMC181B	National Cadet Corps	MC	0	0	2	0	Mandatory Course
3.	19EMC181C	National Sports Organization	MC	0	0	2	0	Mandatory Course
4.	19EMC181D	Yoga	MC	0	0	2	0	Mandatory Course

Engineering Mathematics II (Elective)

S.No	Course Code	Course Name	Category	L	T	P	C	Remarks
1.	19EMA102	Engineering Mathematics-II	BS	3	0	0	3	
2.	19EMA104	Engineering Mathematics-II	BS	3	0	0	3	
3.	19EMA106	Mathematics for Biotechnology –II	BS	3	0	0	3	

Engineering Mathematics III (Elective)

S.No	Course Code	Course Name	Category	L	T	P	C	Remarks
1.	19EMA201	Engineering Mathematics-III	BS	3	0	0	3	
2.	19EMA203	Engineering Mathematics-III	BS	3	0	0	3	
3.	19EMA205	Engineering Mathematics-III	BS	3	0	0	3	
4.	19EMA207	Mathematics for Biotechnology –III	BS	3	0	0	3	

Engineering Mathematics IV (Elective)

S.No	Course Code	Course Name	Category	L	T	P	C	Remarks
1.	19EMA202	Engineering Mathematics-IV	BS	3	0	0	3	
2.	19EMA204	Engineering Mathematics-IV	BS	3	0	0	3	
3.	19EMA206	Engineering Mathematics-IV	BS	3	0	0	3	
4.	19EMA208	Mathematics for Biotechnology –IV	BS	3	0	0	3	

Engineering Physics (Elective)

S.No	Course Code	Course Name	Category	L	T	P	C	Remarks
1.	19EPH131	Engineering Physics	BS	3	0	3	4.5	
2.	19EPH 133	Applied Physics	BS	3	0	3	4.5	
3.	19EPH 135	Physics for Biotechnology	BS	3	0	3	4.5	

Engineering Chemistry (Elective)

S.No	Course Code	Course Name	Category	L	T	P	C	Remarks
1.	19ECY131	Engineering Chemistry	BS	3	0	3	4.5	
2.	19ECY133	Chemistry of materials	BS	3	0	3	4.5	
3.	19ECY135	Chemistry for Biotechnology	BS	3	0	3	4.5	

Open Elective I

S. No.	Course Code	Course Name	Category	L	T	P	C	Remarks
1	19EOE301	Japanese for Beginners	OE	3	0	0	3	All Branches
2	19EOE303	French for Beginners	OE	3	0	0	3	All Branches
3	19EOE305	Biotechnology and Society	OE	3	0	0	3	All Branches
4	19EOE307	Contemporary Relevance of	OE	3	0	0	3	All Branches
5	19EOE309	Indian National Movement	OE	3	0	0	3	All Branches
6	19EOE313	Personality Development	OE	3	0	0	3	All Branches
7	19LOE301	Fundamentals of Cyber Law	OE	3	0	0	3	All Branches
8	19MOE303	Introduction to International Business	OE	3	0	0	3	All Branches
9	19EOE319	Introduction to Music	OE	3	0	0	3	All Branches
10	19EOE321	Environment and Ecology	OE	3	0	0	3	All Branches
11	19EOE323	Indian History	OE	3	0	0	3	All Branches
12	19EOE327	Professional Communication	OE	3	0	0	3	All Branches
13	GEL244	English for Higher	OE	3	0	0	3	All Branches
14	19EOE224	Virtual Reality	OE	1	0	4	3	All Branches

Open Elective II

S. No.	Course Code	Course Name	Category	L	T	P	C	Remarks
1	19EOE302	German for Beginners	OE	3	0	0	3	All Branches
2	19EOE304	Chinese for Beginners	OE	3	0	0	3	All Branches
3	19EOE306	Analytical Essay Writing	OE	3	0	0	3	All Branches
4	19EOE308	Indian Economy	OE	3	0	0	3	All Branches
5	19EOE310	Public Administration	OE	3	0	0	3	All Branches
6	19EOE312	Environmental Management	OE	3	0	0	3	All Branches
7	19EOE315	Telecommunication for Society	OE	3	0	0	3	All Branches
9	19EOE327	Professional Communication	OE	3	0	0	3	All Branches
10	19EOE317	Electrical Safety	OE	3	0	0	3	All Branches
11	19MOE301	Basics of Finance	OE	3	0	0	3	All Branches
12	19LOE301	Fundamentals of Cyber Law	OE	3	0	0	3	All Branches
13	19EOE313	Personality Development	OE	3	0	0	3	All Branches
14	19MOE305	Basics of Marketing	OE	3	0	0	3	All Branches
15	GEL345	Workplace Communication-Basic	OE	3	0	0	3	All Branches
16	GEL347	Workplace Communication-Advanced	OE	3	0	0	3	All Branches

Coursera open electives

S.No.	Course Code	Course Title
1	19COE301	Become a journalist: Report the News! / Introduction to Journalism
2	19COE302	Intellectual Property Law
3	19COE303	Interviewing and Resume Writing in English
4	19COE304	Human Resource Management: HR for People Managers
5	19COE305	Inspirational Leadership: Leading with Sense
6	19COE306	Facebook Social Media Marketing
7	19COE307	Trading Strategies in Emerging Markets
8	19COE308	Economics of Money and Banking
9	19COE309	Good with Words: Writing and Editing/ The Elements of Writing Skills

PROGRAM ELECTIVES

Program Elective I

S. No	Stream	Course Code	Course Name	Category	L	T	P	C
1	Thermal/Renewable Energy	19EME341	Turbo machinery	PE	3	0	0	3
		19EME343	Power Plant Engineering	PE	3	0	0	3
2	Automobile Engineering	19EME345	Vehicle technology	PE	3	0	0	3
3	Design/Product Design	19EME353	Advanced Strength of Materials	PE	3	0	0	3
		19EME355	Product Design	PE	3	0	0	3
4	Industrial Engineering	19EME363	Industrial Engineering and Management	PE	3	0	0	3
5	Smart Manufacturing	19EME346	CAD/CAM	PE	3	0	0	3
6	AI/ML	19EME346	CAD/CAM	PE	3	0	0	3

Program Elective II

S. NO	Stream	Course Code	Course Name	Category	L	T	P	C
1	Thermal/ Renewable Energy	19EME340	Heating Ventilation and Air Conditioning	PE	3	0	0	3
		19EME342	Renewable Energy Technology	PE	3	0	0	3
2	Materials	19EME350	Material Characterization	PE	3	0	0	3
3	Design	19EME352	Finite Element Analysis	PE	3	0	0	3
4	Industrial Engineering	19EME356	Enterprise Resource Planning	PE	3	0	0	3
		19EME358	Statistical Quality Control	PE	3	0	0	3
5	Smart Manufacturing	19EME369	Automation in manufacturing	PE	3	0	0	3
6	AI/ML	19EME369	Automation in manufacturing	PE	3	0	0	3
7	Electric and Hybrid Vehicles	19EME375	Fuel Cell technology and Hydrogen Storage system	PE	3	0	0	3

Program Elective III

S. No	Course Code	Course Name	Category	L	T	P	C
1	19EME362	Solar Energy	PE	3	0	0	3
2	19EME364	Automotive transmission systems	PE	3	0	0	3
3	19EME368	Manufacturing of Automobile Components	PE	3	0	0	3
4	19EME370	Non-Destructive Testing	PE	3	0	0	3
5	19EME376	Inventory control	PE	3	0	0	3
6	19EME378	Plant Layout and Facilities Planning	PE	3	0	0	3
7	19EME447	Computer Integrated Manufacturing	PE	3	0	0	3
8	19EME474	Autonomous vehicles	PE	3	0	0	3

Program Elective IV

S. No	**Course Code**	**Course Name**	**Category**	**L**	**T**	**P**	**C**
1	19EME441	Computational Fluid Dynamics	PE	3	0	0	3
2	19EME443	Wind Energy	PE	3	0	0	3
3	19EME451	Mechanics of Composite Materials	PE	3	0	0	3
4	19EME455	Advanced mechanics of solids	PE	3	0	0	3
5	19EME457	Production Planning and Control	PE	3	0	0	3
6	19EME459	Logistics and Supply Chain Management	PE	3	0	0	3

Program Elective V

S. No	Course Code	Course Name	Category	L	T	P	C
1	19EME461	Energy Conservation and Management	PE	3	0	0	3
	19EME463	Bioenergy	PE	3	0	0	3
2	19EME469	Mobile Robotics	PE	3	0	0	3
4	19EME475	Product Life Cycle Management	PE	3	0	0	3
5	19EME479	Management Information Systems	PE	3	0	0	3
6	19EME456	Optimization techniques	PE	3	0	0	3
7	19EME446	Modern manufacturing Methods	PE	3	0	0	3

INTERDISCIPLINARY ELECTIVES

Interdisciplinary Elective I

S. No.	Course Code	Course Title	Category	L	T	P	C	Remarks Offered by
1	19EEC477	Machine to Machine Communication	ID	3	0	0	3	EECE
2	19EEE477	Electric Vehicle Technology	ID	3	0	0	3	EECE
3	19EHS475	Entrepreneurship Development	ID	3	0	0	3	MANAGEMENT

Interdisciplinary Elective-II

S. No.	Course Code	Course Title	Category	L	T	P	C	Remarks Offered by
1	19EEI472	Micro Electromechanical Systems	ID	3	0	0	3	EECE
2	19ECS472	Introduction to cloud computing	ID	3	0	0	3	CSE
3	19EME435	Electric and Hybrid Vehicle Design	ID	3	0	0	3	EECE
4	19EHS403	Organizational Behaviour	ID	3	0	0	3	Management

19EMA101: ENGINEERING MATHEMATICS I

CALCULUS & ALGEBRA

(Common to all branches of Engineering except Biotechnology)

L	T	P	C
3	0	0	3

This course is designed for the students of all B. Tech programmes except for Biotechnology as a prerequisite for the core programmes. The course imparts knowledge on Matrix Algebra and basic concepts of Calculus as these concepts lay a strong foundation in applications in Engineering.

Course Objectives:

- To familiarize the students with the theory of matrices and quadratic forms.
- To explain the series expansions using mean value theorems.
- To teach basic concepts of partial derivatives.
- To explain the evaluation of double integrals and its applications.
- To demonstrate the evaluation and applications of triple integrals.

Bridge Course: Limits, Continuity, Types of Matrices

UNIT I: **10 hrs**

Matrices: Rank of a matrix by echelon form, solving system of homogeneous and non-homogeneous linear equations. Eigen values, Eigen vectors and their properties, Cayley-Hamilton theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton theorem, diagonalisation of a matrix, quadratic forms and nature of the quadratic forms, reduction of quadratic form to canonical forms by orthogonal transformation.

Learning Outcomes:

At the end of this unit, the student will be able to

- solve systems of homogeneous and non-homogeneous linear equations (L3)
- calculate the eigenvalues and eigenvectors of a matrix (L3)
- identify special properties of a matrix (L3)

UNIT II: **6 hrs**

Mean Value Theorems: Rolle's Theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's and Maclaurin's theorems with remainders (without proof).

Learning Outcomes:

At the end of this unit, the student will be able to

- demonstrate the given function as series of Taylor's and Maclaurin's with remainders (L3)
- illustrate series expansions of functions using mean value theorems (L3)

UNIT III: **8 hrs**

Multivariable Calculus: Partial derivatives, total derivatives, chain rule, change of variables, Jacobian, maxima and minima of functions of two variables, method of Lagrange multipliers.

Learning Outcomes:

At the end of this unit, the student will be able to

- interpret partial derivatives as a function of several variables (L3)
- evaluate maxima and minima of functions (L3)
- apply Jacobian concept to deal with the problems in change of variables (L3)

UNIT IV: **8hrs**

Multiple Integrals-I: Double integrals, change of order of integration, double integration in polar coordinates, areas enclosed by plane curves.

Learning Outcomes:

At the end of this unit, the student will be able to

- apply double integrals of functions of several variables in two dimensions in cartesian and polar coordinates (L4)
- calculate the areas bounded by a region using double integration techniques (L3)

UNIT V: **8 hrs**

Multiple Integrals-II: Evaluation of triple integrals, change of variables between Cartesian, cylindrical and spherical polar co-ordinates, volume as triple integral.

Learning Outcomes:

At the end of this unit, the student will be able to

- apply multiple integrals in Cartesian, cylindrical and spherical geometries (L4)
- evaluate volumes using triple integrals (L4)

Course Outcomes:

At the end of the course, the student will be able to

- utilize the techniques of matrix algebra that is needed by engineers for practical applications (L3)
- apply mean value theorems to engineering problems (L3)
- utilize functions of several variables in optimization (L3)
- employ the tools of calculus for calculating the areas (L3)
- calculate volumes using multiple integrals (L3)

Textbooks:

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 Hass, Thomas Calculus, 13/e, Pearson Publishers, 2013.
3. Glyn James, Advanced Modern Engineering Mathematics, 4/e, Pearson publishers, 2011.

GEL131: COMMUNICATIVE ENGLISH

B TECH, BBA & BSC SEMESTER I (2019-20)

L	T	P	C
2	0	2	3

The course is a unified approach to enhance language skills of learners with an aim to hone their social skills and to increase their employability. The course is designed to acquaint the learners with the necessary LSRW (Listening/ Speaking / Reading/ Writing) skills needed either for recruitment or further studies abroad for which they attempt international exams like TOEFL, IELTS and GRE. It enables the learners to improve their communication skills which are crucial in an academic environment as well as professional and personal lives.

Course Objectives

- To enable learners to develop listening skills for better comprehension of academic presentations, lectures and speeches.
- To hone the speaking skills of learners by engaging them in various activities such as just a minute (JAM), group discussions, oral presentations, and role plays.
- To expose learners to key Reading techniques such as Skimming and Scanning for comprehension of different texts.
- To acquaint the learners with effective strategies of paragraph and essay writing, and formal correspondence such as email, letters and resume.
- To provide learners with the critical impetus necessary to forge a path in an academic environment, in professional life and in an increasingly complex, interdependent world.

UNIT I

LISTENING: Listening for gist and specific information

SPEAKING: Introducing self and others; Developing fluency through JAM

READING: Skimming for gist and scanning for specific information

WRITING: Paragraph writing-writing coherent and cohesive paragraph (narrative and descriptive); use of appropriate Punctuation.

GRAMMAR & VOCABULARY: Articles & Prepositions; Word Families (Verbs, Nouns, Adjectives, Adverbs; Prefixes and Suffixes)

Learning Outcomes:

After completion of this unit, the learners will be able to

- Apply the requisite listening skills and comprehend at local and global level. (L4 and L2) (L5)
- Introduce themselves with accurate structure in diverse social and professional contexts. (L3)
- Apply relevant reading strategies for comprehension of any given text(L3)

- Write a paragraph using cohesive devices maintaining coherence (L3)
- Understand the Use of Articles and Prepositions, and apply appropriately for meaningful communication (L3)
- Understand the relevance of various categories in word family and apply them meaningfully in context (L3)

UNIT II

LISTENING: Listening for Note taking and Summarizing

SPEAKING: Role plays and Oral Presentations.

READING: Intensive Reading-Reading for implicit meaning

WRITING: Note making and summarizing

GRAMMAR & VOCABULARY: Verb Forms-Tenses; synonyms to avoid repetition in speech and writing.

Learning Outcomes:

After completion of this unit, the learners will be able to

- Employ note taking and summarizing strategies to comprehend the listening text (L2)
- Use strategies for successful and relevant oral presentation (L3, L4)
- Demonstrate effective communication skills by applying turn-taking and role distribution techniques for meaningful and contextual Speaking (L3 and L4)
- Apply various reading strategies imbibing inferential and extrapolative comprehension of any given text. (L2, L3)
- Apply various note-making techniques while comprehending the reading text to present a complete and concise set of structured notes (, L3, L4, L5)
- Apply the notes to draft a summary (L3)
- Use correct tense forms and appropriate structures in speech and written communication (L3)
- Context specific use of Prefixes and Suffixes for meaningful communication (L3)

UNIT III

LISTENING: Listening for presentation strategies: introducing the topic, organization of ideas, conclusion.

SPEAKING: Aided presentations

READING: Inferring using textual clues

WRITING: Formal Letter and Email writing

GRAMMAR & VOCABULARY: Active and Passive Voice; linkers and discourse markers.

Learning Outcomes:

After completion of this unit, the learners will be able to

- Notice and understand effective listening strategies to identify discourse markers in presentations. (L1, L2)
- Make formal oral presentations using effective strategies such as audio – visual aids (L3)
- Infer meaning and inter – relatedness of ideas (L4)
- Understand relevant structures and draft formal letters in suitable format (L3, L4)
- Construct relevant sentences in active and passive voice for meaningful communication (L2, L3)
- Comprehend and apply available vocabulary items relevant to the context (L1, L2, L3)

UNIT IV

LISTENING: Listening for labeling-maps, graphs, tables, illustrations

SPEAKING: Aided group presentation using charts, graphs etc.

READING: Reading for identification of facts and opinions

WRITING: Information transfer (writing a brief report based on information from graph/chart/table)

GRAMMAR & VOCABULARY: Subject-verb agreement; language for comparison and contrast; Antonyms

Learning Outcomes:

After completion of this unit, the learners will be able to

- Match visual and auditory inputs and use the information comprehensively and will adequately demonstrate important relationships or patterns between data points (L2)
- choose and coordinate resources appropriate to context and speak intelligibly (L3, L4)
- Develop advanced reading skills for analytical and extrapolative comprehension (L4, L5)
- Make decisions on arrangement of ideas and transfer them from visual to verbal form using context appropriate structure. (L3, L4)
- Demonstrate ability to use task specific grammatically correct structures (L3)
  Comprehend and use expressions for negation/contradiction ((L2, L3)

UNIT V

LISTENING: Listening to discussions for opinions

SPEAKING: Group Discussion

READING: Reading for inferences

<u>WRITING: Coursera Course-Essay Writing-Getting Started with Essay Writing (UCI Division of Continuing Education) 24 hours</u>

GRAMMAR & VOCABULARY: Editing short texts: correcting common errors in grammar and usage; Action verbs for fluency and effective writing.

Learning Outcomes:

After completion of this unit, the learners will be able to

- Apply analytical and problem-solving strategies to identify and interpret facts and opinions from a dialogue. (L3)
- Able to administer group dynamics to contribute valid ideas to a discussion with clarity and precision (L3)
- Demonstrate techniques to analyze contextual clues(L4)
- Compare and correlate ideas and facts to produce an organized essay with adequate supporting evidence (L4, L5)
- Organize the available structural/grammatical knowledge and apply them in a real time context (L3)
- Comprehend meaning for new words/phrases used and apply them in a new context. (L2, L3)

Course Outcomes

By the end of the course, the learners will be able to:

- Think critically, analytically, creatively and communicate confidently in English in social and professional contexts with improved skills of fluency and accuracy.
- Write grammatically correct sentences employing appropriate vocabulary suitable to different contexts.
- Comprehend and analyze different academic texts.
- Make notes effectively and handle academic writing tasks such as Paragraph writing and Essay writing.
- Effectively handle formal correspondence like e-mail drafting and letter writing.

Reference Books:

1.Arosteguy, K.O. and Bright, A. and Rinard, B.J. and Poe, M. ***A Student's Guide to Academic and Professional Writing in Education***, UK, Teachers College Press,2019

2.Raymond Murphy, ***English Grammar in Use A Self-Study Reference and Practice Book for Intermediate Learners of English***: Cambridge University Press;2019

3.Peter Watkins, ***Teaching and Developing Reading Skills***: UK, CUP, 2018

4.DeepthaAchar et al. ***Basic of Academic Writing***. (1and 2) parts New Delhi: Orient Black Swan. (2012& 2013).

5.Kumar S and Lata P, ***Communication Skills***: New Delhi Oxford University Press, 2015

19EPH133: APPLIED PHYSICS

(Civil and Mechanical Branches)

L	T	P	C
3	0	3	4.5

This course is designed for students of 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 Objectives

- **To acquaint** the basic concepts of sound waves and principles in acoustic design
- **To introduce** the concepts of elasticity, strain hardening and failure in materials
- **To impart** the relation between stress and strain.
- **To impart** the phenomenon of heat transfer to understand a wide variety of practical engineering problems.
- **To demonstrate** the use of Newton's laws of motion for understanding the mechanics of a particle
- **To explain** the working principle and construction of different types of *sensors*

UNIT I: **((10 hrs)**

Mechanics: Basic laws of vectors and scalars; Rotational frames; Conservative and non-conservative forces; F = - *grad* V; Central forces; Elliptical, parabolic, and hyperbolic orbits; Non inertial frames of reference; Centripetal acceleration; Harmonic oscillator; Damped harmonic motion; Forced oscillations and resonance. Degrees of freedom.

Learning outcomes

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

- **Explain** forces and moments in mechanical systems using scalar and vector techniques (L2)
- **interpret** the equation of motion of a rigid rotating body (torque on a rigid body) (L3)
- **apply** the Newton's second law for inertial and non-inertial frame of reference (L3)
- **summarize** harmonic motion in undamped, damped, and forced oscillations (L2)

UNIT-II: **(8 hrs)**

Elasticity: Concepts of elasticity and plasticity, stress and strain, Hooke's law, different moduli of elasticity, Poisson's ratio, strain energy, stress-strain diagram, elastic behaviour of a material, factors affecting elasticity, relation between different moduli of elasticity, determination of elastic moduli.

Learning Outcomes:

After completion of this unit the student will be able to

- **explain** the basic concepts of elasticity, plasticity, strain hardening and failure in materials(L2).
- **determine** graphically a material's mechanical properties in terms of its one-dimensional stress-strain curve (L2).
- **Derive** the generalized Hooke's law by recognizing the basic stress-strain response of isotropic materials (L3).
- **Define** several elastic constants and **determine** the relationship between them (L1).
- **evaluate s**train energy under different loadings (L3).

UNIT-III:

(10 hrs)

Thermal Property (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.

Learning Outcomes:

After completion of this unit the student will be able to

- **explain** the process of thermal expansion in solids and liquids (L3).
- **Distinguish** fundamental laws related to conduction, convection and radiation of *heat (L1).*
- **determine** the thermal conductivity of a material by *Forbes and Lee's disc method (L4).*
- **summarize** the working of heat exchangers, refrigerators, ovens and solar water heaters (L2).

UNIT-IV:

(8 hrs)

Acoustics: 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.

Learning Outcomes

After completion of this unit the student will be able to

- **explain** the basic concepts in acoustics and **describe** Weber-Fechner Law (L2)
- **determine** absorption coefficient and reverberation time (L3)
- **derive** Sabine’s formula using growth and decay method (L4)
- **solve** problems involving the intensity of a sound wave (L4).
- **summarize** the principles of acoustics in designing an acoustically good auditorium (L3).

UNIT – V:

(8 hrs)

Sensors: Sensors (qualitative descr (on only); Different types of sensors and applications; Strain and pressure sensors- Piezoelectric, magneto strictive sensors; Fibre optic methods of pressure sensing; Temperature sensor - bimetallic strip, pyroelectric detectors; Hall-effect sensor; Smoke and fire detectors.

Learning Outcomes:

After completion of this unit the student will be able to

- **describe** the principle of strain and pressure sensors (L1)
- **explain** the principle and working of magneto strictive and piezoelectric sensors (L3)
- **illustrate** the fibre optic methods of pressure sensing (L3)
- **infer** the functioning of temperature sensors like bimetallic strip and pyroelectric detectors (L2)
- **outline** the principle and working of Hall-effect sensor, smoke and fire detectors (L2)

Course Outcomes:

After completion of this course the student will be able to

- **describe** the fundamental principles of acoustics with emphasis on physical mechanisms, law and relationships (L1).
- **Apply** the concepts of strain, internal force, stress and equilibrium to deformation of solids (L3).
- **explain** the fundamental theory for the analysis of heat transfer processes in solids and liquids and to apply basic principles of heat transfer in design of refrigerators and heaters (L4).
- **Estimate** forces and moments in mechanical systems using scalar and vector techniques (L4).
- **Outline** the basic principle and operation of different types of *sensors (L2)***.**

Textbooks:

1. D.Kleppner and Robert Kolenkow“An Introduction to Mechanics– II” Cambridge University Press,2015

2. A Textbook of Engineering Physics, Volume-I By M.N. Avadhanulu & T.V.S. Arun Murthy S Chand
3. Ian R Sinclair, Sensor and Transducers 3/e, 2001, Elsevier (Newnes)

Reference Books:

1. M K Varma "Introduction to Mechanics"-Universities Press,2015
2. Prithwiraj Purkait, Budhaditya Biswas and ChiranjibKoley, Chapter 11 *Sensors and Transducers*, *Electrical* and Electronics Measurements and Instrumentation, 1/e., 2013 McGraw Hill Education (India) Private Limited, 2013.

APPLIED PHYSICS LABORATORY

(Civil and Mechanical Branches)

Learning Outcomes

After completion of this lab the student will be able to

- **determine**
  a. rigidity modulus and Poisson's ratio of a material (L5)
  b. thermal conductivity of bad and good conductors (L5)
- **apply** resonance to
  a. **estimate** the frequency of a tuning fork (L3, L5)**.**
  b. **Examine** the relation between frequency and volume of a cavity (L3, L4).
  c. an LCR circuit (L3).
- **demonstrate** elastic limit and stress-strain relationship using Hooke's law (L2)
- **evaluate** the acceptance angle and **determine** numerical aperture and bending loss of an optical fiber (L5).
- **identify** the type of semiconductor i.e., n-type or p-type using Hall effect (L3)
- **relate** damping and quality factor for simple pendulum (L4)
- **determine** resonant frequency of tuning fork using a sonometer (L5)
- **understand** damping using oscillating disc in different media (L2).

List of experiments

1. To determine rigidity modulus of material of a wire-dynamic method (torsional pendulum)
2. To determine the thermal conductivity of a bad conductor by Lee's disc method
3. To determine the numerical aperture of a given optical fiber and hence to find its acceptance angle.
4. To determine the Hall coefficient using Hall effect experiment
5. To investigate Hooke's Law
6. To determine Poisson's Ratio of Rubber experiment
7. To determine thermal conductivity of good conductors (Forbe's Apparatus)
8. To determine the frequency of electrically maintained tuning fork by Melde's method.
9. To verify the relation between the volume of the air in the resonator and the frequency of the note.
10. To determine coefficient of damping and quality factor for damped simple harmonic motion of a simple pendulum.
11. To Study resonance in a LCR circuit.

12. To determine resonance frequency using a sonometer.
13. To study of damping of an oscillating disc in air and water.

References

1. S. Balasubramanian, M.N. Srinivasan “A Textbook of Practical Physics” - S Chand Publishers,2017

19ECY133: CHEMISTRY OF MATERIALS
(COMMON SYLLABUS for AERO, CIVIL and MECH)

L	T	P	C
3	0	3	4.5

The course enables the students to gain knowledge on application of basic principles of chemistry to address issues relevant to engineering. This includes various aspects of water, energy sources and applications, engineering materials and polymers, corrosion of materials, applications of nano and smart materials.

COURSE OBJECTIVES

- To acquaint the students with soft and hard water types and softening methods.
- To introduce the basic concepts to develop electrochemical cells, photovoltaic cells etc.
- To study the preparation of engineering materials, their properties and applications.
- To impart knowledge on corrosion and its significance.
- To expose to nano and smart materials

UNIT- I **8T+6 P**

WATER TECHNOLOGY

Introduction –Hard and Soft water, Estimation of hardness by EDTA Method - Boiler troubles **-** scale and sludge-priming and foaming, specifications for drinking water, Bureau of Indian Standards (BIS) and World health organization (WHO) standards, Industrial water treatment – zeolite and ion-exchange processes- desalination of brackish water, reverse osmosis (RO) and electro dialysis.

Learning outcomes:

After the completion of the Unit I, the student will be able to

- **List** the differences between temporary and permanent hardness of water. (**L-1)**
- **explain** the principles of reverse osmosis and electrodialysis. **(L-2)**
- **compare** the quality of drinking water with BIS and WHO standards. **(L-2)**
- **illustrate** problems associated with hard water. (**L-2)**
- **demonstrate** the Industrial water treatment processes. (**L-2)**

UNIT- II **9T +6 P**

ENERGY SOURCES AND APPLICATIONS

Electrode potential, determination of single electrode potential –Nernst’s equation, reference electrodes, Weston Cd Cell, hydrogen and calomel electrodes – electrochemical series and its applications – primary cell, dry or Leclanché cell – secondary cell, lead acid storage cell, nickel-cadmium cell – lithium batteries (Lithium-MnO_2) – fuel cell, hydrogen-oxygen fuel cell, Solar energy, photovoltaic cell and applications.

Learning outcomes:

After the completion of the Unit II, the student will be able to

- **define** electrode potential. (**L-1)**
- **explain** Nernst's equation. (**L-2)**
- **illustrate** difference between primary and secondary cells. (**L-2)**
- **summarize** the applications of solar energy. (**L-2)**
- **construct** different cells. (**L-3)**

UNIT-III **8T**

CORROSION ENGINEERING

Corrosion: Definition – theories of corrosion, dry corrosion and electro chemical corrosion – factors affecting corrosion, nature of the metal and nature of the environment.

Corrosion controlling methods: Sacrificial and Impressed current cathodic protection, Metallic coatings, anodic coatings, cathodic coating, galvanizing and tinning, anodic inhibitors and cathodic inhibitors –organic coatings, paints and varnishes (constituents and their functions).

Learning outcomes:

After the completion of the Unit III, the student will be able to

- **explain** theories of corrosion. (**L-2)**
- **classify** different corrosion methods. (**L-2)**
- **summarize** the various factors affecting corrosion. (**L-2)**
- **identify** different organic coatings. (**L-3)**
- **apply** the principles of corrosion control. **(L-3)**

UNIT- IV

9T+3P

ENGINEERING MATERIALS AND POLYMERS

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).

Polymers: Introduction, differences between thermoplastic and thermo setting resins, Preparation, properties and uses of polystyrene and polyphosphazines.

Learning outcomes:

After the completion of the Unit IV, the student will be able to

- **classify** the types of steel. **(L-2)**
- **illustrate** the chemical reactions involved in the manufacturing of cement. **(L-2)**
- **identify** preparation and properties of inorganic polymers. **(L-3)**
- **distinguish** between thermoplastic and thermo setting resins. **(L-4)**

UNIT- V

8T+3 P

NANO AND SMART MATERIALS

Nano Materials: Introduction to Nano materials, chemical synthesis of nanomaterials: Sol-gel method, Reverse micellar method, Characterization of nanoparticles by BET method, characterization of nanomaterials by TEM (includes basic principle of TEM), Applications of nanomaterials in wastewater treatment, lubricants and engines.

Smart Materials: Introduction – Types of smart materials-self healing materials

Shape memory alloys and Uses of smart materials.

Learning outcomes:

After the completion of the Unit V, the student will be able to

- **classify** nanomaterials. **(L-2)**
- **explain** the synthesis and characterization methods of nano materials. **(L-2)**
- **build** smart materials and types of smart materials. **(L-3)**
- **compare** the principles of BET and TEM. **(L-4)**

COURSE OUTCOMES

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

- **list** the difference between temporary and permanent hardness of water. **(L-1)**
- **illustrate** the principles and applications of solar and wind energy. **(L-2)**
- **identify** different organic coatings. **(L-3)**
- **analyze** the importance of nano and smart materials**.** **(L-4)**
- **distinguish** the principles of BET and TEM. **(L-4)**

Textbooks:

1. P.C. Jain and M. Jain, Engineering Chemistry, 15/e, Dhanapat Rai & Sons, (2014).
2. B.K. Sharma, Engineering Chemistry, Krishna Prakasham, (2014).

References:

1. Sashichawla, A Textbook of Engineering Chemistry, Dhanapath Rai and sons, (2003)
2. B.S Murthy and P. Shankar, A Textbook of Nanoscience and Nano Technology, University Press (2013).
3. S.S. Dara, A Textbook of Engineering Chemistry, S.Chand & Co, (2010)
4. V.Raghavan, A Material Science and Engineering, Prentice-Hall India Ltd, (2004).
5. N.Krishna Murthy and Anuradha, A text book of Engineering Chemistry, Murthy Publications (2014).
6. K. Sesha Maheshwaramma and MridulaChugh, Engineering Chemistry, Pearson India Edn services, (2016).

ENGINEERING CHEMISTRY LABORATORY

(COMMON SYLLABUS for AERO, CIVIL and MECH)

The course enables the students to gain knowledge on various volumetric analysis, measurements of physical parameters, instrumental methods of analysis, analysis of water, preparation of non materials chromatographic separation techniques and preparation of polymers.

COURSE OBJECTIVES

- To introduce the skills of basic Concepts in Engineering Chemistry.
- To rain the handling of different instruments.
- To familiarize the digital and instrumental methods of analysis.
- To enable the practical expertise of the theoretical aspects.

LIST OF EXPERIMENTS

1. Determination of sulphuric acid in lead-acid storage cell.
2. Estimation of iron as ferrous iron in an ore sample.
3. Estimation of calcium in Portland cement.
4. Determination of chromium (VI) in potassium dichromate
5. Determination of copper in a copper ore.
6. Determination of viscosity of a liquid.
7. Determination of surface tension of a liquid.
8. Determination of Mohr's salt by potentiometric method.
9. Determination of strength of an acid by pH metric method.
10. Determination of Hardness of a ground water sample.
11. Estimation of active chlorine content in Bleaching powder.
12. Preparation of TiO_2/ZnO nano particles
13. Thin layer chromatography.
14. Preparation of Phenol-formaldehyde resin

COURSE OUTCOMES

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

- **illustrate** different ores (Fe, Cr & Cu) and their usage. **(L-2)**
- **compare** the viscosities of oils. **(L-2)**
- **experiment with** the physical parameters of organic compounds. **(L-3)**
- **apply** the TLC technique for the identification of organic compounds. **(L-3)**
- **analyze** the quality of ground water sample. **(L-4)**

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. KBhasin and Sudha Rani Laboratory Manual on Engineering Chemistry 3/e, Dhanpat Rai Publishing Company (2007).

19EID131: PROBLEM SOLVING AND PROGRAMMING

L	T	P	C
3	**1**	**3**	**5.5**

This course focuses on problem solving using visual programming and flowchart tools. Python being simple and easy to learn syntax, it is used as an introductory coding platform to translate flow charts into programs. The course introduces fundamental programming concepts. Python language is used to present concepts including control structures, functions, data structures followed by important Python packages that will be useful in data analysis.

Course Objectives:

- To introduce programming through Visual programming tool - Scratch
- To teach problem solving through Flow charting tool - Raptor
- To elucidate problem solving through python programming language
- To introduce function-oriented programming paradigm through python
- To train in development of solutions using modular concepts
- To teach practical Pythonic solution patterns

Unit I: Computational Thinking and Visual Programming Concepts

Introduction to computational thinking. Visual programming concepts. Scratch environment: sprites -- appearance and motion, angles and directions, repetition and variation, changing costumes, adding background. Input/Output, variables and operators.

Learning Outcomes

After completion of this unit the student will be able to

- develop a program, controlled by a loop. (L3)
- experiment with “costumes” to change the appearance of sprites. (L3)
- perform Input, Output Operations using scratch. (L3)
- perform computation using common mathematical formulas. (L3)
- develop programs by passing messages between sprites. (L3)

Unit II: Algorithms and Flowchart design through Raptor

Introduction to the idea of an algorithm. Pseudo code and Flow charts. Flow chart symbols, Input/Output, Assignment, operators, conditional if, repetition, procedure and sub charts.

Example problems – Finding maximum of 3 numbers, Unit converters, Interest calculators, multiplication tables, GCD of 2 numbers.

Example problems -- Fibonacci number generation, prime number generation. Minimum, Maximum and average of n numbers, Linear search, Binary Search.

Learning outcomes:

After completion of this unit the student will be able to

- Select flowchart symbols for solving problems. (l1)
- Develop basic flowcharts for performing input, output and computations (l3)
- Solve numerical problems using raptor (l3)
- Analyze problems by modular approach using raptor (l4)

Unit III: Introduction to Python

Python – Numbers, Strings, Variables, operators, expressions, statements, String operations, Math function calls, Input/Output statements, Conditional If, while and for loops, User defined Functions, parameters to functions, recursive functions, Turtle Graphics.

Learning outcomes:

After completion of this unit the student will be able to

- Interpret numbers, strings, variables, operators, expressions and math functions using Python Interactive Mode. (L2)
- Solve simple problems using control structures, input and output statements. (L3)
- Develop user defined functions (recursive and non-recursive). (L3)
- Build Python programs for section 1 raptor flowcharts. (L3)
- Develop Python programs for creating various graphical shapes using turtle graphics. (L3)

Unit IV: Data Structures and Idiomatic Programming in Python

Lists, Tuples, Dictionaries, Strings, Files and their libraries. Beautiful Idiomatic approach to solve programming problems.

Learning outcomes:

After completion of this unit the student will be able to

- Summarize the features of lists, tuples, dictionaries, strings and files. (l2)
- Demonstrate best practices of “beautiful idiomatic python”. (l2)
- Build python programs for section 2 raptor flowcharts. (l3).

Unit V: Packages

Numpy -- Create, reshape, slicing, operations such as min, max, sum, search, sort, math functions etc.

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

Matplotlib -- Visualizing data with different plots, use of subplots.

User defined packages, define test cases and perform unit testing.

Learning outcomes:

After completion of this unit the student will be able to

- Read data from files of different formats and perform operations like slicing, insert, delete, update (L3)
- Visualize the data (L4)
- Ability to define packages (L2)
- Define test cases (L1)

Laboratory Experiments

1. Design a script in Scratch to make a sprite to draw geometrical shapes such as Circle, Triangle, Square, Pentagon.

2. Design a script in Scratch to make a sprite to ask the user to enter two different numbers and an arithmetic operator and then calculate and display the result.

3. Design a Memory Game in Scratch which allows the user to identify positions of similar objects in a 3 x 3 matrix.

4. Construct flowcharts to

a. calculates the maximum, minimum and average of N numbers.

b. develops a calculator to convert time, distance, area, volume and temperature from one unit to another.

5. Construct flowcharts with separate procedures to

a. calculates simple and compound interest for various parameters specified by the user.

b. calculates the greatest common divisor using iteration and recursion for two numbers as specified by the user.

6. Construct flowcharts with procedures to

a. generates first N numbers in the Fibonacci series.

b. generates N Prime numbers.

7. Design a flowchart to perform Linear search on list of N unsorted numbers (Iterative and recursive)

8. Design a flowchart to perform Binary search on list of N sorted numbers (Iterative and recursive)

9. Design a flowchart to determine the number of characters and lines in a text file specified by the user

10. Design a Python script to convert a Binary number to Decimal number and verify if it is a Perfect number.

11. Design a Python script to determine if a given string is a Palindrome using recursion

12. Design a Python script to sort numbers specified in a text file using lists.

13. Design a Python script to determine the difference in date for given two dates in YYYY:MM:DD format (0 <= YYYY <= 9999, 1 <= MM <= 12, 1 <= DD <= 31) following the leap year rules.

14. Design a Python Script to determine the Square Root of a given number without using inbuilt functions in Python.

15. Design a Python Script to determine the time difference between two given times in HH:MM: SS format. (0 <= HH <= 23, 0 <= MM <= 59, 0 <= SS <= 59)

16. Design a Python Script to find the value of (Sine, Cosine, Log, PI, e) of a given number using infinite series of the function.

17. Design a Python Script to convert a given number to words

18. Design a Python Script to convert a given number to roman number.

19. Design a Python Script to generate the frequency count of words in a text file.

20. Design a Python Script to print a spiral pattern for a 2-dimensional matrix.

21. Design a Python Script to implement Gaussian Elimination method.

22. Design a Python script to generate statistical reports (Minimum, Maximum, Count, Average, Sum etc) on public datasets.

23. Design a Python script using the Turtle graphics library to construct a turtle bar chart representing the grades obtained by N students read from a file categorizing them into distinction, first class, second class, third class and failed.

Textbook(s):

1. Weingart, Dr. Troy, Brown, Dr. Wayne, an introduction to programming and algorithmic reasoning using raptor.

2. T R Padmanabhan, Programming with python, Springer. 3. Reema Thareja, Python Programming: Using Problem Solving Approach, Oxford University Press. 4. Wes McKinney, Python for Data Analysis, O. Reilly.

Course outcomes:

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

- create interactive visual programs using Scratch. (L3)
- develop flowcharts using raptor to solve the given problems. (L3)
- build Python programs for numerical and text-based problems (L3)
- develop graphics and event-based programming using Python (L3)
- build Python programs using beautiful Pythonic idiomatic practices (L3)

19EEE131: BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

L	T	P	C
3	1	3	5.5

This course introduces the student, to 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 Objectives

- To familiarize the basic DC and AC networks used in electrical and electronic circuits.
- To explain the concepts of electrical machines and their characteristics.
- To identify the importance of transformers in transmission and distribution of electric power.
- To impart the knowledge about the characteristics, working principles and applications of semiconductor diodes, metal Oxide semiconductor field effect transistors (MOSFETs).
- To expose basic concepts and applications of Operational Amplifier and configurations.

UNIT-I

(10L + 6P)

Basic laws and Theorems: Ohms law, Kirchoff's Laws, series and parallel circuits, source transformations, delta-wye conversion. Mesh analysis, nodal analysis. Linearity and superposition theorem, Thevenin's and Norton's theorem with simple examples, maximum power transfer theorem with simple examples.

Learning Outcomes

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

- state Ohms law and Kirchhoff's Laws **(L1)**
- identify and analyze series and parallel connections in a circuit **(L1)**
- predict the behavior of an electrical circuit **(L2)**
- determine the current, voltage and power in the given electrical circuit**(L4)**
- apply various techniques to analyze an electric circuit**(L3)**

UNIT-II

(10L + 6P)

DC Machines: Constructional features, induced EMF and torque expressions, different types of excitations, performance characteristics of different types of dc machines, Starters: 2-point, 3-point starters, losses and efficiency, efficiency by direct loading.

Learning Outcomes

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

- describe the constructional features of DC machines(L1)
- analyze EMF and torque expressions of DC machine(L4)
- demonstrate the performance characteristics of different types of dc machines (L3)
- explain types of starters used for starting of dc motors (L2)
- estimate losses and efficiency of electrical machine(L2)

UNIT-III

(12L + 9P)

Transformers: Constructional details, EMF equation, voltage regulation, losses and efficiency, open/short- circuit tests and determination of efficiency. **Three Phase Induction Motors**: Construction, working principle of three phase induction motor, Torque and Torque-Slip characteristics.

Learning Outcomes

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

- describe the constructional details of transformers **(L1)**
- demonstrate voltage regulation of transformer **(L3)**
- discuss about open and short- circuit tests of transformer**(L2)**
- explain the working principle of three phase induction motor **(L2)**
- describe torque and torque slip characteristics **(L1)**
- estimate losses and efficiency of three Phase Induction Motors**(L2)**

UNIT-IV

(12L + 9P)

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.

Learning Outcomes

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

- describe the device structure and physical operation of a diode **(L1)**
- discuss V-I characteristics of diodes **(L2)**
- explain the use of diode as switch and in electronic circuits**(L5)**
- describe the construction and operation of *n*-channel and *p*-channel MOSFETs **(L1)**

- explain the use of MOSFET as an amplifier and bidirectional switch **(L5)**

UNIT-V

(**10L + 6P)**

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, Effect of finite open loop gain, the voltage follower, Difference amplifiers, A Single Op-amp difference amplifier.

Learning Outcomes

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

- list the characteristics of an ideal Op Amp **(L1)**
- explain the Inverting and Noninverting configurations of Op-Amp **(L2)**
- construct a Single Op-amp difference amplifier **(L3)**

List of Laboratory Experiments

1. Verification of Kirchhoff's Laws KVL and KCL.
2. Verification of DC Superposition Theorem.
3. Verification of Thevenin's Theorem and Norton's Theorem.
4. OCC and External characteristics of separately excited DC generators.
5. Swinburne's test on a DC shunt motor.
6. OC and SC Tests on single phase transformer.
7. Brake Test on DC shunt motor.
8. Current Voltage Characteristics of a p-n Junction Diode/LED.
9. Diode Rectifier Circuits.
10. Voltage Regulation with Zener Diodes.
11. Design of a MOSTFET amplifier and MOSFET inverter/NOR gate
12. Inverting and Non-inverting Amplifier Design with Op-amps.
13. Simulation experiments using PSPICE.
    (a) Diode and Transistor Circuit Analysis.
    (b) MOSFET Amplifier design.
    (c) Inverting and Noninverting Amplifier Design with Op-amps.

Course Outcomes

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

- predict and analyze the behavior of an electrical circuit **(L3)**
- analyze the performance quantities such as losses, efficiency and identify applications of DC machines**(L4)**
- explain the use of transformers in transmission and distribution of electric power and other applications **(L2)**
- demonstrate the operation and applications of various electronic devices **(L2)**
- construct Inverting and Noninverting configurations of Op-Amp **(L5)**

Textbooks:

1. D.P.Kothari, I.J.Nagrath, Basic Electrical and Electronics Engineering, 1^{st}edition, McGraw Hill Education (India) Private Limited,2017.
2. B.L.Theraja, Fundamentals of Electrical Engineering and Electronics, 1^{st}edition,S.ChandPublishing,New Delhi, 2006.
3. Adel S. Sedra and Kenneth C. Smith, Microelectronic Circuits 6^{th} edition, 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.

19EME121: BASIC WORKSHOP

(Common to all branches)

L	T	P	C
0	**0**	**3**	**1.5**

The objective of this course is to make sure that all the engineers gain practical expose to common trades. This course enables the students to gain hands on experience and skills necessary to perform basic mechanical operations such as carpentry, sheet metal working and fitting. It also familiarizes the students with basic electrical house wiring concepts.

Course Objectives

- Explain different tools used in carpentry.
- Impart the skills to do some carpentry operations.
- Demonstrate different types of tools used in fitting, soldering and brazing.
- Train fitting, soldering and brazing jobs.
- Familiarize different types of basic electric circuit connections.

Wood Working:

Familiarity with different types of woods and tools used in wood working and make following joints.

a) Half – Lap joint.
b) Mortise and Tenon joint.
c) Corner Dovetail joint or Bridle joint.

Sheet Metal Working:

Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from GI sheets.

a) Tapered tray b) Conical funnel c) Elbow pipe d) Brazing

Fitting:

Familiarity with different types of tools used in fitting and do the following fitting exercises.

a) V-fit b) Dovetail fit c) Semi-circular fit
d) Bicycle tire puncture and change of two-wheeler tire

Electrical Wiring:

Familiarities with different types of basic electrical circuits and make the following connections.

a) Parallel and series b) Two-way switch c) Godown lighting
d) Tube light e) Three phase motor f) Soldering of wires

Course Outcomes:

After completion of this lab the student will be able to

- summarize various carpentry operation required to create a product in real time applications. (L1)
- develop different parts with metal sheet in real time applications. (L3)
- demonstrate fitting operations in various applications. (L2)
- perform soldering and brazing operations. (L3)
- select different types of electric circuits in practical applications (L3)

19EME131: ENGINEERING GRAPHICS

L	T	P	C
1	0	3	2.5

The course enables the students to convey the ideas and information graphically that come across in engineering. This course includes projections of lines, planes, solids sectional views, and utility of drafting and modelling packages in orthographic and isometric drawings.

Course Objectives

- Create awareness of the engineering drawing as the language of engineers.
- Familiarize how industry communicates, practices for accuracy in presenting the technical information.
- Develop the engineering imagination essential for successful design.
- Demonstrate the usage of drafting and modelling packages in the representation of orthographic and isometric views.
- Train in 2D and 3D modelling software's.
- Teach graphical representation of simple components.

Manual Drawing: **(7 Classes)**

Introduction to Engineering graphics: Principles of Engineering Graphics and their significance-Conventions in drawing-lettering - BIS conventions.

a) Conic sections - general method only,

b) Cycloid, epicycloids and hypocycloid

c) Involutes

(**2L + 6P hours)**

Projection of points, lines and planes: Projection of points in different quadrants, lines inclined to one and both the planes, finding true lengths and angles made by line. Projections of regular plane surfaces.

(2L + 6P hours)

Projections of solids: Projections of regular solids inclined to one and both the reference planes.

(1L + 3P hours)

Sections of solids: Section planes and sectional view of right regular solids- prism, cylinder, pyramid and cone. True shapes of the sections. **(1L + 3P hours)**

Development of surfaces: Development of surfaces of right regular solids-prism, cylinder, pyramid, cone and their sectional parts. **(1L+ 6P hours)**

Computer Aided Drafting: **(6 Classes)**

Introduction to AutoCAD: Basic drawing and editing commands: line, circle, rectangle, erase, view, undo, redo, snap, object editing, moving, copying, rotating, scaling, mirroring, layers, templates, polylines, trimming, extending, stretching, fillets, arrays, dimensions. Dimensioning principles and conventional representations. **(1L + 3P hours)**

Orthographic Projections: Systems of projections, conventions and application to orthographic projections.

(3L + 9P hours)

Isometric Projections: Principles of isometric projection- Isometric scale; Isometric views: lines, planes, figures, simple and compound solids. **(2L + 6P hours)**

Course Outcomes:

After completing the course, the student will be able to

- utilize Engineering Graphics as Language of Engineers. (L3)
- prepare drawings as per international standards. (L3)
- identify various engineering curves. (L1)
- solve plane geometry problems involving lines and plane figures (L3)
- represent solids and sections graphically. (L3)
- implement procedures to develop the surfaces of solids. (L3)
- create isometric and orthographic drawings using CAD packages. (L3)

Textbook(s):

1. K.L. Narayana & P. Kannaiah, Engineering Drawing, 3/e, Scitech Publishers, 2012.
2. N.D. Bhatt, Engineering Drawing, 53/e, Charotar Publishers, 2016.

References:

1. Dhanajay A Jolhe, Engineering Drawing, Tata McGraw-Hill, 2009.
2. Shah and Rana, Engineering Drawing, 2/e, Pearson Education, 2009.
3. Venugopal, Engineering Drawing and Graphics, 3/e, New Age Publishers, 2000.
4. K.C. John, Engineering Graphics, 2/e, PHI, 2013.
5. Basant Agarwal and C.M. Agarwal, Engineering Drawing, Tata McGraw Hill, 2008.

19EMC181A - NATIONAL SERVICE SCHEME (NSS)

L T P C

0 0 2 0

National Service Scheme is a public service program encouraged by Ministry of Youth Affairs and Sports of the Government of India. NSS is a voluntary association of young people in Colleges, Universities and at +2 level working for a campus-community linkage. The objective of this course is to expose the students to the activities of National Service Scheme, concept of social Service and principles of health, hygiene and sanitation.

Unit I

2Hours

XIntroduction and Basic concepts of NSS: History. Philosophy, aims and Objectives of NSS, Emblem, Flag, Motto, Song, Badge etc.: Organizational structure, role and responsibilities of various NSS Functionaries

Unit II

2Hours

Regular activities: College campus activities, NSS, activities in Urban and Rural areas, NSS Annual Activities Calendar, Suggestive List of Activities, Role of Non-Government Organisation (NGO) in social Reforms) Red Cross ii) Rotary

Unit III

2Hours

Special Camp activities: Nature and its objectives: Selection of camp site -Identification of community problems- physical arrangement- Organization of N.S.S. camp through various committees and discipline in the camp- adaption of village-planning for pre -camp during and post campaigning. **Activities-** Activities to be undertaken during the N.S.S. camp- Use of the mass media in the N.S.S activities.

Unit IV

4hours

Health, Hygiene and Sanitation: Definition, needs and scope of health education, food and Nutrition, Safe drinking water, Sanitation, Swachh Bharat Abhiyan. **Disaster Management:** Introduction to Disaster Management, Classification of Disasters. Role of Youth in Disasters Management, Home nursing, First Aid. **Civil Self Defence:** Civil Défense services, aims and objectives of civil Défense, Need for selfself-defence training

Unit V

10hours

Social Project: Problems Identification - Data Collection- Preparation of a Questionnaire- Observation- Schedule Interview-Qualitative Research-Quantities Research-Major Findings-Suggestions-Conclusion-Report Writing.

Text Books:

1) National Service Scheme Manual (Revised) 2006, Government of India, Ministry of Youth Affairs and Sports, New Delhi
2) NSS Diaries
3) Sanjay Bhattacharya, Social Work Interventions and Management-Deep and Deep Publications, New Delhi

19EMC181B – NATIONAL CADET CORPS

L T P C

0 0 2 0

Unit I

5 hours

Aims and objectives of NCC: Organization and training, NCC song, incentives for cadets. national integration and awareness: religion, culture, traditions and customs of India, national integration – importance and necessity, freedom struggle and nationalist movement in India, national interests, objectives, threats and opportunities, problems/ challenges of national integration, national integration and awareness, unity and diversity, national integration council, images/ slogans for national integration, contribution of youth in nation building

Unit II

5 hours

Drill Attention, stand at ease and stand easy, turning and inclining at the at the halt, ceremonial drill-guard mounting, guard of honour, platoon / company drill, instructional practice, weapon training stripping, assembling, care and cleaning and sight setting of .22 rifle, the lying position, holding and aiming, trigger control and firing a shot, short range firing, aiming – alteration of sight

Unit III

5 hours

Personality development: Introduction to personality development, factors influencing / shaping personality – physical , social, psychological and philosophical self-awareness – know yourself / insight, change your mindset, interpersonal relationship and communication communication skills – group discussion / lecturettes, leadership traits, types of leadership, attitude – assertiveness and negotiation, time management, personality development, effects of leadership with historical examples, stress management skills, interview skills, conflict motives – resolution, importance of group – team work, influencing skills, body language, sociability: social skills, values / code of ethics **Disaster Management:** Civil defence organization and its duties – ndma, types of emergencies / natural disasters, fire service and firefighting, traffic control during disaster under police supervision, essential services and their maintenance, assistance during natural / other calamities / floods / cyclone / earth quake / accident, setting up of relief camp during disaster management, collection and distribution of aid material

Unit IV

5 hours

Social awareness and community development: Basics of social service, weaker sections of our society and their needs, social/ rural development projects – menrega , sgsy , nsapetc, ngos : role and contribution, contribution of youth towards social welfare, family planning, drug abuse and trafficking, civil responsibilities, causes and prevention of HIV/ aids role of youth, counter terrorism, corruption, social evils – dowry / female foeticide / child abuse and trafficking, rti and rte, traffic control organization and anti-drunken driving, provision of protection of children from sexual harassment act 2012.

Unit V

5 hours

Health and Hygiene: Structure and functioning of the human body, hygiene and sanitation (personal and food hygiene), physical and mental health, infectious and contagious diseases and its prevention, basic of home nursing and first aid in common medical emergencies, wounds and fractures, introduction to yoga and exercises. **Adventure training:** Para sailing, slithering, rock climbing, cycling / trekking, environment awareness and conservation natural resources conservation and management, water conservation and rain water harvesting, waste management, pollution control, water , air, noise and soil, energy conservation,. wildlife conservation – projects in india. obstacle training, obstacle course, practical training

Text Books

1. Cadet Hand Book (Common Subjects), published by DG NCC.
2. Cadet Hand Book (Specialized Subjects), published by DG NCC.

Reference Books

1. Grooming Tomorrow's Leaders, published by DG, NCC.
2. Youth in Action, published by DG, NCC.
3. The Cadet, Annual Journal of the NCC.

19EMC181C: National Sports Organization (Common to all)

L	T	P	C
0	0	2	0

National Sports Organisation is intended by the Government of India to promote the development of athletics and sporting activities of the nation's youth. This activity enables physical fitness, teamwork and mental health within the students. This course teaches the rules and skills of below sports and games to the students. Each student shall be made proficient in one of the chosen sport from the below list

1. Cricket
2. Volley Ball
3. Table Tennis
4. Foot Ball
5. Throw Ball (Only for Women)
6. Basket Ball
7. Athletics -100 Meters Run, Long Jump, Shot Put
8. Chess
9. Lawn Tennis
10. Kabaddi
11. Aerobics
12. Badminton

Text Books:

1. Myles Schrag, The Sport Rules Book, 4/e, Human Kinetics, 2018
2. DhamaPrakashJyoti, Rules. Of. Games. And. Sports,Laxmi Book Publication, 2018

19EMC181D: YOGA (Common to all)

L	**T**	**P**	**C**
0	**0**	**2**	**0**

The course is designed to enable the student to know about yoga an ancient Indian tradition. It embodies unity of mind and body; thought and action; harmony between human and nature and a holistic approach to health and well-being. It is not only exercise but to discover the sense of oneness with ourselves, the world and nature. The student will be able to learn about Yoga and practice different Yoga asana which influences his lifestyle and creating consciousness, it can help a student to deal with health issues and climate change.

Course Objectives:

- Familiarize the student with YOGA and ancient Indian tradition.
- Enable the student to know the different asana their advantages and disadvantages.
- Explain with the features of different Yoga asana.
- Demonstrate and perform Yoga asana.

- Enable the student to perform pranayama and meditation.

- **Introduction to Yoga:**E volution of Yoga and Schools of Yoga, Origin of Yoga, History and Development of Yoga; Etymology and Definitions, Misconceptions, Nature and Principles of Yoga.
- **Guidelines to yoga practice:** Prayer, warmup exercises/ loosening exercises
- **Yoga Theory:** Therapeutic Benefits of Yoga – primitive, preventive and curative aspects of Yoga
- **Application of Yoga to students,** Suryanamaskaras, Tadasan, Natarajasan, Vrikshasan, Padahasthasan, Ardhachakrasan, Trikonasan, Bramari pranayama.
- **Yoga for allround fitness,** Bhadrasan, Vajrasan, ArdhaUstrasan, Nadishuddhi pranayama, Navasan, Janusirasan, Paschimotthanasan, Shashankasan, Vakrasan, Bhujangasan, Kapalabhati..
- **Meditative Postures**: Sukhasan, ArdhaPadmasan, Padmasan and Siddhasan,Meditation
- **Yoga Practice**: Makarasan, Sethubandhasan, Pavanmuktasan, Sarvangasan, Matsyasan, Halasan.

Text Book(s):

1. Swami Muktibodhanda Saraswathi Shay G.S., Hatha yoga Pradipika, Bihar School of yoga publications, Munger, 2000.
2. Hatha Yoga Pradeepika of Svatmarama, MDNY Publication, 2013
3. Svatmarama, Swami, The Hatha yoga Pradipika/ the original Sanskrit [by] Svatmarama; an English translation [by] Brian Dana Akers. Woodstock, NY:YogaVidya.com, 2002.

References:

3. Bharati, Swami Veda Reddy Venkata: Philosophy of Hatha Yoga (Englis), Himalayan, Pensylvania, Hatha Ratnavali.
4. Swami SatyanandaSaraswathi - Asana, Pranayama, Mudra & Bandha. Bihar School of Yoga, Munger
5. B.KS.Iyenger- The Illustrated Light on Yoga. Harper Collins, New Deli

Course Outcomes:

After completion of this course the student will be able to

- understand history and evolution of Yoga (L2).
- list different schools of yoga (L2).
- interpret the aim and objectives of yoga to students (L2).
- perform yoga asana, pranayama, and meditation (L2).

19EMA102: ENGINEERING MATHEMATICS II

ODE, PDE AND MULTIVARIABLE CALCULUS

(Common to all branches of Engineering except CSE & IT)

L	T	P	C
3	0	0	3

This course is designed to impart knowledge on ordinary, partial differential equations and vector calculus so as to understand concepts like fluid mechanics, signals and systems etc., in engineering applications

Course Objectives:

- To familiarize the students in the concepts of linear differential equations.
- To explain the concept of reducing linear differential equations with variable Coefficients to constant coefficients and their applications.
- To demonstrate the concepts of partial differential equations.
- To explain the concepts of vector differentiation and integration

UNIT I: 8hrs

Linear differential equations of higher order: Definitions, complete solution, operator D, rules for finding complimentary function, inverse operator, rules for finding particular integral, method of variation of parameters.

Learning Outcomes:

At the end of this unit, the student will be able to

- classify and interpret the solutions of linear differential equations (L3)
- identify the essential characteristics of linear differential equations with constant coefficients (L3)
- solve the linear differential equations with constant coefficients by appropriate methods (L3)

UNIT II: 8hrs

Equations reducible to Linear Differential Equations and Applications: Cauchy’s and Legendre’s linear equations, simultaneous linear equations with constant coefficients, Applications: Mass spring system and L-C-R Circuit problems.

Learning Outcomes:

At the end of this unit, the student will be able to

- examine the special type of nonlinear differential equations (L4)
- analyze physical situations using higher differential equations (L4)

UNIT III:8 hrs

Partial Differential Equations – First order: First order partial differential equations, solutions of first order linear PDEs, Charpit's method. Solutions to homogenous and non-homogenous linear partial differential equations.

Learning Outcomes:

At the end of this unit, the student will be able to

- apply a range of techniques to find solutions of PDEs (L3)
- identify the basic properties of PDEs (L3)

UNIT IV: **8hrs**

Multivariable Calculus (Vector differentiation): Scalar and vector point functions, vector operator del, del applies to scalar point functions-Gradient, del applied to vector point functions-Divergence and Curl, vector identities.

Learning Outcomes:

At the end of this unit, the student will be able to

- apply del to Scalar and vector point functions (L3)
- illustrate the physical interpretation of Gradient, Divergence and Curl (L3)

UNIT V: **10hrs**

Multivariable Calculus (Vector integration: Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof).

Learning Outcomes:

At the end of this unit, the student will be able to

- find the work done in moving a particle along the path over a force field (L3)
- construct the rate of fluid flow along and across curves (L3)
- apply Green's, Stokes and Divergence theorem in evaluation of line, surface and volume integrals (L3)

Course Outcomes:

At the end of the course, the student will be able to

- solve the differential equations related to various engineering fields (L3)
- Identify solution methods for partial differential equations that model physical processes (L3)
- inspect the physical meaning of gradient, curl and divergence (L4)

- examine the work done against a field, circulation and flux using vector calculus (L4)

Textbooks:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.

References:

1. Dennis G. Zill and Warren S. Wright, Advanced Engineering Mathematics, Jones and Bartlett, 2011.
2. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018
3. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 13/e, Pearson Publishers, 2013.
4. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002.
5. Glyn James, Advanced Modern Engineering Mathematics, 4/e, Pearson publishers, 2011.

19EID132: DESIGN THINKING

L	T	P	C
2	0	2	3

Design is a realization of a concept or idea into a configuration, drawing or a product. Design Thinking is cognitive and practical processes 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 the design thinking in product innovation.

Course Objectives:

1. To familiarize 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

UNIT I **8 L**

Introduction to design, characteristics of successful product development, product development process, identification of opportunities, product planning, Innovation in product development.

Learning Outcomes:

After completing this unit, the student will be able to

- identify characteristics of successful product development(L3)
- identify opportunities for new product development(L3)
- plan for new product development(L3)

UNIT II **8 L**

Design Thinking: Introduction, Principles, the process, Innovation in Design Thinking, benefits of Design thinking, design thinking and innovation, case studies.

Learning Outcomes:

After completing this unit, the student will be able to

- explain the principles of Design Thinking(L2)
- identify the benefits of Design Thinking(L3)
- use innovations in Design Thinking(L3)

UNIT III **10 L**

Idea generation: Introduction, techniques, Conventional methods, Intuitive methods, Brainstorming, Gallery method, Delphi method, Synectics etc Select ideas from ideation methods, case studies.

Learning Outcomes:

After completing this unit, the student will be able to

- explain the techniques in idea generation(L2)
- select ideas from ideation methods(L3)
- identify the methods used in idea generation in some case studies(L3)

UNIT IV **10 L**

Design Thinking in Information Technology, Design Thinking in Business process model, Design Thinking for agile software development, virtual collaboration, multi user and multi account interaction, need for communication, TILES toolkit, Cloud implementation.

Learning Outcomes:

After completing this unit, the student will be able to

- use Design Thinking in business process model(L3)
- apply Design Thinking for Agile software development(L3)
- use TILES toolkit(L3)

UNIT V **8 L**

Design thinking for service design: How to design a service, Principles of service design, Benefits of service design, Service blueprint, Design strategy, organization, principles for information design, principles of technology for service design.

Learning Outcomes:

After completing this unit, the student will be able to

- use principles of service design(L3)
- explain the benefits of service design(L5)
- apply principles of technology for service design(L3)

Text Book(s):

1. Pahl, Beitz, Feldhusen, Grote – Engineering Design: a systematic approach, Springer, 2007

2. Christoph Meinel and Larry Leifer, Design Thinking, Springer, 2011

3. Aders Riise Maehlum - Extending the TILES Toolkit – from Ideation to Prototyping

4. http://www.algarytm.comA/it-executives-guide-to-design-thinking:e-book.

5. Marc stickdorn and Jacob Schneider, This is Service Design Thinking, Wiely, 2011

Course Outcomes:

At the end of this course, the student will be able to

innovate new methods in product development(L6)

- apply Design Thinking in developing the new designs(L3)

- select ideas from ideation methods in new product development(L5)
- use Design Thinking in developing software products(L3)
- apply principles of Design Thinking in service design(L3)

19EID134: AI TOOLS
(Common to all)
Effective from admitted batch 2020-21 onwards

L T P C
2 0 2 3

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.

Pre-Requisites:

Courser code: 19EID131

Course Name: Problem Solving and Programming

Course Objectives:

- Provide introduction to basic concepts of Artificial Intelligence.
- Explore applications of AI
- Explore the scope, advantages of intelligent systems
- Experiment with different machine learning concepts
- Exposure to AI-intensive computing and information system frameworks

Unit I **6L+6P**

Introduction to Artificial Intelligence: :Basics of AI. Agents and Environment, The Nature of Environment, Applications of AI:Game Playing [Deep Blue in Chess, IBM Watson in Jeopardy, Google's Deep Mind in AlphaGo]

Learning Outcomes:

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

- recognize various domains in which AI can be applied (L2)

Unit II **6L+6P**

Conceptual introduction to Machine Learning:

Supervised, Unsupervised, and Semi-Supervised Learning, Reinforcement Learning, Introduction to Neural Networks, Deep Learning.

Learning Outcomes:

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

- define machine learning and forms of learning (L1)
- identify types of machine learning(L1)

Unit III **7L+6P**

Image Processing & Computer Vision:

Introduction to Image processing, Image Noise, Removal of Noise from Images, Color Enhancement, Edge Detection, Segmentation, Feature Detection & Recognition. Classification of images. Face recognition, Deep Learning algorithms for Object detection & Recognition.

Learning Outcomes:

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

- identify the concepts of image processing (L2)
- implement the methods in processing an image (L3)

Uni**it IV** **6L+4P**

Conceptual introduction to Natural Language Processing: Speech Recognition & Synthesis: Speech Fundamentals, Speech Analysis, Speech Modelling, Speech Recognition, Speech Synthesis, Text-to-Speech, Sentiment Analysis, Segmentation and recognition.

Learning Outcomes:

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

- illustrate how to construct a Chabot (L4)
- describe natural language processing and concepts for converting speech to different forms (L2)

Unit V **7L+6P**

BOT Technologies: Chatbots: Introduction to a 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.

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

Learning Outcomes:

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

- understand the application of intelligence in various domains(L2)
- correlate Artificial Intelligence to advanced applications(L4)

Text Book(s)

1. Tom Markiewicz & Josh Zheng, Getting started with Artificial Intelligence, Published by O'Reilly Media,2017
2. Stuart J. Russell and Peter Norvig, Artificial Intelligence A Modern Approach.

References

1. AurélienGéron, Hands on Machine Learning with Scikit-Learn and TensorFlow [Concepts, Tools, and Techniques to Build Intelligent Systems], Published by O'Reilly Media,2017
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 with Python-Packt Publishing (2016).
4. Curated Datasets on Kagglehttps://www.kaggle.com/datasets.

AI TOOLS LABORATORY

List of Practical Experiments:

1. Supervisely - Perform Data Labelling for various images using object recognition
2. Teachable Machine - In Browser Object Recognition through Brain.JS
3. Lobe.ai - Build custom models using the visual tool for Object recognition and sentiment analysis that can convert facial expressions into emoticons
4. Haar Cascade Object detection for Eye and Face in Python using OpenCV
5. Text to Speech recognition and Synthesis through APIs
6. Sentiment Analysis and Polarity detection
7. Building a Chatbot using IBM Watson visual studio
8. Building a Chatbot using Pandora bots
9. Build a virtual assistant for Wikipedia using Wolfram Alpha and Python

Online Resources:

Pytorch: https://pytorch.org/ https://github.com/pytorch Keras:
https://keras.io/ https://github.com/keras-team Theano:
http://deeplearning.net/software/theano/ https://github.com/Theano/Theano Cafee2:
https://caffe2.ai/ https://github.com/caffe2 Deeplearning4j:
https://deeplearning4j.org/ Scikit-learn:
https://scikit-learn.org/stable/ https://github.com/scikit-learn/scikit-learn
Deep Learning.Ai:
https://www.deeplearning.ai/ OpenCv:
https://opencv.org/ https://github.com/qqwweee/keras-yolo3 YOLO:
https://www.pyimagesearch.com/2018/11/12/yolo-object-detection-with-opencv/
nVIDIA:CUDA:
https://developer.nvidia.com/cuda-math-library

Course Outcomes:

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

- able to grasp the concepts of artificial intelligence, machine learning, natural language processing, image processing. (L1)
- recognize various domains in which AI can be applied.(L2)
- implement the methods in processing an image.(L3)
- implement simple of chatbots.(L4) .
- identify smart applications. (L4)

19EME122: MECHANICAL ENGINEERING WORKSHOP

L	T	P	C
0	0	3	1.5

The course enables the students of mechanical engineering to gain hands on experience and skills necessary to perform traditional manufacturing operations such as moulding, casting and welding. It also introduces the students to modern manufacturing techniques such as development of composites and use of power tools. The major objective of this course is to make sure that all the mechanical engineering graduates gain practical exposure to manufacturing methods and various manufacturing tools.

Course Objectives

- introduce concepts of moulding and casting techniques .
- train on different types of welding joints.
- impart assembling or disassembling skills.
- demonstrate the manufacturing of plastic components.
- familiarize the use of power tools.

Foundry Practice: (2 Sessions)

i a) Determination of average grain size for sand sample using sieve shaker.
 b) Preparation of a green sand mould using single piece pattern.

ii. Preparation of a green san mould using split piece pattern with core and demonstration of casting.

Welding Practice: (2 Sessions)

i. Lap joint, butt joint and T joint using arc welding.

ii. a) Lap joint using resistance spot welding.
 b) Lap and butt joints using gas welding.

Assembling/Disassembling Practice: (3 Sessions)

i. Bicycle.

ii. Clutch and carburetor.

iii. Two wheeler engine.

Manufacture of a Plastic Component (2 Sessions)

i. Use of injection moulding machine.

ii. FRP composite using hand layup method.

iii. Joining of plastic components.

Design and manufacture any two domestic utility productswith any material (2 Sessions)

Use of Power Tools (2 Sessions)

Course Outcomes:

After completion of this lab student will be able to

- Make moulds for sand casting. (L3)
- Create different welded joints. (L3)
- Assemble or disassemble simple machine components. (L3)
- create plastic components.(L3)
- Use power tools for different applications. (L1)
- Outline the applications of hydraulic and pneumatic circuits. (L2)

19EHS122: Comprehensive Skill Development I

L	T	P	A	C
0	0	0	6	1

Course Objectives:

- To encourage the all-round development of students by focusing on soft skills, Coding & domain skills.
- To make the engineering students aware of the importance, the role and the content of soft skills, Coding and domain skills through instruction, knowledge acquisition, demonstration and practice.
- To develop and nurture the soft skills, coding and domain skills of the students through individual and group activities.
- To expose students to right attitudinal and behavioral aspects and to build the same through activities

Part-1

A. Verbal and Soft Skills

Self-Awareness and Motivation, Goal Setting and Time Management, Interpersonal Skills, Team Work.

B. Quantitative Aptitude and Reasoning

Puzzles, Non-Verbal Reasoning, Data Sufficiency, Analytical Reasoning,

Part-2

Coding: **GitHub** – Accepting assignments pull and push the code or resource, GitHub configuration,

Visual Studio code – Configuring, integrating Git for assignment submission

Online competitive coding platforms – Introduction to online coding platforms to get prepared for competitive coding.

Problem Solving with Python: Collections, Techniques for manipulating Strings, Recursion, Searching, Sorting, Stacks and Queues.

Problem Solving with C: Memory, C Syntax, Conditions and Loops, Functions and Recursion, Arrays, Techniques for manipulating Strings, Searching, Sorting, Stacks and Queues,Structures.

Course Outcomes:

- On completion of the course, student will be able to– Effectively communicate through verbal/oral communication and improve the listening skills
- Write precise briefs or reports and technical documents, Actively participate in group discussion / meetings / interviews and prepare & deliver presentations. Become more effective individual through goal/target setting, self motivation and practicing creative thinking.
- Student will be able to understand the problems and develop his competitive coding skills.
- Apply the skills in various domains and will be able to solve complex problems faced by the industry.
- Function effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality

VDC111: VENTURE DISCOVERY

L	T	P	A	C
0	0	2	0	2

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 for all the disciplines is a foundation on venture development. It is an experiential course that lets students venture and find out what is a business, financial and operating models of a business are. How to design and prototype a solutions that meets their customers' needs and generate revenue for the business.

COURSEOBJECTIVES

- Discover who you are – Values, Skills, and Contribution to Society.
- Gain experience in actually going through the innovation process.
- Conduct field research to test or validate innovation concepts with target customers.
- Understand innovation outcomes: issues around business models, financing for start-ups, intellectual property, technology licensing, corporate ventures, and product line or service extensions.

On successful completion of this course, students will be able to:

	COURSE OUTCOME	Assessment
1	Understand conceptual framework of the foundation of a venture	A1, A2
2	Understand the concept of purpose, mission and value-add service offered by a venture	A3
3	Analyze design and positioning of the product	A3
4	Demonstrate prototyping	A3
5	Analyze business, revenue and operating models	A3

Course outline and indicative content

Unit I (6 sessions)

Personal Values: Defining your personal values, Excite & Excel, Build a Team, Define purpose for a venture. Four stages: Personal Discovery, Solution Discovery, Business Model Discovery, Discovery Integration.

Unit II (6 sessions)

Solution Discovery: Craft and mission statement, Experience design, Gaining user insight, Concept design and positioning, Product line strategy, Ideation & Impact.

Unit III (6 sessions)

Business Model Discovery: Prototyping solutions, Reality Checks, Understand your industry, Types of business models, Define Revenue Models, Define Operating Models

Unit IV (6 sessions)

Discovery Integration: Illustrate business models, Validate business models, Define company impact

Unit V (6 sessions)

Tell a Story: Can you make money, Tell your venture story.

Assessment methods

Task	Task type	Task mode	Weightage (%)
A1. Assignments	Individual	Report/Presentation	20
A2. Case / Project/Assignment	Groups* or Individual	Presentations/Report/Assignment	40
A3. Project	Individual/Group	Report/Pitch	40

Transferrable and Employability Skills

	Outcomes	Assessment
1	Know how to use online learning resources: G-Learn, online journals, etc.	A1 & A2
2	Communicate effectively using a range of media	A1& A2
3	Apply teamwork and leadership skills	A2
4	Find, evaluate, synthesize & use information	A1 & A2
5	Analyze real world situation critically	A3
6	Reflect on their own professional development	A3
7	Demonstrate professionalism & ethical awareness	A2
8	Apply multidisciplinary approach to the context	A2

Learning and teaching activities

Mixed pedagogy approach is adopted throughout the course. Classroom based face to face teaching, directed study, independent study via G-Learn, case studies, projects and practical activities (individual & group)

Teaching and learning resources

Soft copies of teaching notes/cases etc. will be uploaded onto the G-learn. Wherever necessary, printouts, handouts etc. will be distributed in the class. Prescribed text book will be provided to all. However you should not limit yourself to this book and should explore other sources on your own. You need to read different books and journal papers to master certain relevant concepts to analyze cases and evaluate projects. Some of these reference books given below will be available in our library.

***Prescribed Modules*:**

Access to NU-IDEA online modules will be provided.

***Referential text books and journal papers*:**

Personal Discovery Through Entrereneurship, Marc H. Meyer and Chaewon Lee, The Institute of Enterprise Growth, LLC Boston, MA.

Suggested journals:

Vikalpa, Indian Institute of Management, Ahmedabad

Journal of General Management, Mercury House Business Publications, Limited

Harvard Business Review, Harvard Business School Publishing Co. USA

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19EMA201: ENGINEERING MATHEMATICS III
(APPLICATIONS OF PDE, COMPLEX VARIABLES AND TRANSFORM TECHNIQUES)
(Common to CIVIL & MECH)

L	T	P	C
3	0	0	3

This course is developed on concepts in applications of partial differential equations and transform techniques to get understand the applications in engineering.

Course Objectives:

- To explain the concept of complex functions and their applications.
- To explore the concept of Laplace and inverse Laplace transforms.
- To express a periodic function by Fourier series and a non-periodic function by Fourier transform.
- To familiarize the students with the techniques of partial differential equations.

UNIT I: 10 hours

Complex Variables: Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate. Cauchy theorem, Cauchy integral formula, Taylor's series,Laurent's series, singularities, residues, Cauchyresidue theorem (All theorems without proof).

Learning Outcomes

At the end of this unit, the student will be able to

- identify continuous and differentiable complex functions (L3)
- apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic (L3)
- evaluate the Taylor and Laurent expansions of simple functions, determining the nature of the singularities and calculating residues (L5)
- make use of the Cauchy residue theorem to evaluate certain integrals (L3)

UNIT II: 9hours

Laplace transforms: Definition of Laplace transform, existence conditions, properties of Laplace transforms, inverse Laplace transforms, transforms of derivatives, transforms of integrals, multiplication by t^n, division by t, convolution theorem, periodic functions, unit step function, unit impulse function, applications to ordinary differential equations. (Without proofs)

Learning Outcomes:

At the end of this unit, the student will be able to

- examine the properties of Laplace transformation (L4)
- apply the Laplace and inverse Laplace transformations for different types of functions (L3)
- solve ordinary differential equations by using Laplace transformation technique (L3)

UNIT III: **6 hours**

Fourier series: Fourier series, Dirichlet's conditions, functions of any period, odd and even functions - half range series.

Learning Outcomes:

At the end of this unit, the student will be able to

- build the Fourier series expansion for different periodic functions (L3)
- analyze the nature of the Fourier series that represent even and odd functions and how derivation of a Fourier series can be simplified in this way (L4)

UNIT IV: **8 hrs**

Fourier Transforms: Fourier integrals, Fourier cosine and sine integrals, Fourier transform, sine and cosine transform, properties, convolution theorem.

Learning Outcomes:

At the end of this unit, the student will be able to

- examine the properties of Fourier transformation (L4)
- apply Fourier transformation for different functions (L3)

UNIT V: **9 hrs**

Applications of Partial Differential Equations: Classification of second order partial differential equations, method of separation of variables, solutions of one dimensional wave equation, one dimensional heat equation and two dimensional Laplace's equation in Cartesian coordinates.

Learning Outcomes:

At the end of this unit, the student will be able to

- classify the nature of the partial differential equations (L4)
- solve the boundary value problems (related to heat diffusion, one dimensional wave equation) (L3)

Course Outcomes:

At the end of the course students will be able to

- make use of differentiation and integration of complex functions in engineering problems (L3)
- apply the Laplace transform for solving differential equations (continuous systems) (L3)

- find the Fourier series of periodic signals (L3)
- know and apply integral expressions for the forwards and inverse Fourier transform to a range of non-periodic waveforms (L3)
- solve the boundary value problems pertaining to partial order differential equations (L3)

Text Books:

3. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2018.
4. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.

References:

1. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9/e, Wiley India, 2009.
2. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India,1995.
3. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7/e, Mc-Graw Hill, 2004.
4. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, 2008.

19EID132: DESIGN THINKING

L	T	P	C
2	0	2	3

Design is a realization of a concept or idea into a configuration, drawing or a product. Design thinking is cognitive and practical processes 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 the design thinking in product innovation.

Course Objectives:

- To bring awareness on innovative design and new product development.
- To explain the basics of design thinking.
- To familiarize the role of reverse engineering in product development.
- To train for identification of the needs of society and convert into demand.
- To introduce product planning and product development process.

UNIT-I **8 hrs**

Science to Engineering: Job of engineers, engineering units and measurement, elements of engineering analysis, forces and motion, energy, kinematics and motion, conversion of linear motion to rotary and vice versa, motion transmission.

Physics to Engineering: Application of Newton laws, Pascal's law, Bouncy, Bernoulli's theorem, Ohm's law, and electrical induction in engineering products.

Learning Outcomes:

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

- relate the principles of science to engineering (L2)
- explain simple mechanics of motion and force transmission (L2)
- apply the laws of physics to engineering products (L3)

UNIT-II **8 hrs**

Historical Development: Invention wheel, early mechanics in design, mechanical advantages, industrial revolution, steam and petrol for mobility. Innovations in Electrical and Electronics: Electrical energy generation, electrical bulb, electrical equipment, electronics and automation, computing for early days to present, innovations in communications.

Learning Outcomes:

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

- identify innovation in early mechanical designs (L2)
- explain development of electrical equipment (L2)
- list out the developments in computing machines (L4)
- summarize innovations in communication systems (L2)

UNIT-III **8 hrs**

Systematic approach to product development: Design Thinking, Innovation, Empathize Design Thinking as a systematic approach to Innovation, brainstorming, visual thinking, design challenges, innovation, art of Innovation, strategies for idea generation, creativity, teams for innovation. Solution finding methods: Conventional, intuitive, discursive, methods for combining solution, decision making for new design.

Learning Outcomes:

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

- explain the steps in the design process (L2)
- apply systematic approach in design (L3)
- develop strategies for new product development (L3)

UNIT-IV **8 hrs**

Reverse engineering in product development: Reversing engineering methods, identifying the bad features in a product, reduction in size and weight, usage of new materials, 3D printing, study of introducing electrical and electronic controls to the old products, importance of ergonomics in product development, environmental considerations in design, safety considerations in design.

Learning Outcomes:

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

- understand reverse engineering methods in product development (L2)
- use new materials to improve the product (L2)
- apply electronic controls to improve the product acceptability (L3)
- summarize the safety and environmental factors in new product design (L2)
- understand 3D printing in manufacturing (L2)

UNIT-V **8 hrs**

Study of Product Development: Agriculture, development of machines for separation of corn seeds, peeling of groundnut shells, husk removing from paddy. Electrical: Design of burglar alarm, speedometer, water level indicator, smart gates, and smart lights. Design of electrical vehicles, unmanned vehicles, design principles in drones.

Learning Outcomes:

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

- identify the needs for new product development in agriculture (L3)
- develop simple electrical gadgets (L3)
- explain the principles in design electrical vehicles and drones (L2)

Course Outcomes

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

- summarize the importance of basic sciences in product development (L2)
- explain the historical developments in mechanical, electrical, communications and computational engineering (L3)
- apply systematic approach to innovative designs (L3)
- identify new materials and manufacturing methods in design (L3)
- utilize design principles to develop new products (L3)

Reference Books:

1. Philip Kosky, Robert T. Balmer, William D. Keat, George Wise, "Exploring Engineering: An Introduction to Engineering and Design", 4/e, Elsevier, 2016
2. David Ralzman, "History of Modern Design", 2/e, Laurence King Publishing Ltd., 2010
3. An AVA Book, "Design Thinking", AVA Publishing, 2010
4. G. Pahl, W.Beitz, J. Feldhusen, KH Grote, "Engineering Design: A Systematic Approach", 3/e, Springer, 2007
5. Tom Kelley, Jonathan Littman, "Ten Faces in Innovation", Currency Books, 2006

19EME201: ENGINEERING MECHANICS

L	T	P	C
3	0	0	3

This course is an introduction to learning and applying the principles required to solve engineering mechanics problems. Concepts will be applied in this course from previous courses of basic mathematics and physics This course addresses the modeling and analysis of static equilibrium problems with an emphasis on real world engineering applications and problem solving.This course forms the backbone of mechanical engineering design and acts as a prerequisite to mechanics of solids, design of machine elements and kinematics and dynamics of machinery.

Course Objectives

- Explain the conditions for mechanical equilibrium of the systems subjected to forces and moments.
- Compute geometric properties such as centroid and moment of inertia of various plane sections.
- Explain kinematics of particles and rigid bodies.
- Analyze the rigid bodies under dynamic conditions.
- Expose the concepts of work-energy, conservation of energy and momentum to rigid bodies.

UNIT I

8 hours

Introduction to Engineering Mechanics: Units, Significance of Engineering Mechanics, Composition and resolution of forces, parallelogram law, principle of transmissibility, types of force systems - concurrent and non-concurrent, coplanar forces, resultant of coplanar force systems, couple, moment of a force, Varignon's theorem, concept of free body diagrams, concept of equilibrium of coplanar force systems.

Learning Outcomes:

At the end of this unit, the student will be able to

recognize the significance of Engineering Mechanics in engineering applications . [**L-1**]

calculate the resultant of forces and moments of the system of forces . [**L-3**]

draw free body diagrams of mechanical systems under loads . [**L-3**]

apply the concept of mechanical equilibrium of the systems . [**L-3**]

UNIT II **8**

hours

Friction: Laws of friction, types of friction, equilibrium of force systems involving frictional forces, wedge friction. Free body diagrams involving frictional forces.

Analysis of Structures: Introduction to plane trusses, analysis of plane trusses by method of joints and method of sections.

Learning Outcomes:

At the end of this unit, the student will be able to

- comprehend the role of friction in engineering applications. [**L-2**]
- identify different types of trusses. [**L-2**]
- analyze the plane trusses by method of joints and the method of sections. [**L-4**]

UNIT III **8 hours**

Properties of: Centroid and center of gravity, derivation of centroids from first moment of area, centroids of composite areas.

Moment of Inertia: Area moment of inertia of plane and composite shapes, parallel axis theorem, perpendicular axis theorem, polar moment of inertia, radius of gyration.

Learning Outcomes:

At the end of this unit, the student will be able to

- locate the centre of gravity of plane figures. [**L-1**]
- calculate the centre of gravity of composite plane shapes. [**L-3**]
- understand the concepts of moment of inertia and radius of gyration. [**L-2**]
- determine moment of inertia for composite plane shapes. [**L-3**]

UNIT IV **8 hours**

Kinematics: Equations of motion for rigid bodies under constant and variable acceleration, rectilinear and curvilinear motion, projectile motion, use of rectangular coordinates, tangential and normal coordinates, radius of curvature, rotation of a rigid body about a fixed axis.

Learning Outcomes:

At the end of this unit, the student will be able to

- develop equations of motion for particles and rigid bodies in motion. [**L-3**]
- find velocity and acceleration in rectilinear and curvilinear motions. [**L-3**]
- trace the path of projectile. [**L-2**]

UNIT V **8**

hours

Kinetics: Principles of dynamics - Newton's Laws of motion, D'Alembert's principle in rectilinear translation, principle of work and energy.

Ideal Systems: Principle of conservation of energy, concept of power, conservation of linear momentum, principle of momentum and impulse, impact - types of impact.

Learning Outcomes:

At the end of this unit, the student will be able to

- apply Newton’s laws and D'Alembert's principle in rectilinear translation. [**L-3**]
- apply the principle of work and energy in dynamic systems. [**L-3**]
- use of principles of momentum and impulse on dynamic systems. [**L-3**]

Course Outcomes:

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

- apply equilibrium concepts on mechanical systems [**L-3**]
- Analyse the forces and moments on the mechanical systems [**L-5**]
- Calculate the physical properties of rigid bodies in engineering systems. [**L-3**]
- understand the role of friction in engineering practices [L1]
- analyze various static and dynamic engineering mechanical systems and understand the mechanics and identify the drawbacks/problems. [**L-4**]

Textbook(s):

1. N.H. Dubey, Engineering Mechanics: Statics and Dynamics, Tata McGraw Hill, 2014.

2. S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati, Engineering Mechanics (in SI units), 5/e, McGraw Hill, 2013.

References:

1. Basudeb Bhattacharya, Engineering Mechanics, 2/e, Oxford University Press (India), 2015.

2. Irving Shames, G.K.M. Rao, Engineering Mechanics: Statics and Dynamics, 4/e, Pearson, 2009.

3. K.L. Kumar, Veenu Kumar, Engineering Mechanics, 4/e, Tata McGraw Hill, 2010.

4. S.S. Bhavikatti, Engineering Mechanics, 4/e, New Age International, 2008.

19EME203: THERMODYNAMICS

L	T	P	C
2	1	0	3

The course thermodynamics is foundation course in thermal stream, which draws the attention by connecting day-to-day activities with thermodynamic.
c concepts. The basic concepts such as internal energy, enthalpy, entropy and flow and non-flow process are able to develop the problem-solving skills pertinent to thermodynamics. Further, the course provides enhanced insight into the steam and usage of steam tables

Course Objectives

- Familiarize concepts of heat, work, energy and governing rules for conversion of one form to other.
- Explain relationships between properties of matter and basic laws of thermodynamics.
- Teach the concept of entropy for identifying the disorder and feasibility of a thermodynamic process.
- Introduce the concept of available energy for maximum work conversion.
-
- Familiarize steam properties to understand working of steam power plants.

UNIT I **10 hours**

Introduction: Macroscopic and microscopic viewpoints, definitions of thermodynamic terms, quasi – static process, point and path function, forms of energy, ideal gas and real gas, Zeroth law of thermodynamics.

First law of Thermodynamics: Joule's experiment - first law of thermodynamics, corollaries-perpetual motion machines of first kind, first law applied to non-flow and flow process- limitations of first law of thermodynamics**.**

Learning outcomes

At the end of this Unit, the student will be able to

- Identify thermodynamic systems, properties and their importance in solving engineering problems. (L2)
- explain energy balance for closed systems and open systems. (L3)
- solve simple thermodynamics problems. (L3)

UNIT II **8 hours**

Second Law of Thermodynamics: Kelvin - Planck statement and Clausius statement and their equivalence, corollaries - perpetual motion machines of second kind - reversibility and irreversibility, cause of irreversibility - Carnot cycle, heat engine, heat pump and refrigerator, Carnot theorem, Carnot efficiency.

Learning outcomes

At the end of this Unit, the student will be able to

- apply second law of thermodynamics in design of heat engine, refrigerator and heat pump. (L3)
- explain the efficiency of thermodynamic systems.(L2)
- enumerate the causes for poor performance of thermodynamic systems. (L3)

UNIT III **8 hours**

Entropy: Clausius inequality -Concept of Entropy- entropy equation for different processes and systems

Availability and Irreversibility: Definition of exergy and energy, expressions for availability and irreversibility. Availability in steady flow, non-flow processes, irreversibility.

Learning outcomes

At the end of this Unit, the student will be able to

- apply entropy affects to estimate the performance of systems. (L3)
- evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process. (L3)
- explain thermo-economics. (L3)

UNIT IV **8 hours**

Properties of Steam and use of Steam Tables: Pure Substances, P-V-T surfaces, T-s and h-s diagram, Mollier chart, dryness fraction, property tables, analysis of steam undergoing various thermodynamic processes using Mollier chart– steam calorimetry.

Learning outcomes

At the end of this Unit, the student will be able to

- apply properties of steam to design steam systems. (L3)
- examine steam systems using conservation equations. (L3)
- evaluate the performance of steam systems. (L4)

UNIT V **8 hours**

Thermodynamic Relations: Maxwell relations, TDS equations, difference in heat capacities, ratio of heat capacities, Energy equation, Joule Thompson coefficient, Clausius-Clapeyron equation.

Learning outcomes

At the end of this Unit, the student will be able to

- explain the importance of T-ds equations. (L2)
- relate specific heats, internal energy, enthalpy and Joule-Thomson coefficient in standard form. (L3)

Course Outcomes

After completing the course, the student will be able to

- explain the importance of thermodynamic properties related to conversion of heat energy into work.(L3)
- apply the laws of thermodynamics to boilers, heat pumps, refrigerators, heat engines, compressors and nozzles. (L3)
- apply concept of entropy for identifying the disorder and feasibility of a thermodynamic process
- utilize steam properties to design steam-based components. (L4)
- apply the thermodynamic equations studied to design thermal systems (L4)

Textbook(s)

1. P.K.Nag, Engineering Thermodynamics, 5/e, Tata McGraw Hill, 2013.
2. Yunus A. Cengel, Michaela A. Boles, Thermodynamics, 7/e, Tata McGraw Hill, 2011.

References

1. J.B.Jones and G.A.Hawkins, Introduction to Thermodynamics, 2/e, John Wiley & Sons,2012.
2. Moran, Michael J. and Howard N. Shapiro, Fundamentals of Engineering Thermodynamics, 3/e, Wiley, 2015
3. Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics, 7/e, Wiley, 2009
4. R.K. Rajput, S.Chand & Co., Thermal Engineering, 6/e, Laxmi publications, 2010.

19EME205: MATERIAL SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

The focus of the course is on crystal structures of metals. The course addresses both theoretical and practical aspects of materials engineering. It imparts knowledge on the microstructure, mechanical properties and heat treatment methods of ferrous and nonferrous metals and alloys. This course also gives an insight in to the properties and applications of ceramics, polymers, composites and nanomaterials.

Course Objectives:

- To teach the principles of physical metallurgy, i.e., crystallography of metals, constitution of alloys and construction of phase diagrams.
- To explain the methods to change the properties of steels through various heat treatment processes.
- To explain the properties and applications of commercially important steels and cast irons with their engineering constraints.
- To explain the properties and applications of important nonferrous metals/alloys.
- To familiarize students with the structure, properties and applications of ceramics, polymers, composite materials and nanomaterials.

UNIT I **10 hours**

Structure of Metals: Crystal Structures: Unit cells, Metallic crystal structures. Imperfection in solids: Point, Line and Volume imperfections. Dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

Constitution of Alloys: Necessity of Alloying, substitutional and interstitial solid solutions, Intermediate alloy phases. Phase diagrams: Phase rule, methods of construction of phase diagrams, lever rule. Eutectic, peritectic, peritectoid and monotectic reactions. Study of Iron - Iron carbide diagram and microstructural aspects of ferrite, cementite, austenite, ledeburite and pearlite.

Learning Outcomes:

At the end of this unit the student will be able to

- Recall crystallography of various metals. (L1)
- Distinguish between metals and alloys. (L4)
- Construct binary phase diagrams. (L3)

- Identify various invariant reactions in binary phase diagrams. (L3)

UNIT II **8 hours**

Heat Treatment of Steels: Annealing, normalizing, hardening and tempering. Isothermal transformation diagrams for steels and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties. Aus tempering martempering. Case hardening: Carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening.

Learning Outcomes:

At the end of this unit the student will be able to

- Explain the importance of heat treatment of metals and alloys. (L2)
- Summarize the effect of heat of treatment on modification of properties of steels. (L2)
- Develop a heat treatment cycle based on properties required. (L3)
- Explain the principles of various surface hardening methods. (L2)

UNIT III **8 hours**

Steels: Plain carbon steels, use and limitations of plain carbon steels. Classification of alloys steels. Microstructure, properties and applications of alloy steels - stainless steels and tool steels.

Cast Irons: Microstructure, properties and applications of white cast iron, malleable cast iron, grey cast iron, nodular cast iron and alloy cast irons.

Learning Outcomes:

At the end of this unit the student will be able to

- Explain the uses and limitations of plain carbon steels. (L2)
- Classify various types of alloy steels and explain their microstructure, properties and applications. (L2)
- Identify various types of cast irons and explain their microstructure, properties and applications. (L3)
- Compare properties of steels and cast irons and their limitations. (L4)

UNIT IV **8 ho**

Non-ferrous Metals and Alloys: Microstructure, properties and applications of copper and its alloys, aluminium and its alloys. Study of Al-Cu phase diagram, precipitation hardening. Microstructure, properties and applications of titanium and its alloys.

Learning Outcomes:

At the end of this unit the student will be able to

- Identify the differences between ferrous and non-ferrous metals and alloys. (L3)
- Explain the importance of non-ferrous metals and alloys in engineering applications. (L2)
- Explain various microstructures, properties and applications of commercially important non-ferrous alloys. (L2)
- Identity the difference between hardening method of ferrous and non-ferrous alloys. (L3)

UNIT V **8 hours**

Ceramics, Polymers and Composites: Structure, properties and applications of ceramics, polymers and composites. Introduction to super alloys and nanomaterials.

Learning Outcomes:

At the end of this unit the student will be able to

- Explain the structure, properties and applications of ceramics. (L2)
- Summarize the structure and properties of polymers and composites and their uses. (L2)
- Explain the properties of nanomaterials and their applications. (L2)
- Identify the difference between the micro and nano scale materials and their uses. (L3)

Course Outcomes:

After completing the course, the student will be able to

- Explain the crystallography of metals, constitution of alloys and can construct binary phase diagrams. (L2)
- Select an appropriate heat treatment method to modify the properties of steels. (L3)
- Select a suitable type of steel, cast iron for a given application. (L3)
- Choose an appropriate nonferrous metal/alloy for various applications. (L3)
- Explain the structure, properties and applications of composite, polymer, ceramic materials and nanomaterials. (L2)

Textbook(s):

1. V. Raghavan, Material Science and Engineering, 5/e, Prentice Hall of India, 2004.
2. R. Balasubramaniam, Callister's, Material Science and Engineering, 2/e, Wiley India, 2014.

References:

1. Y. Lakhtin, Engineering Physical Metallurgy, University Press of the Pacific, 2000.
2. S.H. Avner, Introduction to Physical Metallurgy, 2/e, Tata McGraw Hill, 1997.
3. L.H. VanVlack, Elements of Material Science and Engineering, 6/e, Pearson Education, 2008.
4. George E. Dieter, Mechanical Metallurgy, 3/e, Tata McGraw Hill, 2013.

19EME231: COMPUTER AIDED MACHINE DRAWING

L	T	P	C
1	0	3	2.5

This course familiarizes the students to representation of mechanical components such as threads, keys, joints etc. and introduces modelling software to represent assembling and disassembling of mechanical components with emphasis on dimensioning and tolerancing. This course acts as a prerequisite to computer aided engineering software to perform structural and thermal analysis on structures.

Course Objectives

- Introduce conventional representations of materials and machine components.
- Provide Training on 2D and 3D modelling software for creating 2D assembly drawings from 3D assemblies.
- Give exposure to thread profiles, riveted, welded and key joints.
- Teach solid modelling techniques for drawing of machine parts and their sections.
- Familiarize with limits, fits and tolerances in mating components.

The following contents are to be done by any 2D software package.

Conventional representation of materials and components:

Detachable joints: Drawing of thread profiles, hexagonal and square-headed bolts and nuts, bolted joint, bolted joint with washer and locknut, stud joint, screw joint.

Riveted joints: Drawing of rivet, lap joint, butt joint with single strap, single riveted, double riveted double strap joints.

Welded joints: Lap joint and T joint with fillet, butt joint with conventions.

Keys: Taper key, sunk taper key, round key, saddle key, feather key, woodruff key.

Shaft coupling, bushed pin-type flange coupling, universal coupling, Oldhams' coupling.

The following contents to be done by any 3D software package.

Sectional views

Creating solid models of complex machine parts and create sectional views.

Assembly drawings: (Any four of the following using solid model software)

Lathe tool post, tool head of shaping machine, tail stock, machine vice, gate valve, carburettor, piston, connecting rod, excentric, screw jack, plumber block, axle bearing, pipe vice, clamping device, Geneva cam, universal coupling,

Manufacturing drawing:

Representation of limits fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.

Course Outcomes:

After completion of this lab student will be able to

- Demonstrate the conventional representations of materials and machine components. **[L-2]**
- Draw riveted, welded and key joints using CAD system.**[L-3]**
- Create solid models and sectional views of machine components. **[L-3]**
- Generate solid models of machine parts and assemble them. **[L-3]**
- Translate 3D assemblies into 2D drawings. **[L-3]**
- Create manufacturing drawing with dimensional and geometric tolerances. **[L-3]**

Textbook(s):

1. K.L. Narayana, P. Kannaiah, A text book on Engineering Drawing, SciTech Publications, 2014.

References:

1. Cecil Jensen, Jay Helsel and Donald D. Voisinet, Computer Aided Engineering Drawing, Tata McGraw Hill, 2000.
2. James Barclay, Brain Griffiths, Engineering Drawing for Manufacture, Kogan Page Science, 2003.
3. N.D. Bhatt, Machine Drawing, 50/e, Charotar, 2014.
4. K.L. Narayana, Production Drawing, 3/e, NewAge International Publishers, 2014.

19EMC281: CONSTITUTION OF INDIA

(Mandatory Course)

L	T	P	C
3	0	0	0

UNIT I **10 hours**

Introduction to Indian Constitution: Constitutional history, constituent assembly, salient features of the constitution, significance of preamble, amending process of the constitution.

UNIT II **8 hours**

Rights and Duties: Citizenship, fundamental rights and directive principles, fundamental duties.

UNIT III **8 hours**

Union Government: President and vice president, election, removal and powers, prime minister and council of ministers, parliament, supreme court, union, state relations, emergency provisions.

UNIT IV **8 hours**

State and Local Governments: Governor, state legislature, assembly and council, chief minister and council of ministers, high court, rural and urban local governments with special reference to 73rd and 74th constitutional amendment acts.

UNIT V **8 hours**

Other Constitutional and Statutory Bodies: Comptroller and auditor gen-eral, election commission, finance commission, attorney general and advocate general, union public service commission (UPSC), state public service commissions (SPSCs), tribunals, national human rights commission (NHRC).

Text Book(s):

1. J. C. Johari, Indian Government and Politics, Vishal Publications, Delhi, 2009.
2. M. V. Pylee, Introduction to the Constitution of India, 5/e, Vikas Publishing House, Mumbai, 2007.

References:

1. D.D. Basu, Introduction to the Indian Constitution, 21/e, Lexis Nexis, Gurgaon, India, 2011.
2. Subhas C. Kashyap, Our Constitution, 2/e, National Book Trust India, New Delhi, 2013.

19EMC282: ENVIRONMENTAL SCIENCES

(COMMON SYLLABUS FOR ALL BRANCHES)

L	T	P	C
3	0	0	0

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 leads to pollution, finding solutions through application of control measures to combat pollution and legal measures to achieve sustainable development.

COURSE OBJECTIVES

- To familiarize the students about the importance of the environmental studies.
- To acquaint with different natural resources and their associated problems.
- To introduce various ecosystems, values of biodiversity and their conservation.
- To expose to today's pollution levels and their impacts.
- To create awareness on different social issues such as conservation of water, green building concept.
- To study on present population scenario, its impacts and role of informational technology on environment and human health.

UNIT – I

10 hrs

Introduction to Environment and Natural Resources: Introduction to environment: Definition, scope and importance, multidisciplinary nature of environment, need for public awareness. Natural Resources: Renewable and non-renewable resources, natural resources and associated problems. Forest resources: Uses, Reasons for over-exploitation, deforestation effects, timber extraction, case studies. Water resources: Use and over – utilization of surface and ground water, floods, drought, conflicts over water, dams- benefits and problems. Mineral resources: Uses, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, Impacts of overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, use of renewable and non-renewable energy sources, case studies. Role of an individual in conservation of natural resources.Equitable use of resources for sustainable lifestyles.

Learning outcomes

After the completion of the Unit I, the student will be able to

- **list** different renewable and non-renewable resources. **(L1)**
- **learn how** the over-exploitation of natural resources impact human life. **(L1)**
- **demonstrate** the role of an individual in the conservation of natural resources. **(L1)**
- **explain** the equitable use of natural resources for sustainable lifestyles. **(L2)**

UNIT -II **9 hrs**

Ecosystems and Biodiversity: 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. Biogeochemical cycle: (Nitrogen, carbon, Phosphorus cycle). Introduction, types, structure and function of the following ecosystem:- Forest ecosystem. Grassland ecosystem. Desert ecosystem. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity: Definition, Levels of biodiversity: genetic, species and ecosystem diversity. Biogeographical classification of India, Values of biodiversity: consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega – diversity nation.Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Conservation of biodiversity: In – situ and Ex-situ conservation of biodiversity.

Learning outcomes

After the completion of the Unit II, the student will be able to

- **learn** ecosystem functions. **(L1)**
- **explain** the structure and function of terrestrial and aquatic ecosystems. **(L2)**
- **illustrate** the values and threats to biodiversity. **(L2)**
- **explain**t he importance of conservation of biodiversity. **(L2)**

UNIT – III **8 hrs**

Environmental Pollution and Control: Environmental Pollution: Definition, causes, effects and control measures: Air Pollution, Water pollution, Soil pollution, Marine pollution, Thermal pollution, Nuclear hazards, Solid waste Management, e-waste, Hazardous waste management. Role of an individual in prevention of pollution. Pollution case studies. Disaster Management: floods, earthquake, cyclone and landslides.

Learning outcomes

After the completion of the Unit III, the student will be able to

- **list** causes, effects and control measures of pollution (air, water & soil). **(L1)**
- **classify** different types of pollutants. **(L2)**
- **explain** disaster management of floods, earthquake, cyclone and landslides. **(L2)**
- **identify** the pollution related case studies. **(L3)**
- **demonstrate** the role of an individual in prevention of pollution. **(L3)**

UNIT – IV **9 hrs**

Social Issues and Global Environment Problems and Efforts: From unsustainable to sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management, and remote sensing and GIS methods. Resettlement and rehabilitation of people: its problems and concerns. Case Studies, Environmental ethics: Issues and possible solutions. Green building concept, Environmental Impact Assessment (Checklists, matrix methods), Environmental Management Plan, Climate change: global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Learning outcomes

After the completion of the Unit IV, the student will be able to

- **explain**different water conservation methods. **(L2)**
- **compare** remote sensing and GIS methods. **(L2)**
- **apply** green building concept. **(L3)**
- **demonstrate**the consequences of global warming, acid rains and ozone layer depletion. **(L3)**
- **analyze** environmental impact assessment and management plan. **(L4)**

UNIT - V **6 hrs**

Human Population and Environment Legislation: Population growth, variation among nations. Family Welfare programme .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. Forest Conservation Act. Environmental Protection Act, Pollution prevention act. Issues involved in enforcement of environmental legislation. Public awareness. Project Work.

Learning outcomes

After the completion of the Unit V, the student will be able to

- **compare** population growth and variation among nations. **(L2)**
- **apply** value education. **(L3)**
- **classify** women and child welfare. **(L3)**
- **distinguish** different environmental legislation acts and issues involved in enforcement of legislation. **(L4)**
- **analyze** the role of information technology in environment and human health. (**L4)**

COURSE OUTCOMES

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

- **explain** about environment and natural resources. **(L2)**
- **illustrate** the values and threats to biodiversity. **(L2)**
- **identify** the pollution related case studies. **(L3)**
- **demonstrate** the consequences of global warming, acid rains and ozone layer depletion. **(L3)**
- **analyze** the role of information technology in environment and human health. **(L4)**

Text Book:

1. Anubha Kaushik and C.P. Kaushik, Textbook of environmental studies New Age International Publisher (2014).
2. ErachBarucha, Text book of environmental studies for undergraduates courses, published by – University Grants Commission, University Press (2005)
3. AninditaBasak, Environmental Studies. Pearson (2009)

References:

1. D.K. Asthana and Meera Asthana, A Textbook of Environmental Studies, S. Chand (2010).
2. P.M Cherry Solid and Hazardous waste Management, CBS Publisher (2016).
3. Charles H. Ecclestion, Environmental Impact Assessment, CRC Press (2011).
4. K.K. Singh, Natural Resources Conservation and Management, MD Publications (2008).
5. J. Jeffrey Peirce, Ruth F. Weiner and P. AarneVesilind, Environmental Pollution and Control, Butterworth-Heinemann (1998).
6. James Maclaurin and Kim Sterelny, what is Biodiversity, The University of Chicago Press (2008).
7. R.B. Mandal, Introductory Methods in Population Analysis, Concept Publishing Co, (2007).

19EHS221: Comprehensive Skill Development II

L	T	P	A	C
0	0	0	6	1

Course Objectives:

- To encourage the all round development of students by focusing on soft skills, Coding & domain skills.
- To make the engineering students aware of the importance, the role and the content of soft skills, Coding and domain skills through instruction, knowledge acquisition, demonstration and practice.
- To develop and nurture the soft skills, coding and domain skills of the students through individual and group activities.
- To expose students to right attitudinal and behavioral aspects and to build the same through activities

Course Outcomes:

- On completion of the course, student will be able to– Effectively communicate through verbal/oral communication and improve the listening skills
- Write precise briefs or reports and technical documents, Actively participate in group discussion / meetings / interviews and prepare & deliver presentations. Become more effective individual through goal/target setting, self motivation and practicing creative thinking.
- Student will be able to understand the problems and develop his competitive coding skills.
- Apply the skills in various domains and will be able to solve complex problems faced by the industry.
- Function effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality

Part-1

A. Verbal and Soft Skills:

Communication Skills, Presentation Skills, Decision Making and Problem-Solving, Group Discussion.

B. Quantitative Aptitude and Reasoning

Puzzles, Numbers, Arithmetic, Data Interpretation.

Part-2

Coding: Complex problem solving using Data Structures in terms of improving efficiency:

Time Complexity and Space Complexity, Linked List, Stacks and Queues using Linked List, Binary Trees, Binary Search Trees, Trie, Representation of graphs, Breadth First Search, Depth First Search, Dynamic Programming.

SEMESTER IV

19EMA202: ENGINEERING MATHEMATICS IV

(Numerical methods, Probability and Statistics)

(Common to EEE, MECH and CIVIL)

L	T	P	C
3	0	0	3

This course is designed to cover basic numerical methods, probability& statistical concepts. The first two units focus on solution of algebraic equations, interpolation and numerical methods for differentiation and integration, the other three units cover the concepts of probability and statistics to lay a strong foundation in engineering applications.

Course Objectives:

- To familiarize the students with the ways of solving nonlinear equations numerically.
- To teach various topics such as interpolation, numerical differentiation, numerical integration and numerical solution of ordinary differential equations.
- To impart knowledge on the concepts in probability, random variables and several distributions in engineering applications.
- To demonstrate the concept of Testing of hypothesis for large and small samples.

UNIT I: **9 hrs**

Solution to Algebraic Equations: Solution of polynomial and transcendental equations: bisection method and Newton-Raphson method. Finite differences, relation between operators, interpolation using Newton's forward and backward difference formulae, interpolation with unequal intervals: Lagrange's formula.

Learning Outcomes:

At the end of this unit, the student will be able to

- find approximate roots of the an equation by using different numerical methods (L3)
- explain various discrete operators and find the relation among operators(L3)
- apply Newton's forward and backward formulae for equal and unequal intervals (L3)

UNIT II: **10 hrs**

Numerical Differentiation and Integration: Numerical Differentiation- Newton's forward and backward difference formulae, numerical integration- trapezoidal rule and Simpson's 1/3rd and 3/8 rules. Ordinary differential equations- Euler, modified Euler's, Runge-Kutta method of fourth order for solving first and second order equations.

Learning Outcomes:

At the end of this unit, the student will be able to

- find differentiation of a function by using different numerical methods (L3)
- find integration of a function by using different numerical methods (L3)
- solve ordinary differential equations by using different numerical schemes (L3)

UNIT III: **8 hrs**

Probability: Random variables (discrete and continuous)**,** probability distribution: Binomial - Poisson approximation to the binomial distribution, normal distribution and exponential distribution-their properties (mathematical expectation and variance).

Learning Outcomes:

At the end of this unit, the student will be able to

- apply Binomial and Poisson distributions for real data to compute probabilities, theoretical frequencies (L3)
- interpret the properties of normal distribution, exponential distribution and their applications (L3)

UNIT IV: **8 hrs**

Testing of Hypothesis: Formulation of null hypothesis, critical regions, level of significance.

Large sample tests: test for single proportion, difference of proportions, test for single mean and difference of means.

Learning Outcomes:

At the end of this unit, the student will be able to

- explain the concept of estimation, interval estimation and confidence intervals (L3)
- apply the concept of hypothesis testing for large samples (L3)

UNIT V: **7 hrs**

Small Sample Tests: Student t-distribution (single mean, two means and paired t-test), Testing of equality of variances (F-test), $\chi 2$ - test for goodness of fit.

Learning Outcomes:

At the end of this unit, the student will be able to

- apply the concept of testing hypothesis for small samples to draw the inferences (L3)
- test for the goodness of fit (L4)

Course Outcomes:

At the end of the course students will be able to

- solve approximating the roots of polynomial and transcendental equations by different algorithms (L3)

- apply different algorithms for approximating the solutions of ordinary differential equations to its analytical computations (L3)
- apply discrete and continuous probability distributions (L3)
- identify the components of a classical hypothesis test (L3)
- inference based on small and large sampling tests using statistical methods (L4)

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.
2. P. Kandasamy, K. Thilagavathy, K. Gunavathi, Numerical Methods, S. Chand & Company, 2/e, Reprint 2012.

References:

1. Veerarajan T., Engineering Mathematics, Tata McGraw-Hill, New Delhi, 2008.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9/e, John Wiley & Sons, 2006.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.

19EID234: LIFE SCIENCES FOR ENGINEERS

L	T	P	C
2	0	2	3

This course introduces the student, to the basics of biology such as cell structure, bimolecular structure and function, metabolism, inheritance and basic concepts of recombinant DNA technology.

Course 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 I **(5+5) hours**

Introduction to Biology: Comparison of eye and camera, flying bird and aircraft, Biological observations and major discoveries- genera, species and strains, and Classification of living organisms: Cellularity, Ultrastructure, carbon and energy sources, excretion, habitat and molecular taxonomy.

Learning Outcomes:

After completing this unit, the student will be able to

- summarize the basis of life. (L2)
- distinguish prokaryotes from eukaryotes. (L3)
- compare biological organisms and manmade systems. (L2)
- classify organisms. (L2)

UNIT II **(6+6) hours**

Water, Biomolecules: sugars, starch and cellulose, Amino acids and proteins, lipids, Nucleotides and DNA/RNA, structure and functions of proteins and nucleic acids, haemoglobin, antibodies and enzymes, Industrial applications of enzymes, Fermentation and its industrial applications

Learning Outcomes:

After completing this unit, the student will be able to

- outline the importance of water. (L2)
- explain the relationship between monomeric units and polymeric units (L2)

- explain the relationship between the structure and function of proteins. (L2)
- interpret the relationship between the structure and function of nucleic acids. (L2)
- summarize the applications of enzymes in industry. (L2)
- explain the applications of fermentation in industry. (L2)

UNIT III **(6+6) hours**

Bioenergetics, Respiration: Glycolysis and TCA cycle, Electron transport chain and oxidative phosphorylation, Mechanism of photosynthesis, Human physiology, neurons, synaptic and neuromuscular junctions

Learning Outcomes:

After completing this unit, the student will be able to

- apply thermodynamic principles to biological systems. (L2)
- explain the mechanism of respiration and photosynthesis. (L2)
- summarize the principles of information transfer and processing in humans. (L2)

UNIT IV **(6+6) hours**

Mendel's laws, gene mapping, Mitosis and Meiosis, Epistasis, single gene disorders in humans, Genetic code, DNA replication, Transcription, Translation

Learning Outcomes:

After completing this unit, the student will be able to

- define Mendel's laws. (L1)
- demonstrate the mapping of genes. (L2)
- explain interactions among genes and their significance.
- differentiate the mitosis and meiosis. (L3)
- explain the medical importance of gene disorders. (L2)
- identify DNA as a genetic material in the molecular basis of information transfer. (L2)

UNIT V **(5+5) hours**

Recombinant DNA Technology: recombinant vaccines, transgenic microbes, plants and animals, animal cloning, biosensors, biochips.

Learning Outcomes:

After completing this unit, the student will be able to

- outline the principles of recombinant DNA technology. (L2)
- appreciate the potential of recombinant DNA technology. (L2)
- summarize the use of biological materials for diagnostic devises. (L2)

Course Outcomes

After studying the course, the student will be able to:

- explain catalytic properties of enzymes. (L2)
- summarize application of enzymes and fermentation in industry. (L2)
- identify DNA as a genetic material in the molecular basis of information transfer. (L2)
- apply thermodynamic principles to biological systems. (L2)
- analyze biological processes at the reductionistic level. (L4)
- appreciate the potential of recombinant DNA technology. (L2)

Lab Experiments (Virtual or Field Experiments)

Microscopy, Mendel's laws, mapping, interactions, - 4 lab experiments

Nitrogen cycle, Species interactions, Sterilization, Bacterial population growth, - 4 lab experiments

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

Reference Books:

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

19EID232: **INTERNET OF THINGS**

(For 2020-21 Odd and Even Sems and 2021-22 Odd Sem only)

L	T	P	C
2	0	2	3

The Internet of Things (IoT) is a network of a wide variety of devices like vehicles, humans, soil etc. These devices gather data using sensors, which can be used for monitoring or control. This course is an introduction to the embedded devices, communication protocols and APIs used in IoT.

Course Objectives

- Introduce the fundamental concepts of IoT and physical computing.
- Expose the student to a variety of embedded boards and IoT Platforms
- Create a basic understanding of the communication protocols in IoT communications.
- Familiarize the student with application program interfaces for IoT.
- Enable students to create simple IoT applications.

UNIT I **5 L**

Overview of IoT: The Internet of Things: An Overview, The Flavor of the Internet of Things, the "Internet" of "Things", The Technology of the Internet of Things, Enchanted Objects, Who is Making the Internet of Things? Design Principles for Connected Devices, Calm and Ambient Technology, Privacy, Keeping Secrets, Whose Data Is It Anyway?,Web Thinking for Connected Devices, Small Pieces, Loosely Joined, First-Class Citizens On The Internet, Graceful Degradation, Affordances.

Learning Outcomes:

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

- explain IoT architecture(L2)
- interpret the design principles that govern connected devices(L2)
- summarize the roles of various organizations for IoT(L2)

UNIT II **6 L**

Embedded Devices - I: Embedded Computing Basics, Microcontrollers, System-on-Chips, Choosing Your Platform, Arduino, Developing on the Arduino, Some Notes on the Hardware, Openness.

Learning Outcomes:

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

- explain the basics of microcontrollers(L2)
- outline the architecture of Arduino(L2)
- develop simple applications using Arduino(L3)

UNIT III **6 L**

Embedded Devices - II: Raspberry Pi, Cases and Extension Boards, Developing on the Raspberry Pi, Some Notes on the Hardware, Openness, Other notable platforms, Mobile phones and tablets, Plug Computing: Always-on Internet of Things.

Learning Outcomes:

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

- outline the architecture of Raspberry Pi(L2)
- develop simple applications using Raspberry Pi(L3)
- select a platform for a particular embedded computing application(L3)

UNIT IV **6 L**

Communication in the IoT: Internet Principles, Internet Communications: An Overview, IP, TCP, The IP Protocol Suite (TCP/IP), UDP, IP Addresses, DNS, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6, MAC Addresses, TCP and UDP Ports, An Example: HTTP Ports, Other Common Ports, Application Layer Protocols- HTTP, HTTPS: Encrypted HTTP, Other Application Layer Protocols.

Learning Outcomes:

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

- interpret different protocols and compare them(L2)
- select which protocol can be used for a specific application(L3)
- utilize the Internet communication protocols for IoT applications(L3)

UNIT V **5 L**

Prototyping Online Components: Getting Started with an API, Mashing Up APIs, Scraping, Legalities, writing a New API, Clockodillo, Security, Implementing the API, Using Curl to Test, Going Further, ReaLTime Reactions, Polling, Comet, Other Protocols, MQ Telemetry Transport, Extensible Messaging and Presence Protocol, Constrained Application Protocol.

Learning Outcomes:

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

- select IoT APIs for an application(L3)
- design and develop a solution for a given application using APIs(L6)
- test for errors in the application(L4)
- judge the security issues in Real time applications. (L5)

INTERNET OF THINGS LABORATORY

List of Practical Experiments:

1. Select any one development board (Eg., Arduino or Raspberry Pi) and control LED usingthe board.
2. Using the same board as in (1), read data from a sensor. Experiment with both analog anddigital sensors.
3. Control any two actuators connected to the development board using Bluetooth.
4. Read data from sensor and send it to a requesting client. (using socket communication)Note: The client and server should be connected to the same local area network.
5. Create any cloud platform account, explore IoT services and register a thing on theplatform.
6. Push sensor data to cloud.
7. Control an actuator through cloud.
8. Access the data pushed from sensor to cloud and apply any data analytics or visualizationservices.
9. Create a mobile app to control an actuator.
10. Identify a problem in your local area or college which can be solved by integrating thethings you learned so far and create a prototype to solve it (Mini Project).

Textbook(s):

Adrian McEwen, Hakim Cassimally, Designing the Internet of Things, Wiley Publications,2012.

References

1. ArshdeepBahga, Vijay Madisetti, Internet of Things: A Hands-On Approach,Universities Press, 2014.
2. Pethuru Raj, Anupama C. Raman, The Internet of Things, Enabling technologies and usecases –CRC Press, 2017.

WebSources

https://www.arduino.cc/

https://www.raspberrypi.org/

Course Outcomes:

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

- choose the sensors and actuators for an IoT application(L1)
- select protocols for a specific IoT application(L2)
- utilize the cloud platform and APIs for IoT application(L3)
- experiment with embedded boards for creating IoT prototypes(L3)
- design a solution for a given IoT application(L6)

19EID232: INTERNET OF THINGS
(With effect from 2021-22 Even Semester)

L T P C
2 0 2 3

The Internet of Things (IoT) is a network of a wide variety of devices like vehicles, humans, soil etc. These devices gather data using sensors, which can be used for monitoring or control. This course is an introduction to the embedded devices, communication protocols and APIs used in IoT.

Course Objectives

- Introduce the fundamental concepts of IoT and its characteristics
- Expose the student to sensors used for sensing different physical quantities
- Create a basic understanding of the communication protocols in IoT communications.
- Familiarize the student with different application program interfaces for accessing Cloud services.
- Enable students to create simple IoT applications.

Unit I **5 Hours**

Introduction to Internet of Things (IoT): Introduction and Definition of Internet of Things, IoT Growth, Application Areas of IoT, Characteristics of IoT, Things in IoT, IoT Stack, Enabling Technologies, IoT Challenges, IoT Levels, IoT vs. Cyber physical Systems, IoT vs WSN

Learning Outcomes:

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

- describe IoT architecture and application areas (L2)
- interpret the design principles that govern connected devices(L2)
- summarize the different IoT levels and compare with different systems (L2)

Unit II **6 Hours**

Introduction to Sensors, Microcontrollers, and Their Interfacing: Introduction to Sensor Interfacing, Types of Sensors, Controlling Sensors through Webpages, Microcontrollers

Learning Outcomes:

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

- list the different physical quantities and their sensing mechanisms (L1)
- describing the interfacing of sensors with embedded computing systems (like Arduino/Raspberry Pi and electrical signal relationships(L2)
- demonstrate the control of sensors using webpage interfaces (L4)

Unit III **6 Hours**

Protocols for IoT – Messaging and Transport Protocols: Messaging Protocols, Transport Protocols (Li-Fi, BLE), Protocols for IoT – Addressing and Identification: Internet Protocol Version 4 (IPv4), Internet Protocol Version 6 (IPv6), Uniform Resource Identifier (URI)

Learning Outcomes:

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

- interpret different protocols and compare them(L2)
- select which protocol can be used for a specific application(L3)
- utilize the Internet communication protocols for IoT applications(L3)

Un**it IV** **5 Hours**

Cloud for IoT: IoT with Cloud – Challenges, Selection of Cloud Service Provider for IoT Applications, Introduction to Fog Computing, Cloud Computing: Security Aspects, Case Study: How to use Adafruit Cloud?

Learning Outcomes:

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

- describe the cloud architecture for collecting data from different sensors and analyzing them (L2)
- choose a service provider for a specific IoT application(L3)
- analyze different case studies involving Cloud IoT and discuss the security aspects (L3)

Unit V **6 Hours**

Data Analytics – Visualizing the Power of Data from IoT, Data Analysis, Machine Learning, Types of Machine Learning Models, Model Building Process, Modelling Algorithms, Model Performance.

Application Building with IoT: Smart Perishable Tracking with IoT and Sensors, Smart Healthcare – Elderly Fall Detection with IoT and Sensors, IoT–Based Application to Monitor Water Quality

Smart Warehouse Monitoring, Smart Retail

Learning Outcomes:

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

- describe the architecture of IoT involving data collection and analysis
- list the types of machine learning models used to analyze collected data (L2)
- discuss different applications of IoT illustrating the use of different data analyses and machine learning algorithms (L3)

Text Book:

1. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, Internet of Things, Wiley India, 2019

List of Experiments (2 Hours each)

1. Blinking led with Arduino using software delay, LED Control with switch
2. Temperature measurement using LM35 and display both on LCD and serial monitor
3. Control DC motor with H-bridge and as well as PWM
4. Raspberry pi installation and led control
5. DHT11 sensor interfacing to Raspberry pi and Transfer the data to Thing speak server
6. Interfacing camera and raspberry pi
7. Accelerometer ADXL345 with i2c with raspberry pi
8. Nodemcu to control LED with thinger.io
9. With Nodemcu HTTP protocol get and post
10. With nodemcu Webserver control led
11. MQTT protocol using Nodemcu
12. Blinky app with led control

Text Book(s)

1. Simon Monk, Programming Arduino: Getting Started with Sketches, Mc Graw Hill Publications, 2011
2. Simon Monk, Programming the Raspberry Pi, Getting Started with Python, Mc Graw Hill Publications, 2015
3. Simon Monk, Hacking Electronics: Learning Electronics with Arduino and Raspberry Pi, Mc Graw Hill Publications, 2017
4. Manoj R. Thakur, NodeMCU ESP8266 Communication Methods and Protocols : Programming with Arduino IDE Amazon Media, 2018.

19EME202: STRENGTH OF MATERIALS

L	T	P	C
3	1	0	4

This course helps in understanding the material and geometrical behaviour of solid structures such as beams, shafts and other members. This courses teaches the fundamentals required to perform design calculations to check the safety, reliability and life of structures and other mechanical components and hence central to the whole activity of engineering design. The basic knowledge gained from this course is vital to understanding advanced material behaviour which can later be studied in courses such as design of machinery and polymer materials

Course Objectives:

- Introduce the concepts of different stresses, strains and their relationships.
- Explain shear force and bending moment of different beams under different loading conditions.
- Demonstrate the calculation of bending stresses and shear stresses on beams and to predict the slope and deflection of beams
- Explain shearing stresses and strains in a circular shaft subject to torsion
- Discuss the principal stresses and components of stress on different planes under different loads

UNIT I **10 hours**

Simple Stresses and Strains: Types of stresses and strains - Hooke's law in three dimensions, stress- strain diagrams - Axially loaded bars of uniform and varying cross section, Compound bars, Relation between elastic moduli, Thermal stresses.

Learning outcomes:

After completing this unit, the student will be able to

- determine the stresses and deformation due to axial loads in simple structures. (L3)
- analyse the stresses in compound bars. (L4)
- understand the relationships between various elastic constants. (L1)
- analyse the stresses in bars due to temperature change.(L4)

UNIT II **10 hours**

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Shear Force and Bending Moment Diagrams: Types of beams and loads, Shear force and bending moment diagram for cantilever, simply supported and overhanging beams for different types of loadings, Point of contra flexure, Relation between load, shearing force and bending moment.

Learning outcomes:

After completing this unit, the student will be able to

- draw shear force and bending moment diagrams of beams under different loading conditions.(L3)
- evaluate the maximum shear force and bending moment and their location in beams. (L3)
- Locate contra flexural points

UNIT III **10 hours**

Bending and Shear stresses in beams: Flexural formula, distribution of bending and shear stresses across various cross sections of beams.

Learning outcomes:

After completing this unit, the student will be able to

- determine bending and shear stresses in beams under different loading. (L3)

UNIT IV **10 hours**

Torsion of Circular Shafts: Torsion - Torsion equation - solid and hollow circular shaft - Torsional rigidity - power transmitted by the shafts, combined bending and torsion.

Complex stresses: Biaxial state of stress with and without shear- principal stresses - Mohr's circ

Learning outcomes:

After completing this unit, the student will be able to

- analyse circular shafts subjected to twisting couple. (L4)
- design shafts for power transmission. (L4)
- Understand the principal stresses and planes
- construct the Mohr's circle for calculating stresses on oblique planes.(L4)

UNIT V . **8 hours**

Deflection of Beams: Differential equations of the deflection curve, Slope and deflection using double integration method, Macaulay's method

Learning outcomes:

After completing this unit, the student will be able to

- compute the slope and deflection in beam under different loading.(L3)
- distinguish various approaches for calculating slope and deflection. (L2)v

Text Books:

1. F.P. Beer, E.R. Johnston, Jr&John.T. DeWolf, Mechanics of Materials, 7/e, Tata McGraw-Hill, 2016.
2. SS Rattan, Strength of materials, 3/e, Tata McGraw-Hill, 2016.

References:

1. Timoshenko, Strength of Materials Part-I& II, 3/e, CBS Publishers, 2004.
2. Popov, Mechanics of Solids, 2/e, New Pearson Education, 2015.

Course Outcomes:

After successful completion of this course student will be able to

- Understand the concepts of stress and strains in members due to different types of loading. (L1)
- Interpret the significance of shear forces and bending moments in beams. (L2)
- Apply the concepts of shear forces and bending moments to find the stresses, slopes and deflections in beams.(L3)
- Analyse the stresses and strains in various mechanical Engineering components.(L5)

19EME232: APPLIED THERMODYNAMICS

L	T	P	C
2	1	3	4.5

The course Applied Thermodynamics is the application of the concepts acquired course from previous courses you have taken in Engineering Thermodynamics. This course mainly focus on air-standard and vapour cycles where thermodynamic process involving energy conversion takes place in power plants, compressors, turbines or rocket engines, IC engines, refrigeration systems. The knowledge of this course is essential in solving several practical applications in the power sector.

Course Objectives

- provide fundamental concepts of thermodynamic cycles used in steam power plants, IC engines and gas turbines
- familiarize the developments in IC engines.
- teach combustion process in SI and CI engines.
- familiarize concepts of thermodynamic cycles used in steam power plants and gas turbines
- impart knowledge on the working of nozzles, refrigeration and air conditioning

UNIT I **8 hours**

Air Standard Cycles: Otto, Diesel and dual cycles, P-V and T -S diagrams - description and efficiencies, mean effective pressures. Comparison of Otto, Diesel and dual cycle

IC Engines: Working and classification of IC engines, comparison of two stroke and four stroke engines, comparison of SI and CI Engines.

Learning outcomes

At the end of this Unit, the student will be able to

- examine the importance of compression ratio. (L2)
- explain the cycles on which internal combustion engines work. (L3)
- understand working of IC engines on the basis of thermodynamic cycles. (L2)

UNIT II **10 hours**

Testing and Performance of IC Engines: Methods of testing IC Engines, performance analysis of IC Engines.

Combustion in IC Engines: SI engine: stages of combustion, normal combustion, abnormal combustion, variables effecting delay period and knocking, pre-ignition. CI engine: stages of combustion, normal combustion, abnormal combustion, variables effecting delay period and knocking. Fuel requirements and fuel rating.

Learning outcomes :

After completion of this unit, students will be able to

- Estimate engine performance. (L4)
- Identify the effects of abnormal combustion in IC engines. (L3)

UNIT III **8 hours**

Vapour Power Cycles: Vapour power cycle, simple Rankine cycle, mean temp of heat addition thermodynamic variables effecting efficiency and output of Rankine cycle

Nozzles: Type of nozzles - air and steam nozzles. Compressible flow through nozzle-condition for maximum discharge - nozzle efficiency.

Learning outcomes:

After completion of this unit, students will be able to

- Explain concepts of vapour power cycle used in steam power plant. (L2)
- compare the performance of nozzles, used in turbines. (L2)

UNIT IV **8 hours**

Gas power Cycle: Brayton cycle, Simple gas turbine plant, closed cycle and open cycle for gas turbines, condition for maximum pressure ratio and optimum pressure ratio, actual cycle

Learning outcomes:

After completion of this unit, students will be able to

- Evaluate the cycles used in gas turbines. (L4)
- outline the jet propulsion system (L2)

UNIT V **8 hours**

Refrigeration: Bell-Coleman cycle - vapour compression cycle, effect of vapour condition on COP of VCR, vapour absorption cycle, properties of common refrigerants

Principles of Psychrometry and Air Conditioning: Psychometric terms, psychometric processes and air conditioning systems.

Learning outcomes:

After completion of this unit, students will be able to

- Outline the operation of refrigerators. (L2)
- identify different refrigerants and applications. (L3)
- Use properties of moist air in calculations for air-conditioning system. (L3)

Textbook(s)

1. Ganesan V, Internal Combustion Engines, Tata McGraw Hill, 2017.
2. M.L.Mathur and F.S.Mehta, Thermal Engineering, Jain brothers,2014

References:

1. Cengal Y.A and Boles M.A, Thermodynamics: An Engineering Approach, 5/e, McGraw-Hill, 2006.
2. Yahya, S. M., Turbines, Compressors and Fans, 4/e, Tata McGraw Hill, 2010.
3. Nag P.K, Engineering Thermodynamics, 4/e, Tata McGraw-Hill, 2008.
4. Onkar Singh, Thermal Turbomachines, 3/e, Wiley India, 2014.
5. P.L.Ballaney, Thermal Engineering, 2/e, Khanna, 2005.

Course Outcomes

After completing this course, the students will be able to

- compare thermodynamic relations and air standard cycles. (L2)
- Explain working of IC engines with combustion process. (L2)
- use T-s diagram in vapour power and gas power cycles. (L3)
- select appropriate refrigerant for different applications. (L3)

THERMAL ENGINEERING LAB

Course Objectives:

- Understand the functioning and performance of I.C. Engines
- Find heat losses in various engines.

LIST OF EXPERIMENTS

1. Demonstration of diesel and petrol engines by cut models.
2. Valve timing diagram of 4-stroke diesel engine
3. Port timing diagram of 2-stroke petrol engine
4. Performance of 2-stroke single cylinder petrol engine
5. Morse test on multi cylinder petrol engine
6. Performance of 4-stroke single cylinder diesel engine
7. Performance of two stage reciprocating air compressor
8. Performance of Refrigeration system

9. Performance of Air conditioning system
10. Assembly and disassembly of diesel and petrol engines
11. Performance of heat pipe
12. Performance of heat pump
13. Exhaust gas analysis of orsat apparatus.
14. Determinations of nozzle characteristics.

Course Outcomes

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

- Explain different working cycles of engine.
- describe various types of combustion chambers in IC engines.
- illustrate the working of refrigeration and air conditioning systems.
- evaluate heat balance sheet of IC engine.

19EME234: FLUID MECHANICS

L	T	P	C
3	1	3	5.5

This course provides an introduction to the properties of fluids. It introduces concepts of statics, kinematics and dynamics of fluids and unfolds the procedure to develop the underlying governing equations that explains the behaviour of fluids in motion. Successively, solutions to various practical problem involving internal flows and external flows are covered. This course extends to compressible fluid flow concepts at fundamental level and addresses the dimensional analysis and enables to apply the concepts in wide range of disciplines engineering.

Course Objectives

- To impart the knowledge of fluid properties and their behavior in static and dynamic states.
- To acquaint mathematical techniques to fluid flow problems.
- To familiarize solution methods in one dimensional viscous flow of different cases
- To introduce the concepts of boundary layer
- To teach the concepts of compressible fluids

UNIT-I **9 hours**

Definition of fluid. Properties of fluid, compressibility, surface tension, vapour pressure, Newton's law of viscosity, Newtonian and Non-Newtonian fluids. Pressure and its measurement, basic principles of hydrostatic forces on surfaces.

Fluid kinematics: Classification of flows-steady and unsteady, uniform and non-uniform, laminar and turbulent, rotational and irrational, viscous and inviscid, internal and external flows, continuity equation,stream line, stream tube, stream function, potential function, vorticity and circulation, vortex motion, free and forced vortices.

Learning outcomes:

After completion of this unit, students will be able to

- interpret the properties of fluid and their application (L2)
- select appropriate method for analyzing fluid flow problems (L1)
- understand principles of continuity in fluid motions (L2)

UNIT – II **9 hours**

Fluid Dynamics: Conservation of momentum, conservation of energy, Euler's equation, Bernoulli's equation Measurement of flow- Venturimeter, Orificemeter and Pitot tube.

Flow through pipes: Loss of head due to friction in pipes, Darcy-Weisbach equation - friction factor, minor losses. Laminar and turbulent flow through pipes, Hagen-Poiseuille flow.

Learning outcomes:

After completion of this unit, students will be able to

- convert conservation laws into flow governing equations (L3)
- apply Bernoulli's principle for determining flow in measuring devices (L3)
- solve governing equations for solutions of simple fluid flow problems (L3)
- compute major and minor losses in pipe flows (L4)

UNIT – III

Boundary layer theory: Concept of boundary layer, boundary layer thicknesses, von-Karman momentum integral method, effect of pressure gradient, Boundary layer separation, Methods to prevent separation.

Learning outcomes:

After completion of this unit, students will be able to

- identify importance of boundary layer theory (L3)
- evaluate factors influencing laminar and turbulent flow (L4)
- employ suitable method to control flow separation(L4)

UNIT – IV **9 hours**

Dimensional analysis: Fundamental and derived dimensions, Rayleigh method, Buckingham theorem, dimensionless groups, application of dimensional groups, model testing and similitude, types of similarity - geometric, kinematic and dynamic, model testing methods.

Learning outcomes:

After completion of this unit, students will be able to

- Identify repeating and non-repeating variables to form π- terms
- employ suitable scaling laws for converting model to prototype (L3)
- use similitude principle to test prototypes of machines (L3)

UNIT – V **9 hours**

Compressible fluid flow: Introduction, thermodynamic relations, basic equations in compressible flow, velocity of pressure wave in a fluid, propagation of pressure waves, Mach number, stagnation properties, area and velocity relation in compressible flow, applications

Learning outcomes:

After completion of this unit, students will be able to

- identify the difference between compressible and incompressible flows (L2)
- use the gas equation for compressible fluid flow (L2)
- apply Mach number in compressible fluid flow applications (L3)

Text Book(s)

1) S K Som, Gautam Biswas, S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, McGraw Hill Education, 2017

References:

2) C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, Fluid Mechanics and Machinery, OxfordUniversity Press, 2010
3) P N Modi and S M Seth, Hydraulics & Fluid Mechanics Including Hydraulics Machines, Standard Book House, 2017
4) YunusCengel, John Cimbala, Fluid Mechanics, McGraw Hill Education, 2017
5) Jagdish Lal, Hydraulic Machines Including Fluidics, Metropolitan Book Co. Pvt. Ltd., 2016

Course Outcomes

At the end of the course, student will be able to

- Interpret the behavior under static and dynamic conditions. (L2)
- analyze one dimensional viscous flows using conservation laws for compressible and incompressible flows. (L4)
- apply boundary layer flows for laminar and turbulent regimes. (L3)
- explain procedure of dimensional analysis and its application. (L3)
- compare compressible and incompressible flows and interpret significance of Mach number (L2)

FLUID MECHANICS AND HYDRAULIC MACHINERY LAB

Course Objectives:

- Explain the application of Bernoulli's equation in internal flows
- Familiarize with the performance of turbines and pumps
- Develop skill for measurement of pressure in external flows

LIST OF EXPERIMENTS

1. Free and Forced vortex apparatus
2. Calibration of Venturi meter / Orifice meter
3. Resistance characteristics of pipes – friction factor.
4. Minor losses in pipes – sudden contraction/bends/valves
5. Impact of a jet on flat and curved plates
6. Performance characteristics of single and multi stage centrifugal pump.
7. Performance characteristics of reciprocating pump.
8. Performance characteristics of Pelton wheel turbine.
9. Performance characteristics of Francis turbine.
10. Performance characteristics of Kaplan turbine.

Course Outcomes:

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

- explain the devices used for measuring flow
- compute major losses in pipes
- illustrate the operating parameters of turbines
- explain the working of different types of pumps

19EME204: MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

This course emphasizes the basics of various manufacturing processes so that the student will able to choose an appropriate manufacturing process for a given application. It imparts knowledge of unconventional processes and their application.

Course Objectives:

- To explain different casting processes and gating systems.
- To familiarize with different welding processes and welding defects.
- To teach plastic deformation, cold and hot working process,different types of rolling mills.
- To explain forging tools and dies.
- To familiarize manufacturing methods of plastics, ceramics and powder metallurgy components.

UNIT I **8 hours**

Introduction: Importance and selection of manufacturing processes.

Casting Processes: Introduction to casting process. Process steps. Pattern: types, materials and allowance. Cores: Types of cores, core prints. Principles and design of gating system. Solidification of casting: Concept, solidification of pure metal and alloy. Special casting processes: Shell casting, investment casting, die casting, centrifugal casting. Casting defects and remedies.

Learning Outcomes:

At the end of this unit, the student will be able to

- Select suitable manufacturing process for a given product. (L3)
- describe steps involved in and metal casting, pattern making. (L2)
- choose gating systems and risers. (L3)
- compare the working of various metal casting processes. (L2)
- identify the various casting defects. (L3)

UNIT II **8 hours**

Metal Forming: Introduction, nature of plastic deformation, hot and cold working of metals, mechanics of metal forming; Rolling: Principle, types of rolling mill and products, roll passes, forces in rolling and power requirements. Extrusion: Basic extrusion process and its characteristics, hot extrusion and cold extrusion, wire drawing, tube drawing.

Forging: Principle of forging. Tools and dies used in forging. Types: Smith forging, drop forging, forging hammers, rotary forging and forging defects. Sheet metal forming: Mechanics of sheet metal working, blanking, piercing, bending, stamping.

Learning Outcomes:

At the end of this unit, the student will be able to

- compare cold working and hot working processes. (L2)
- explain the working of rolling mills. (L2)
- evaluate the forces and power in rolling and extrusion processes. (L3)
- summarize the working of various extrusion processes. (L2)
- identify the principles of forging, tools and dies. (L3)
- summarize the various operations of Sheet metal forming. (L2)

UNIT III **8hours**

Metal Joining Processes: Classification of welding processes, types of welds and welded joints and V-I characteristics, arc welding, weld bead geometry, submerged arc welding, gas tungsten arc welding, gas metal arc welding. Applications, advantages and disadvantages of the above processes. Heat affected zone in welding. Soldering and brazing: Types and their applications. Welding defects: causes and remedies.

Learning Outcomes:

At the end of this unit, the student will be able to

- classify various welding processes. (L2)
- explain V-I characteristics of different welding processes. (L2)
- summarize the applications, advantages of various welding processes. (L2)
- identify the defects in welding. (L3)

UNIT IV: Plastic Processing, Ceramics and Powder Metallurgy: **8 hours**

Plastics: Processing of plastics, extrusion of plastics, transfer molding and compression molding, injection molding, thermoforming, rotational molding and blow molding.

Ceramics: Ceramic powder preparation; Processing of ceramic parts: Pressing, casting, sintering; secondary processing of ceramics: Coatings, finishing.

Powder Metallurgy: Manufacture of powders, steps involved in making a component using powder metallurgy.

Learning Outcomes:

At the end of this unit, the student will be able to

- explain methods of manufacturing plastics parts. (L2)
- explain the steps in making ceramics parts. (L2)
- explain the steps in manufacturing of powder metallurgy parts. (L2)
  illustrate the application of plastic, ceramics and power metallurgy. (L2)

UNIT V **10 hours**

Unconventional Machining Processes: Principle and processes parameters of Electrical discharge machining (EDM), electro-chemical machining (ECM) Laser beam machining (LBM), plasma arc machining (PAM), electron beam machining (EBM), Abrasive jet machining (AJM), water jet machining and ultrasonic machining

Learning Outcomes:

At the end of this unit, the student will be able to

- identify different unconventional machining processes. (L2)
- evaluate process parameters of EDM, ECM, LBM, PAM and AJM.(L4)
- apply various unconventional machining processes. (L3)

Course Outcomes:

At the end of the course, the student will be able to

- demonstrate different metal casting processes and gating systems. (L2)
- classify working of various welding processes. (L2)
- evaluate the forces and power requirements in rolling process. (L4)
- explain the principles of various forging operations. (L3)
- outline the manufacturing methods of plastics, ceramics and powder metallurgy. (L1)
- identify different unconventional processes and their applications. (L3)

Text Books:

1. S.Kalpakjain andS.R.Schmid, Manufacturing Engineering and Technology, 7/e, Pearson, 2018.
2. P.N.Rao, Manufacturing Technology – Volume I, 5/e, McGraw-Hill Education, 2018.

Reference Books:

1. P.Millek. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and Systems, 4/e, John Wiley and Sons Inc, 2010.
2. P.C.Sharma, A Text book of Production Technology, 8/e, S Chand Publishing, 2014.
3. Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 1st Edition, Springer, 2010.

19EME292: Comprehensive Skill Development III

L	T	P	A	C
0	0	0	6	1

Course Objectives:

- To encourage the all-round development of students by focusing on soft skills, Coding & domain skills.
- To make the engineering students aware of the importance, the role and the content of soft skills, Coding and domain skills through instruction, knowledge acquisition, demonstration and practice.
- To develop and nurture the soft skills, coding and domain skills of the students through individual and group activities.
- To expose students to right attitudinal and behavioral aspects and to build the same through activities

Course Outcomes:

- On completion of the course, student will be able to– Effectively communicate through verbal/oral communication and improve the listening skills
- Write precise briefs or reports and technical documents, Actively participate in group discussion / meetings / interviews and prepare & ṁnbvcxṁ nb bv deliver presentations. Become more effective individual through goal/target setting, self motivation and practicing creative thinking.
- Student will be able to understand the problems and develop his competitive coding skills.
- Apply the skills in various domains and will be able to solve complex problems faced by the industry.
- Function effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality

Part-1

A. Verbal and Soft Skills:

Vocabulary Builder, Reading Comprehension, Fill-in-the-Blanks, General Usage

B. Quantitative Aptitude and Reasoning

Puzzles, Arithmetic, Geometry, Mensuration.

Part-2

Coding:-Medium Level problem solving techniques:

Permutations and Combination, Probability, Hash Tables, Heap, Greedy Method, Backtracking

SEMESTER V

19EME331: MANUFACTURING TECHNOLOGY

(Common to AI and ML, Electrical and Hybrid Vehicles and Smart Manufacturing)

L	T	P	C
3	0	3	4.5

The course enables the students of mechanical engineering to gain hands on experience and skills necessary to perform traditional manufacturing operations such as moulding, casting and welding. It also introduces the students to modern manufacturing techniques such as development of composites and use of power tools. The major objective of this course is to make sure that all the mechanical engineering graduates gain practical exposure to manufacturing methods and various manufacturing tools.

Pre-requisites: None

Co-requisties: None

Specific Instructional Objectives: None

Course Objectives:

- To teach various cutting tools, tool materials and metal cutting process.
- To explain tool life and the variables that control them.
- To teach calculation of machining time for different machining processes.
- To impart various metal cutting processes. (lathe, drilling, boring shaping, slotting, milling and grinding).
- To introduce principles of jigs and fixtures and types of clamping and work holding devices.

UNIT-I **10 hours**

Metal Cutting Basics:

Theory of metal cutting (Introduction-schematic diagram-crack propagation- Piispanen model of Card Analogy), Single point cutting tool (Nomenclature), Orthogonal vs Oblique cutting, Various force components, Tool Materials, Types of chips, Taylor's tool life equation, Cutting Fluids.

Learning Outcomes: At the end of this unit, the student will be able to

- describe cutting processes and variables. (L2)

● classify various types of chips, cutting tool materials and cutting fluids. (L2)

● calculate cutting forces, speed, and feed in machining. (L3)

UNIT II **6Hours**

Machine Tools using Single point cutting tools.

Lathe and Lathe Operations: Principle of working, specifications, types of lathes, Operations performed, Machining time calculations, Lathe Attachments, and accessories.

Shaping, Slotting, and planning machines -Quick Return Mechanisms- principal parts, operations performed, machining time calculations.

Learning Outcomes: At the end of this unit, the student will be able to

● Explain the specifications and operations performed on lathe, shaping, slotting and planning machines. (L2)

● Identify principal parts and explain quick return motion mechanisms. (L2)

● Calculate machining time. (L3)

UNIT III **8 Hours**

Surface Planers using Mutli-point cutting tools.

Milling machines: Principle of working. Up-milling vs Down-milling. Machining operations. Geometry of a typical milling cutter. Methods of indexing. Machining time calculations.

Grinding machines: Grinding process, types of grinding machines, grinding wheel specification, honing, lapping, other finishing processes.

Learning Outcomes: At the end of this unit, the student will be able to

● explain the specifications and operations performed milling and grinding machines. (L2)

● understand the principles of abrasive processes. (L2)

● identify parts of milling and grinding machines. (L2)

● differentiate honing, lapping and other finishing processes (L2)

UNIT IV **8 Hours**

Drill & Bore (Hole making Machine tools)

Drilling Machines: Principle of working, specifications, types and operations performed. Tool holding devices. Nomenclature of twist drill.

Boring Machines- Principle of working, specifications, types, and operations performed - tool holding devices - nomenclature of boring tools.

Learning Outcomes: At the end of this unit, the student will be able to

● explain the specifications and principles of working of drilling and boring machines. (L2)

● explain various operations performed on drilling and boring machines (L2)

● identify parts of drilling and boring machines. (L2)

UNIT V **8 Hours**

Work holding and Tool guiding devices

Jigs and Fixtures: Principles of design of Jigs and fixtures and uses, 3-2-1 principle of location and clamping, classification of Jigs & Fixtures, types of clamping and work holding devices, typical examples of jigs and fixtures. Introduction to additive manufacturing.

Learning Outcomes: At the end of this unit, the student will be able to

● classify various types of jigs and fixtures. (L2)

● identify various types of work and tool holding devices. (L2)

● choose jig and fixture for a given application. (L3)

● visualise how 3D models can be made with additive manufacturing (L4)

Textbooks:

1. P.N. Rao, Manufacturing Technology: Metal Cutting and Machine Tools, (Volume 2), 3/e, Tata McGraw-Hill Education, 2013
2. A Course in Workshop Technology - Vol. II, by B.S. Raghuwanshi (Publishers: Dhanpat Rai & Co) Published in 2017

Reference books:

1. S.Kalpakzian and S.R. Schmid, Manufacturing Engineering and Technology,7/e, Pearson,2018.
2. Milton C.Shaw, Metal Cutting Principles, 2/e, Oxford, 2012
3. V.K.Jain, Advanced Machining Process,12/e, Allied Publications, 2010
4. AB. Chattopadhyay, Machining and Machine Tools, 2/e, Wiley, 2017

Course Outcomes: At the end of the course, the student will be able to

- select cutting tools, tool materials for various metal cutting process. (L2)
- calculate machining time and tool life. (L3)
- identify suitable machining methods to generate different types of surfaces. (L2)
- choose suitable work-holding requirements. (L3)
- choose jigs and fixtures for a given application. (L3)

MACHINE TOOLS LABORATORY

Course objectives:

● To familiarize with the construction and working of various machine tools.

● To Teach selection of parameters for different machining processes.

Contents:

1. Demonstration of construction and operations of general purpose machines : Lathe, drilling machine, milling machine, shaper, slotting machine, cylindrical grinder and surface grinder.
2. Measure the characteristic features of lathe with simple step turning operation.
3. Job on step turning, taper turning, knurling, thread cutting on lathe machine.
4. Perform drilling, reaming and tapping operations.
5. Job on milling (Groove cutting/Gear cutting).
6. Job on shaping and planning.
7. Job on slotting.
8. Job on cylindrical and surface grinding.
9. Job on grinding of tool angles.

Course outcomes: After completion of this course the student may be able to

● choose machine tools and work to get a specific output.

● get hands on experience on various machine tools and machining operation

19EME301: MECHANICS OF MACHINERY

(Common to AI and ML, Electrical and Hybrid Vehicles and Smart Manufacturing)

L	T	P	C
3	1	0	4

This course provides adequate knowledge on simple mechanisms along with the kinematic analysis. This course also introduces the concepts of gears, vibrations and balancing of rotating and reciprocating masses. These concepts will help the students to analyze and design various mechanisms for different applications.

Course Objectives:

To introduce various mechanisms and their applications.

To explain the importance of degree of freedom.

To familiarize the evaluation of velocity and acceleration in mechanisms.

To explain gear terminology and the analysis of gears and gear trains.

To explain the balancing of rotating and reciprocating engines.

To introduce the equations of motion of systems with single degree freedom.

UNIT I **10 hours**

***Simple Mechanisms**:* Classification of mechanisms – Basic kinematic concepts and definitions – Degrees of freedom, Grashof's law, kinematic inversions of four bar chain, single slider, and double slider crank chains -Mechanical advantage- Transmission angle– steering gear mechanisms- Universal Joint – Simple problems.

Learning outcomes:

After completion of this unit, students will be able to

- contrast between machine and structure (L2)
- find degrees of freedom for different mechanisms (L1)
- identify the inversions of four bar mechanism (L3)
- explain the difference between Davis and Ackerman steering gear mechanisms (L2)
- explain Universal joint mechanisms (L2)

UNIT II **12 hours**

Velocity and acceleration in Mechanisms*:* Velocity analysis of simple mechanisms by Instantaneous center method, relative velocity method (graphical method), Kennedy's theorem. Acceleration analysis of simple mechanisms- Slider crank mechanism, Coriolis component of acceleration, crank and slotted lever mechanism.

Learning outcomes:

After completion of this unit, students will be able to

- calculate the velocities and acceleration of various links in a mechanism (L4)
- determine instantaneous centers for a given mechanism (L4)
- determine Coriolis component of acceleration (L4)

UNIT III 10 hours

Gears and Gear trains: Classification of Gears, gear terminology, fundamental law of gearing, Involute and cycloidal gear profiles, spur gear contact ratio and interference/undercutting-helical, bevel, worm, rack & pinion gears, Simple, compound, reverted and epicyclic gear train, Analysis of epicyclic gear train.

Learning outcomes:

After completion of this unit, students will be able to

- explain the different gear profiles and parameters (L2)
- identify different types of gears and application (L3)
- analyze gear trains(L4)

UNIT IV 12 hours

Balancing of Rotating and reciprocating machines: Need for balancing, static and dynamic balancing, balancing of single mass and several masses in different planes, using graphical methods. Balancing of reciprocating mass, Balancing of locomotives, effects of partial balancing of locomotives.

Learning outcomes:

After completion of this unit, students will be able to

- explain the importance and need for balancing (L2)
- analyze balancing problems in rotating and reciprocating engines (L4)

UNIT V
12 hours

Vibrations: Introduction, degree of freedom, types of vibrations, free natural vibrations, Newton method and energy method for single degree of freedom. Damped vibrations- under damped, critically damped; and over damped systems, forced vibrations with and without damping in single degree of freedom; Vibration isolation and transmissibility, torsional vibrations- rotor systems.

Learning outcomes:

After completion of this unit, students will be able to

- formulate equations of motion and solve for single degree of freedom system with damping. (L5)
- estimate the natural frequency of vibratory systems. (L5)
- explain the concept of vibration isolation and transmissibility. (L2)

Text Book(s)

1. S.S.Rattan,Theory of Machines, 4/e, Tata Mc-Graw Hill, 2014
2. G.K.Groover, Mechanical Vibrations, 8/e,Nemchand Bros, 2009

References

1. F. Haidery, Dynamics of Machines, 5/e,NiraliPrakashan, Pune, 2003
2. J.E.Shigley, Theory of Machines and Mechanisms, 4/e, Oxford, 2014
3. P.L.Ballaney, Theory of Machines & Mechanisms, 25/e, Khanna Publishers, Delhi, 2003.
4. Norton, R.L.,Design of Machinery - An introduction to Synthesis and Analysis of Mechanisms and Machines,2/e, McGraw Hill, New York, 2000.
5. William T. Thomson, Theory of vibration with applications, 4/e, Englewood Cliffs, N.J.: Prentice Hall, 1993.

Course Outcomes:

At the end of the course the students will be able to

- Understand different mechanisms and their inversions (L2)
- Calculate the velocity and acceleration of different links in a mechanism (L4)
- Analyze different gears and gear trains and design the gears for various applications (L5)
- Determine the position and magnitude of balancing masses required for rotating and reciprocating machines (L4)
- Calculate the natural frequency of vibrating systems (L4).

19EID234: LIFE SCIENCES FOR ENGINEERS

(Common to AI and ML, Electrical and Hybrid Vehicles and Smart Manufacturing)

L	T	P	C
2	0	2	3

This course introduces the student, to the basics of biology such as cell structure, bimolecular structure and function, metabolism, inheritance and basic concepts of recombinant DNA technology.

Course 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 I **10 L**

Introduction to Biology: Comparison of eye and camera, flying bird and aircraft, biological observations and major discoveries- genera, species and strains, and Classification of living organisms: Cellularity, Ultrastructure, carbon and energy sources, excretion, habitat and molecular taxonomy.

Learning Outcomes:

After completing this UNIT, the student will be able to

- summarize the basis of life. (L2)
- distinguish prokaryotes from eukaryotes. (L3)
- compare biological organisms and manmade systems. (L2)
- classify organisms. (L2)

UNIT II **12 L**

Water, Biomolecules: sugars, starch and cellulose, Amino acids and proteins, lipids, Nucleotides and DNA/RNA, structure and functions of proteins and nucleic acids, haemoglobin, antibodies and enzymes, Industrial applications of enzymes, Fermentation and its industrial applications

Learning Outcomes:

After completing this UNIT, the student will be able to

- outline the importance of water. (L2)
- explain the relationship between monomeric UNITs and polymeric UNITs (L2)
- explain the relationship between the structure and function of proteins. (L2)
- interpret the relationship between the structure and function of nucleic acids. (L2)
- summarize the applications of enzymes in industry. (L2)
- explain the applications of fermentation in industry. (L2)

UNIT III **12 L**

Bioenergetics, Respiration: Glycolysis and TCA cycle, Electron transport chain and oxidative phosphorylation, Mechanism of photosynthesis, Human physiology, neurons, synaptic and neuromuscular junctions

Learning Outcomes:

After completing this UNIT, the student will be able to

- apply thermodynamic principles to biological systems. (L2)
- explain the mechanism of respiration and photosynthesis. (L2)
- summarize the principles of information transfer and processing in humans. (L2)

UNIT IV **12 L**

Mendel's laws, gene mapping, Mitosis and Meiosis, Epistasis, single gene disorders in humans, Genetic code, DNA replication, Transcription, Translation

Learning Outcomes:

After completing this UNIT, the student will be able to

- define Mendel's laws. (L1)
- demonstrate the mapping of genes. (L2)
- explain interactions among genes and their significance.
- differentiate the mitosis and meiosis. (L3)
- explain the medical importance of gene disorders. (L2)
- identify DNA as a genetic material in the molecular basis of information transfer. (L2)

UNIT V **10 L**

Recombinant DNA Technology: recombinant vaccines, transgenic microbes, plants and animals, animal cloning, biosensors, biochips.

Learning Outcomes:

After completing this UNIT, the student will be able to

- outline the principles of recombinant DNA technology. (L2)

- appreciate the potential of recombinant DNA technology. (L2)
- summarize the use of biological materials for diagnostic devises. (L2)

Course Outcomes

After studying the course, the student will be able to:

- explain catalytic properties of enzymes. (L2)
- summarize application of enzymes and fermentation in industry. (L2)
- identify DNA as a genetic material in the molecular basis of information transfer. (L2)
- apply thermodynamic principles to biological systems. (L2)
- analyze biological processes at the reductionistic level. (L4)
- appreciate the potential of recombinant DNA technology. (L2)

Lab Experiments (Virtual or Field Experiments)

Microscopy, Mendel's laws, mapping, interactions, - 4 lab experiments

Nitrogen cycle, Species interactions, Sterilization, Bacterial population growth, - 4 lab experiments

Text book(s):

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

Reference Book(s):

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

19EME335: Smart Manufacturing Systems

L	T	P	C
3	0	0	3

This course is designed with fundamentals of automation and knowledge based intelligent manufacturing systems and study of algorithms for in group technology. This course provides a general understanding of Group technology and automated process planning, Knowledge Based System for Equipment Selection (KBSES), Knowledge Based Group Technology. The unifying themes of this course are how manufacturing systems work and uses of in intelligent environments. We learn inference engines how it works.

Pre-requisites: Basics of manufacturing technology, Artificial intelligence

Course Objectives

1. This course is designed to introduce students to the basics of Machine leaning and learn intelligence and its application manufacturing domain.
2. The course introduces knowledge-based systems where students learn about its basics Automated systems, Languages - ES Building Tools or Shells and its application in fault diagnosis, manufacturing, robotics, and CAPP (computer aided process planning).
3. The course describes the importance of artificial intelligence in the manufacturing system
4. This course combines value creation with strategic development in a manufacturing environment, providing you with the latest manufacturing techniques and processes
5. This course is aimed to make the students understand the analysis of a complex problem and various solutions being followed with the help of real time case studies.

Unit 1 Computer Integrated Manufacturing Systems No of Hours: 08

Structure and functional areas of CIM system- CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems – MAP/TOP, OSI Model, Data Redundancy, Top down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing – System Components, System Architecture and Data Flow, System Operation.

Learning Outcomes

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

• Identify different types of and gain knowledge on CIM systems	L2
• Apply the concepts of on real time Intelligent Manufacturing	L4
• Design the Intelligent Manufacturing System that can be controlled by the CIM systems.	L5

Unit 2 Components of Knowledge Based Systems No of Hours: 10

Basic Components of Knowledge Based Systems, Knowledge Representation, Interference Engine, Knowledge Acquisition. Machine Learning – Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks, Applications in Manufacturing.

Learning Outcomes After completion of this unit, the student will be able to

• Understand the concepts of on basic components of Knowledge Based Systems	L3
• Gain the knowledge on Artificial Neural Networks and Machine Learning	L1
• Apply the concepts on real life manufacturing systems	L4

Unit 3 Automated Process Planning No of Hours: 08

Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning.

Learning Outcomes

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

• Gain the knowledge on generative approach concepts of automated process planning	L1
• Develop the expert systems for automated process planning	L4
• Identify the concepts of feature recognition on automated phases of process planning	L2

Unit 4 Knowledge Based System for Equipment Selection (KBSES) No of Hours: 08

Manufacturing system design, Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KBSES.

Learning Outcomes

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

• Demonstrate the types of Manufacturing system design and related equipment	L2
• Gain the knowledge on Problem Solving approach in KBSES	L3
• Apply the concepts of Modeling the manufacturing equipment on structure of the KBSES	L4

Unit 5 Group Technology No of Hours: 10

Models and Algorithms – Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation – Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Knowledge Based Group Technology - Group Technology in Automated Manufacturing System.

Learning Outcomes

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

• Develop models and algorithms for Intelligent manufacturing systems environment.	L3
• Gain the knowledge on Knowledge Based Group Technology	L2
• Apply the concepts of Group Technology in Automated Manufacturing System	L4

Texbook(s)	**Topics**
1. Intelligent Manufacturing Systems by Andre Kusaic.	All
2. Artificial Neural Networks by Yagna Narayana	3
3. Automation, Production Systems and CIM by Groover M.P.	1,2

Additional Reading(s)	**Topics**
1.Neural Networks by Wasserman.	3

Course Outcomes (COs)

On completion of this course students should be able to:

1. Comprehend basic concepts of AI, Knowledge based systems and manufacturing systems.
2. Understand the underlying concepts in programming languages PROLOG and LISP used in expert system.
3. Apply expert system for Manufacturing applications in CAD, CAPP, MRP, Adaptive Control, Robotics, Process Control, Fault Diagnosis, Failure Analysis, Process Selection and GT.
4. Link Expert Systems to readily available commercial software such as DBMS, MIS and MDB.

Develop the algorithm-based solutions using group technology in Automated Manufacturing Systems.

19ECS344 Introduction to Machine Learning

L	T	P	C
2	1	0	3

Preamble/course introduction (Italics)

Machine Learning is a flourishing subject in Computer Science which devises models that can automatically learn from data and detect patterns from data. The applications of machine learning are diverse ranging from self-driven cars to disaster management systems. With easy availability of data from different devices and measurements, machine learning techniques become imperative in analysing trends hidden in the data. This course focuses on the major tasks of machine learning viz., supervised and unsupervised learning approaches that can robustly address data that is non-linear, noisy as well as high-dimensional in nature.

Course objectives:

1. Introduce the concepts of machine learning and the complete process model for working with real data.
2. Impart the various approaches to supervised learning.
3. Demonstrate unsupervised learning approaches.
4. Illustrate the performance of ensemble models and familiarize with dimensionality reduction techniques.
5. Differentiate between shallow and deep neural networks.

Module 1: Machine Learning Fundamentals

L	T	P
6	3	0

Machine Learning Fundamentals: Use of Machine Learning, Types of machine learning systems, machine learning challenges, testing and validating, working with real data, obtaining the data, visualizing the data, data preparation.

Learning outcomes:

After completion of this unit, the student will be able to:

1. Identify different machine learning approaches and applications (L1)
2. Demonstrate basic machine learning approach using real world data (L2)
3. Use machine learning approach to train and fine tune a learner (L3)

Module II: Supervises Learning

L	T	P
6	3	0

Supervised Learning: Classification, training in a binary classifier, performance measures, multiclass classification, error analysis, multi label classification, multi output classification.

Linear Regression, Polynomial Regression, Logistic Regression.

Learning outcomes:

After completion of this unit, the student will be able to:

1. Demonstrate various supervised learning approaches (L2)
2. Describe classification techniques for real-time data. (L2)
3. Apply regression to make good predictions (L3)

Module III: Unsupervised Learning

L	T	P
6	3	0

Unsupervised Learning: Clustering, K-Means, Using clustering for image segmentation, Semi- supervised learning, DBSCAN, other clustering algorithms.

Gaussian Mixtures, anomaly detection, selecting number of clusters.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Illustrate various clustering techniques (L2)
2. Construct Gaussian Mixture Models to implement anomaly detection (L3)
3. Analyze suitability of different clustering techniques for real-time data (L4)

Module IV: **Dimensionality Reduction & Ensemble Learning**

L	T	P
6	3	0

Dimensionality Reduction: The curse of dimensionality, main approaches for dimensionality reduction, PCA, Kernel PCA, LLE.

Learning Outcomes:

After completion of this unit, the student will be able to:

1. Choose best features defining a dataset through dimensionality reduction (L3)
2. Apply PCA and its variants to find the significant feature subset (L3)
3. Compare the performance of ensemble learners to weak learners (L4)

Module V: **Neural Networks & Deen Neural Networks**

L	T	P
6	3	0

Neural Networks: From biological to artificial neurons, implementing MLPs with Keras, fine tuning neural network hyperparameters.

Learning

Outcomes:

After completion of this unit, the student will be able to:

1. Show the working of neural networks (L3)
2. Differentiate between shallow and deep neural networks (L4)
3. Evaluate the performance of deep neural networks on real time data (L5)

Textbooks(s)

1. AurelionGeron, Hands-on Machine Learning with Scikit-Learn, Keras, and Tensor Flow: Concepts, Tools and Techniques to build Intelligent Systems, 2/e, O'Reilly Media, 2019.

Reference Book(s)

1. Tom M. Mitchell, Machine Learning, McGraw Hill, 2017.
2. EthemAlpaydin, Introduction to Machine Learning, 3/e, PHI, 2015.

Recommended Coursera Courses:

1.

Course Outcomes:

1. Describe different machine learning categories (L2)
2. Apply supervised learning approaches on real-time problems (L3)
3. Utilize unsupervised learning approaches for applications such as anomaly detection (L3)
4. Analyze ensemble models for performance improvement (L4)
5. Estimate significant feature subset to handle high dimensionality issue (L5)
6. Construct deep neural networks for computer vision applications (L6)

19EME332: HEAT AND MASS TRANSFER

(Common to AI and ML, Electrical and Hybrid Vehicles and Smart Manufacturing)

L	T	P	C
3	**1**	**3**	**5.5**

This course focuses on the fundamental concepts and techniques of heat and mass transfer and emphasizes application of mathematical principles in heat transfer. The knowledge of Thermodynamics and Fluid mechanics are prerequisite in understanding the concepts fluid kinematics & boundary layer concepts with respect to heat and mass transfer. Further, this course gives good understanding of industrial related problems as phase change heat transfer and heat exchangers.

Course Objectives

- To impart the basic laws of conduction, convection and radiation heat transfer and their applications
- To familiarize the convective heat transfer concepts
- To explain basics of radiation heat transfer
- To make conversant with the heat transfer analysis related to thermal systems like heat exchangers, evaporator, and condenser.

UNIT I 9 L

Introduction: Basic modes of heat transfer- rate equations- generalized heat conduction equation - steady state heat conduction solution for plain and composite slabs - cylinders - critical thickness of insulation-

Learning outcomes:

After completion of this UNIT, students will be able to

- identify the phenomenon related to different modes of heat transfer (L2)
- compare different types of conduction heat transfer(L2)
- apply concept of thermal resistance and its importance in practical problems(L3)

UNIT II 9 L

Fins: Heat conduction through fins of uniform cross section- fin effectiveness and efficiency.

Unsteady State Heat Transfer - Transient heat conduction- lumped system analysis and use of Heisler charts.

Learning outcomes:

After completion of this UNIT, students will be able to

- compare different types of Fins(L2)
- apply concept transient heat conduction in practical problems(L3)

UNIT III **10 L**

Convection: Basic concepts of convection–heat transfer coefficient - types of convection – forced convection and free convection. Dimensional analysis in convection

External Flow: Concepts of hydrodynamic and thermal boundary layer- use of empirical correlations for flow over plates and cylinders. Fluid friction – heat transfer analogy

Internal Flow: Use of empirical relations for convective heat transfer in horizontal pipe flow.

Free Convection -development of hydrodynamic and thermal boundary layer along a vertical plate – use of empirical relations for convective heat transfer on plates and cylinders in horizontal and vertical orientation

Learning outcomes:

After completion of this UNIT, students will be able to

- Apply the physical phenomenon of convective heat transfer(L3)
- Calculate convective heat transfer using empirical relations for different cases (L4)
- Use analogy between fluid friction and heat transfer to solve engineering problems. (L4)

UNIT IV **9 L**

Boiling and Condensation: Different regimes of boiling- nucleate, transition and film boiling – condensation - film wise and dropwise condensation.

Heat Exchangers: Types of heat exchangers- parallel flow- counter flow- cross flow heat exchangers- overall heat transfer coefficient- LMTD and NTU methods- fouling in heat exchangers

Learning outcomes:

After completion of this UNIT, students will be able to

- identify different regimes of boiling in design of boilers(L1)
- interpret the basic modes of condensation heat transfer (L2)
- explain the working of different types of heat exchangers (L1)
- calculate the heat transfer in heat exchangers (L5)
- design a heat exchanger for a given application(L5)

UNIT V **9 L**

Radiation: Radiation heat transfer – thermal radiation – laws of radiation - Black and Gray bodies – shape factor-radiation exchange between surfaces - Radiation shields - Greenhouse effect.

Mass Transfer: Conservation laws and constitutive equations - Fick's law of diffusion, isothermal equi-mass - Equimolar diffusion- - diffusion of gases and liquids- mass transfer coefficient.

Learning outcomes:

After completion of this UNIT, students will be able to

- Apply the principles of radiation heat transfer(L3)
- Design a radiation shield for given conditions (L5)
- Examine the effect of greenhouse gases on atmosphere(L2)
- Explain the basic mechanism of mass transfer(L2)
- Differentiate between mass transfer due to convection and diffusion (L3)

Course Outcomes

At the end of the course, the student will be able to

- Apply the concepts of different modes of heat transfer. (L2)
- Apply knowledge of conduction heat transfer in the design of insulation of furnaces and pipes. (L3)
- Analyse free and forced convection phenomena in external and internal flows. (L2)
- Design of thermal shields using the concepts of black body and non-black body radiation. (L4)
- Apply the basics of mass transfer for applications in diffusion of gases. (L3)

Textbook(s):

1. P.K. Nag, Heat Transfer, 3/e, Tata McGraw-Hill, 2011.
2. F. P. Incropera and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, 6/e, John Wiley, 2007.

References:

1. J.P.Holman, Heat Transfer, 9/e, Tata McGraw-Hill,2008.
2. Cengel. A.Yunus, Heat Transfer- A Practical Approach, 4/e, Tata McGraw-Hill, 2007.
3. S.P. Sukhatme, A Textbook of Heat Transfer, Universities Press, 2005
4. Lienhard and Lienhard, A Heat and Mass Transfer, Cambridge Press, 2011.
5. C.P. Kothandaraman and S. Subramanyan, Heat and Mass Transfer data book, New Age Publications, 2014

HEAT TRANSFER LAB

Course Objectives:

Students undergoing this course would.

- Understand different modes of heat transfer.
- Gain knowledge about natural and force convection phenomenon
- Estimate experimental uncertainty in measurements.

LIST OF EXPERIMENTS

1. Determine the overall heat transfer coefficient across the width of composite wall.
2. Determine the thermal conductivity of a metal rod.
3. Determine the thermal conductivity of insulating powder material through concentric sphere apparatus.
4. Determine the thermal conductivity of insulating material through lagged pipe apparatus.
5. Determine the efficiency of a pin fin in natural and forced convection.
6. Determine the heat transfer coefficient for a vertical cylinder in natural convection
7. Determine the heat transfer coefficient in forced convection of air in a horizontal tube.
8. Determine the heat transfer coefficients on film and drop wise condensation apparatus.
9. Determine the effectiveness of a parallel and counter flow heat exchanger.
10. Study the pool boiling phenomenon and different regimes of pool boiling.
11. Experiment on pool boiling.
12. Determine the emissivity of the test plate surface.
13. Experiment on Stefan-Boltzmann apparatus
14. Determine the heat transfer rate coefficient in fluidized bedapparatus.s

Course Outcomes

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

- Explain different modes of heat transfer L1
- identify parameters for measurement for calculating heat transfer L2.
- determine effectiveness of heat exchanger L3
- design new equipment related to heat transfer L4.
- apply principles of heat transfer in wide application in industries **L4**

19EME391: COMPREHENSIVE SKILL DEVELOPMENT IV

(Common to AI and ML, Electrical and Hybrid Vehicles and Smart Manufacturing)

Semester -V (3-1)

Stream	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**A**	**C**	**Marks**
Comprehensive Skill Development	Department specific	Soft Skills and Quantitative Aptitude	PW	0	0	0			50
		Coding					6	1	50
Total number of hrs per week									100

Coding Syllabus: -

Permutations and Combination, Probability, Hash Tables, Heap, Greedy Method, Backtracking

Semester -V (3-1)

Stream	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**Marks**
Comprehensive Skill Development	Department specific	Soft Skills and Quantitative Aptitude	PW	1	2		1	50
		Coding				3		50
Total number of hrs per week						6		100

Coding Syllabus: -

Permutations and Combination, Probability, Hash Tables, Heap, Greedy Method, Backtracking

Reasoning skills

Unit	Module/ Topics	Hrs
1.	Combinatorics [i. Permutations & Combinations, ii. Probability]	3
2.	Cryptarithmetic & Modular Arithmetic [i. Cryptarithmetic, ii. Application of base system (7, 24) Clocks (Base 24) Calendars (Base 7)]	3
3.	Mental Ability [i. Number series ii. Letter series & Alpha numeric series iii. Analogies (Numbers, letters) iv. Classifications]	4
4.	Algebra [i. Exponents, ii. Logarithms, iii. Problems related to Equations, iv. Special Equations, v. Statistics]	5
	Total	15

Verbal skills

Unit	**Module/ Topics**	**Hrs**
1.	**Grammar and Error Detection Exercises**	**6**
2.	**Structure and Sentence Correction/ Improvement Exercises**	**6**
3.	**Error Detection & Sentence Correction–FAQs with Solutions**	**2**
4.	**Fill-in-blanks and Cloze Passages**	**3**
	Total	**15**

19EME348: ROBOTICS AND AUTOMATION

L	T	P	C
3	0	0	3

This course helps in understanding the basics of robotics such as origin of robotics, types of robotics and various generation of robots. This course teaches the fundamentals of robotics required to design the robot anatomy, kinematics of robots, robot dynamics, robot drive systems, robot programming and its applications. The Knowledge gained from this course is to apply the concepts in handling the automated systems like assembly systems, material handling systems, storage, and retrieval systems.

Course Objectives

- To familiarize the history and automation of robot and its applications.
- To enhance the students' knowledge about robot end effectors, sensors, and their design as well as their applications.
- To impart computational skills related to kinematics and dynamics of robots.
- To acquire knowledge about Robot Programming methods & Languages of robot.
- To develop the ability to analyze and design the Automated systems and their applications.

Course Outcomes

At the end of the course work, the students will be able to

1. Understand the basic components of robots and the types of robots and robot grippers.
2. Comprehend and interpret various aspects relating to the designing of end effectors.
3. Analyze and demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics
4. Interpret basic safety guidelines for robotic applications.
5. Describe and judge the use of Automated systems in industrial applications.

UNIT I **8 L**

Fundamentals of Robotics:

Introduction to robot, Definition need and scope of robots, robot anatomy, co-ordinate system, work envelop, robot classification, robot parts and functions, need of robot and its applications.

UNIT II **8 L**

Robot Drive systems and Control:

Design of drive systems, Mechanical, hydraulic, and pneumatic drives, electric drives, motors, designing of end effectors, mechanical, hydraulic, vacuum, and magnetic grippers.

Robot Sensors and Machine vision:

Need of sensors, position sensor, tactile sensor, proximity and range sensors, wrist-force sensing, frame grabbers, robotic vision system.

UNIT III **10 L**

Robot Kinematics and Robot Programming:

Direct and inverse kinematics of manipulators, Homogeneous transformations, D-H parameter notation, Jacobian, trajectory planning. Robot Programming Methods, and programming languages for robotics.

UNIT IV **8 L**

Robot Cell Design and Application:

Robot work cell design and control, safety in robotics, robot cell layouts, multiple robots and machine interference, robot cycle time analysis. Industrial application of robots.

UNIT V **8 L**

Automation:

Types of automation, analysis of automated assembly systems, line balancing problems, analysis of automated material handling systems, automated storage, and retrieval systems.

Textbook(s):

1. Robotics and Control / Mittal R K & Nagrath I J / TMH.
2. Automation, Production systems and Computer Integrated Manufacturing – M P Groover, Prentice Hall India.
3. S.R. Deb and Sankha Deb Tata, Robotics Technology and Flexible Automation, 2/e, McGraw Hill, 2009.

References:

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, Robotics Control, Sensing, Vision and Intelligence, 2/e, McGraw Hill, 1987.
2. Yoram Koren, Robotics for Engineers, McGraw Hill, 1987.
3. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, Industrial Robotics Technology, Programming and Applications, 1/e, McGraw Hill, 1986
4. Robotics: Control, sensing, vision and intelligence, Fu, K., Gonzalez, R. and Lee, C. S. G McGraw Hill.
5. Robotic Engineering / Richard D. Klafter,
6. Introduction to Robotics / John J Craig / Pearson Edu. Prentice Hall
7. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley & Sons (ASIA) Pte Ltd.

19EME302:DESIGN OF MACHINE ELEMENTS

(Common to AI and ML, Electrical and Hybrid Vehicles and Smart Manufacturing)

L	T	P	C
3	1	0	4

This course introduces the design procedures for various mechanical elements. Concepts applied in this course are from previous courses such as Strength of materials and Dynamics of Machinery. The course aims to throw knowledge on design against static and fatigue loadings. The course addresses designing of fasteners, couplings, shafts and other machine components and limited to strength and rigidity-based designs.

Course Objectives:

- To provides an introduction to design of machine elements.
- To familiarize with fundamental approaches to failure prevention for static and dynamic loading.
- To explain design procedures for different types of joints.
- To explain the working principle of clutches and brakes and their design procedures.
- To instruct different types of bearings and design procedures.

UNIT I 9 L

Mechanical Engineering Design: Design process, design considerations, codes and standards of designation of materials, selection of materials.

Design for Static Loads: Modes of failure, design of components subjected to axial, bending, torsional and impact loads, Static theories of failures.

Design for Dynamic Loads: Endurance limit, fatigue strength under axial, bending and torsion, stress concentration, notch sensitivity. Types of fluctuating loads, fatigue design for infinite life. Soderberg, Goodman and modified Goodman criterion for fatigue failure.

Learning outcomes:

After completion of this UNIT, students will be able to

- **Select** materials for specific applications.(L1)
- **Understand the** standards in design. (L3)
- **Apply** failures theories in designing components subjected to static and dynamic loads. (L3)

UNIT II 9 L

Bolted Joints: Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening, eccentrically loaded bolted joints, and gasketed joints.

Welded Joints: Strength of lap and butt welds, eccentrically loaded welded joints. Joints subjected to bending and torsion.

Learning outcomes:

After completion of this UNIT, students will be able to

- Understand the advantage and disadvantages of various joints. (L1)
- **analyze the** stresses induced in joints subjected to different loads. (L4)
- **design** the different joints subjected to different loading conditions. (L5)

UNIT III 9 L

Keys: Function, types, design of sunk, saddle, Kennedy and Woodruff keys.

Power Transmission Shafts: Design of shafts subjected to bending, torsion and axial loading. Shafts subjected to fluctuating loads using shock factors.

Couplings: Design of flange and bushed pin couplings, universal coupling.

Learning outcomes:

After completion of this UNIT, students will be able to

- **Understand the functions of** different keys. (L2)
- **Select** coupling for a given application and outline the design procedure. (L3)
- **design a** shaft subjected to different loading conditions. (L5)

UNIT IV 9 L

Friction Clutches: Torque transmitting capacity of disc and centrifugal clutches. Uniform wear theory and uniform pressure theory.

Brakes: Different types of brakes. Concept of self-energizing and self-locking of brake. Band brake, block brakes and disc brakes.

Learning outcomes:

After completion of this UNIT, students will be able to

- **Contrast** the difference between sliding and rolling contact bearings. (L2)
- **Explain** the mechanics of lubrication in sliding contact bearings. (L2)
- **Identify various** failures in bearings. (L3)
- **Evaluate** static and dynamic load capacity of rolling contact bearings. (L5)
- **Explain** the procedure to select bearings from manufacturer's catalogue. (L3)

Course Outcomes:

At the end of the course the students will be able to

- **Estimate** safety factors of machine members subjected to static and dynamic loads. (L3)
- **Design** different fasteners subjected to various loads. (L5)
- **Analyze** the loads and design various machine components such as keys, shafts, couplings, springs and bearings. (L5)
- **Determine** torque transmitting capacity of Clutches & preambles.
- **Determine** load carrying ability of Bearings and Gears.

Textbook(s):

1. J.E. Shigley, Mechanical Engineering Design, 2/e, Tata McGraw Hill, 1986.
2. V.B.Bhandari, Design of Machine Elements, 3/e, Tata McGraw Hill, 2010.

References:

1. R.L. Norton, Machine Design an integrated approach, 2/e, Pearson Education, 2004.
2. R.K. Jain, Machine Design, Khanna Publications, 1978.
3. M.F.Spotts and T.E.Shoup, Design of Machine Elements, 3/e, Prentice Hall (Pearson Education), 2013.

Note: PSG Design data book is permitted.

19EHS302: ENGINEERING ECONOMICS AND MANAGEMENT

(Common to AI and ML, Electrical and Hybrid Vehicles and Smart Manufacturing)

L	T	P	C
3	0	0	3

This course aims at introducing the student with basic concepts of engineering economic analysis, principles of management and its role in engineering decision making. The students are introduced to the basic tools needed for presentation of the effect of the time value of money in engineering problem solving. The tools introduced include topics such as demand and supply analysis, depreciation, costing analysis and break-even analysis. It also helps the students to analyze financial statements.

Course objectives

- To define the basic terms of economics and analyze law of demand and elasticity of demand.
- To analyze the cost concepts and interpret financial statements.
- To apply break even analysis concept in business organization.
- To discuss the advantages of different forms of organization.
- To elaborate the principles of Management.

UNIT I **8 L**

Economics: Utility, value, wealth, consumption, wants necessaries, comforts and luxuries.

Demand: Law of demand, elasticity of demand, price elasticity of demand, factors affecting elasticity of demand, problems.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- define utility and time value of economic goods. [**L1**]
- distinguish between necessities, comforts and luxuries. [**L2**]
- classify demand for different types of goods. [**L2**]
- analyze the elasticity of demand for various economic goods. [**L4**]

UNIT II **8 L**

Costing: Cost concepts, elements of cost, marginal cost, marginal revenue, sunk cost, opportunity costs, methods of distribution of overhead costs, UNIT costing, job costing and process costing; Simple problems.

Accounts: Preparation of profit and loss account and balance sheet (outlines only).

Learning Outcomes:

At the end of this UNIT, the student will be able to

- list elements and types of costs. **[L1]**
- apply cost analysis to determine profit. **[L3]**
- classify accounts. **[L2]**
- compose & interpret balance sheet for a given enterprise. [**L3**]

UNIT III **6 L**

Break-Even Analysis: Assumptions, break-even charts, simple problems.

Depreciation: Depreciation methods - Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the year's digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Simple problems.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- apply break even analysis in business organization. **[L3]**
- examine the impact of fixed and variable costs on profits. **[L2]**
- list depreciation methods. **[L1]**
- compute the depreciation of assets. **[L3]**

UNIT IV **10 L**

Forms of Business Organization: Single trader, partnership and public limited company.

Principles of Organization: Types of organization; Span of management; Authority, delegation and decentralization, source of formal authority, difference between authority and power, line and staff authority, simple case studies.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- comprehend the pros and cons of different forms of business organization. **[L1]**
- illustrate advantages and disadvantages of each form of organization. **[L2]**
- evaluate the effect of span of management on decision making. **[L2]**
- differentiate between authority and power. **[L2]**

UNIT V **10 L**

Principles of Management: Importance of management, definition of management, management process, roles of a manager; Management, a science or art - Management, a profession; Functions of management.

Leadership: Difference between a leader and a manager, characteristics of leadership, functions of a leader, simple case studies.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- summarize the function of management. **[L1]**
- recall the roles of manager. **[L1]**
- Comparison between Leader and Manager. **[L2]**
- List the characteristics of a Leader. **[L1]**

Course outcomes

- obtain the basic terminology, laws of demand and supply. **[L1]**
- evaluate the economic theories and cost concepts. **[L2]**
- analyze various accounting concepts and financial management techniques for preparing effective profit and loss statements. **[L3]**
- examine and analyze break even evaluation concepts for identification of minimum production volume for survival and to gain profits. **[L3]**
- adapt and build good manager skills by employing the concepts of various skills like good leadership qualities, utilizing motivation capabilities and incorporating communications skills. **[L2]**

Textbook(s):

1. Tara Chand, Engineering Economics, Vol - 1, 13/e, Nem Chand & Bros, 2012

2. O.P Khanna, Industrial Engineering and Management, 14/e, Dhanpat Rai Publications, 2011.

References:

1. Maheswari, Engineering and Managerial Economics, 19/e, Sultan Chand & Co, 2009

2. Shukla, Grewal, Cost Accounting, 12/e, S.Chand & Company, 2007

3. L.M.Prasad, Principles and Practice of Management, 8/e, Sultan Chand & Sons, 2012

19EME431: MEASUREMENTS AND METROLOGY

(Common to AI and ML, Electrical and Hybrid Vehicles and Smart Manufacturing)

L	T	P	C
3	**0**	**2**	**4**

Course Description

The objective is to make the students to have knowledge on the various measuring and inspection devices and to provide tolerances during design. This is useful for every engineer who is working in any industry as every industry producing any good should be inspected and then only will be sent out for the release in the market for customers. Course intends to introduce the technological and engineering concepts and study the applications of measuring quantities like force, torque and temperature.

Pre-requisites: None

Co-requisites: None

Specific Instructional Objectives: None

Course Objectives:

- To introduce the basic concepts of metrology and measurement methods.
- To demonstrate the importance of metrology in manufacturing.
- To explain the concepts of transducers and its practical applications.
- To expose with various measuring instruments
- To familiarize calibration methods of various measuring instruments.

UNIT I **8 hrs**

Concept of Measurement: General concept-generalized measurement system, units and standards, measuring instruments, sensitivity, readability, range of accuracy, precision, static and dynamic response, repeatability, systematic and random errors, correction, calibration, terminology and limits fits and tolerances, hole basis and shaft basis system, interchangeability.

Learning Outcomes:

At the end of this unit the student will be able to

- Identify important parameters in metrology. (L3).
- Differentiate interchangeability and selective assembly. (L4).
- Select limits and tolerances for different assemblies. (L1)

UNIT II **8 hrs**

Linear measuring instruments: Vernier instruments, micrometres, slip gauges, tool makers microscope. Comparators: Mechanical-Johansson microkatal, sigma and reed type, pneumatic-solex and differential type and electrical- visual gauging and multi gauging.

Angular measurements: Sine bar, bevel protractor and angle decker.

Learning Outcomes:

At the end of this unit the student will be able to

- Explain the principles of measurement of various comparators. (L2).
- Discuss about the principles of slip gauges, micrometres and vernier height gauges. (L2)

UNIT III **8 hrs**

Screw thread measurements: Elements of threads, errors in screw threads, various methods of measuring external and internal screw threads, screw thread gauges and errors in screw threads.

Gear Measurement: Gear tooth terminology, measurement of gear elements-runout, lead, pitch backlash, profile and tooth thickness by chordal thickness method, constant chord and base tangent method.

Learning Outcomes:

At the end of this unit, the student will be able to

- Identify the errors in screw threads. (L3)
- Explain the principles of gear measuring instruments. (L2)
- Select the tools and methods for measuring screw thread, gear profiles. (L1)

UNIT IV **10 hrs**

Surface Roughness: Terminology, differences between surface roughness and surface waviness- Numerical assessment of surface finish - CLA, RMS and ten-point height average Value. Methods of measurement of surface finish-Profilometer, Tomlinson surface meter, Taylor Hobson talysurf.

Inspections systems: Classification of automatic inspections systems, co-ordinate-measuring machines, non-contact inspection techniques-machine vision, laser scanning systems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Recall the terms used in surface roughness measurement. (L1)
- Explain the factors affecting the surface finish in machining. (L2)
- Demonstrate the application of different surface measuring instruments. (L2)

UNIT V

8 hrs

Measurement of Force: Direct method - analytical balance, platform balance; elastic members – load cells, cantilever beams and proving rings.

Measurement of Torque: Torsion bar dynamometer, servo-controlled dynamometer and absorption dynamometer.

Measurement of Temperature: Pressure thermometers and bimetallic strip thermometers.

Learning Outcomes:

At the end of this unit, the student will be able to

- Identify various types of transducers used for the measurement of force, torque, and temperature. (L3)
- Explain methods of measurement of force, torque and temperature. (L2)
- Develop the techniques for calibration of force, torque and temperature measuring devices. (L3)

Course Outcomes:

1. have knowledge on basic concepts and apply the concepts of limits, fits, tolerances to engineering drawing & design (L4)
2. Demonstrate the concepts of linear and angular measurements to practical applications (L3)
3. Examine geometry of screw threads and gear profiles. (L4)
4. evaluate surface finish and also inspect various components using non-contact and contact techniques. (L5)
5. Select suitable techniques to measure and evaluate force torque and temperature. (L5)

Textbooks:

1. Beckwith, Marangoni, Lienhard, Mechanical Measurements, 6/e, PHI, 2013.
2. R.K. Jain, Engineering Metrology, 20/e, Khanna Publishers, 2013.

Reference Books:

1. Mahajan, Engineering Metrology, 2/e, Dhanpat Rai, 2013.

2. S.Bhaskar, Basic Principles - Measurements and Control Systems, Anuradha Publications, 2014.

3. Anand K Bewoor&Vinay A Kulkarni, Metrology & Measurement, 15/e, McGrawHill, 2015

Practical Experiment

1) Calibration of micrometer and dial gauge by using slip gauges.

2) a. Measurement of V-groove angle using 2 roller method.

   b. Measurement of angles using angle gauges

3) To determine the gear tooth thickness and height of a given spur gear

4) Measurement of screw thread parameters using tool makers microscope

5) Measurement of roundness and concentricity of a given spigot

6) Measurement of angles using vernier bevel protractor and sine bar

7) Measurement of central distance between two holes by using vernier height gauge

8) a. Measurement of straightness using Autocollimator

   b. Measurement of flatness using monochromatic check lite

9) To measure surface roughness parameters of a given specimen

19EMC382: ENGINEERING ETHICS

(Common to AI and ML, Electrical and Hybrid Vehicles and Smart Manufacturing)

L	T	P	C
3	0	0	0

UNIT I **8 L**

Basic Concepts: Terminology, morals, ethics, values, integrity and spirituality, edicts-religious, social and constitutional edicts, the question of universality, personal and professional ethics, emotional intelligence, dimensions of ethics.

UNIT II **8 L**

Rights and Responsibilities: As citizens, as professionals, concepts of justice and fairness, preservation, production, exchange for mutual fulfilment vs. storage for future use, social responsibility and individual rights.

UNIT III **9 L**

Global Issues in Ethics: Technology and globalization, business ethics, corporate social responsibility, environmental ethics, media ethics, protecting the common good while respecting the values and beliefs of nations/ ethnic groups, issues of compliance and governance, equal opportunities.

UNIT IV **8 L**

Ethical Integrity and Attitudes: Integrity as wholeness and consistency of character, beliefs, actions, methods and principles, core group of values, accountability, prioritization, subjectivity and objectivity, attitude, com-ponents (cognitive, behavioural and affective), attitude formation and attitude change.

UNIT V **9 L**

Ethical Living: Needs of life, materialistic and non-materialistic, qualitative and quantitative, harmony in living, self (physical and mental wellbeing), family, building trust, sharing of responsibilities, cultivating sense of security, society, peace, non-violence, diversity, multiculturalism and oneness, nature, environmental sustainability, reorganizing living conditions, reappraising economic sectors and work practices, developing green technologies, ethical consumerism.

References:

1. G. Subba Rao, Roy Chowdhury, P.N. Ethics, Integrity and Aptitude: For Civil Services Main Examination Paper V, Access Publishing, 2013.
2. Singer, Peter. Practical Ethics, Cambridge University Press, 1999.
3. Swami Tathagatananda, Healthy Values of Living, Advaita Ashrama, Kolkata, 2010.
4. M. Frost (Ed), Values and Ethics in the 21st Century, BBVA, Available at https://www.bbvaopenmind.com/wp-content/uploads/2013/10/Val-ues-and-Ethics-for-the-21st-Century_BBVA.pdf

19EME392: COMPREHENSIVE SKILL DEVELOPMENT V

(Common to Mechanical engineering, Mechanical engineering with (AI and ML, Electrical and Hybrid Vehicles and Smart Manufacturing))

Semester –VI

Stream	Course Code	Course Title	Category	L	T	P	A	C	M
Comprehensive Skill Development	Department specific	Soft Skills and Quantitative Aptitude	PW	0	0			1	50
		Coding				3	6		50
Total number of hrs per week						6*			100

* or 3 hours of activities in domain skills i.e. 50% for soft skills and 50% for Domain skills.

S.No	Specialization	Name of the Course	No of Hours
1	All Branches	Introduction to Digital technologies	20
2	MECH	Simulation technologies and python programming	30
3	MECH	AI in mechanical Engineering	30
4	MECH	Robotics and Automation	30
5	MECH	Electrical Vehicle Design/ Batteries Technology.	30
6	MECH	3-D Printing in Mechanical Engineering	30
7	MECH	Industry 4.0	20
8	MECH	AI/ML	20
9	MECH	IoT and Micro controllers	20
10	MECH	Data Science	20
11	MECH	Additive manufacturing	20
12	MECH	CNC machines and programming	20
13	MECH	Computational fluid dydnamcis	40
14	MECH	Product life cycle management	80

Reasoning skills

Unit	Module/ Topics	Hrs
1.	GRE-Oriented Advanced Concepts Discussion	4
2.	CAT-Oriented Advanced Concepts	4
3.	TCS, Infosys-Oriented Advanced Concepts	4
4.	Successful Test Cracking Techniques	3
	Total	15

Verbal skills

Third Year Second Semester

Unit	**Module/ Topics**	**Hrs**
1.	**Resume Writing & Acing Job Interviews**	**4**
2.	**Corporate Readiness 1**	**3**
3.	**Mock Tests with Solutions 1**	**5**
4.	**Company-Specific Tests with Solutions 1**	**3**
	Total	**15**

19EME304: VEHICLE ELECTRICAL POWER SYSTEMS

L	T	P	C
3	**0**	**0**	**3**

To acquire knowledge of electric vehicle battery systems and to make the student understand the working of different Charging and discharging conditions and emphasize the need for maintenance of battery systems.

Course Objectives

- To familiarize concepts of batteries for electric vehicles.
- To explain different battery capacity
- To introduce the concept of charging and discharging of battery systems.
- To provide fundamental concepts of battery performance in electric Vehicles

Module-1 **9 hrs**

ELECTRIC VEHICLE BATTERIES: introduction to electric vehicle batteries, choice of a battery type for electric vehicles, electric vehicle battery efficiency, effects of current density on battery formation, effects of excessive heat on battery cycle life, battery storage, the lithium-ion battery

Learning outcomes

At the end of this Unit, the student will be able to

- identify different types of Batteries. (L2)
- explain the different mechanisms and materials used for Batteries. (L2)
- develop excessive heat on battery cycle life. (L4)

Module-2 **9 hrs**

ELECTRIC VEHICLE BATTERY CAPACITY: battery capacity, the temperature dependence of battery capacity, state of charge of a vrla battery, capacity discharge testing of vrla batteries, battery capacity recovery, definition of NiMH battery capacity, li-ion battery capacity, battery capacity tests, energy balances for the electric vehicle

Learning outcomes

At the end of this Unit, the student will be able to

- apply various battery capacities. (L3)
- explain the efficiency of different battery systems. (L2)
- enumerate the discharge testing of different batteries. (L3)

Module-3 **9 hrs**

electric vehicle battery charging: charging a single VRLA battery, charge completion of a single vrla battery, temperature compensation during battery charging, charging NiMH batteries, rate of charge effect on charge acceptance efficiency of traction battery packs, environmental influences on charging, charging methods for NiMH batteries, charging technology, battery pack corrective actions, the fast charging process, fast charging strategies, the fast charger configuration, inductive charging—making recharging easier, range testing of electric vehicles using fast charging.

Learning outcomes

At the end of this Unit, the student will be able to

- explain the different charging methods. (L3)
- relate fast charging configuration. (L3)
- examine range testing of electric vehicles. (L4)

Module-4 **9 hrs**

ELECTRIC VEHICLE BATTERY DISCHARGING : Definition of VRLA Battery Capacity, Definition of NiMH Battery Capacity, Discharge Capacity Behaviour, Discharge Characteristics of Li-ion Battery, Discharge of an Electric Vehicle Battery Pack, Cold-Weather Impact on Electric Vehicle Battery Discharge

Learning Outcomes

- Understand the various Discharge Capacity Behaviour. (L2)
- Study the Discharge Characteristics. (L2)
- Identify the Cold-Weather Impact on Electric Vehicle Battery Discharge. (L3)

Module-5 **9 hrs**

ELECTRIC VEHICLE BATTERY PERFORMANCE: The Battery Performance Management System, BPMS Thermal Management System, The BPMS Charging Control, High-Voltage Cabling and Disconnects, Safety in Battery Design, Battery Pack Safety—Electrolyte Spillage and Electric Shock, Charging Technology, Electrical Insulation Breakdown Detection, Electrical Vehicle Component Tests, Building Standards

Learning outcomes

At the end of this Unit, the student will be able to

- understand The Battery Performance Management System(L3)
- Understand the Safety in Battery Design. (L2)
- examine the Electrical Vehicle Component Tests (L2)

Course Outcomes:

After learning the course, the students should be able to:

1. To understand the different types of batteries for electric vehicles. (L2)
2. select proper batteries for electric vehicles for a vehicle, L3
3. To understand the charging and discharging of battery system (L3)
4. To understand and develop concepts of battery performance in electric Vehicles (L4)

Textbooks:

1. Sandeep Dhameja, Electric Vehicle Battery Systems, Newness publication, 2001
2. Masataka Wakihara and Osamu Yamamoto, Lithium-ion Batteries Fundamental and Performance, Wiley–VCH, Verlag GmbH, 1999.

References:

1. Robert A.Huggins, Advanced Batteries – Materials science aspects, Springer, 2009

PROGRAM ELECTIVE – I

19EME341: TURBO MACHINERY

L	T	P	C
3	0	0	3

Turbo machines are basically rotodynamic machines which work on the principles of dynamic action. This course deals with the definition of a turbo machines, main parts, classification and its comparison with positive displacement machines. The first and second laws of thermodynamics, adiabatic efficiency, drawing of velocity triangles diagram, dimensionless parameters are the common factors for the calculation of power of the turbo machines.

Course Objectives:

- Calculate the main dimensions of hydro- and gas-turbines.
- Evaluate which turbine to be used in a Hydro Power Plant or a Gas Power Plant.
- Evaluate which pump or compressor to be used in a process-, gas- or a fluid-system.
- To have knowledge about Hydro turbines, Gas turbines, Pump turbines, Centrifugal pumps and Compressors.
- To introduce product planning and product development process.
- Use this knowledge in projects where this turbo machinery is a part of for example a process system or a power plant

UNIT I

Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification of turbo machines, Dimensionless parameters and their significance, UNIT and specific quantities, model studies and its numerical.

Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, overall isentropic efficiency, stage efficiency and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process.

Learning Outcomes:

- Able to identify the main parts of turbo machines, Classify turbo machines. and compare it with positive displacement machines (L1)
- Understand the effect of Reynolds number, specific speed & dimensionless parameters and their physical significance on turbo machines (L2)
- Know Compression process – Overall isentropic efficiency of compression; Stage efficiency, Polytropic efficiency and preheat factor (L3)
- Explore the principles of model studies and apply same to design of turbo machines (L3)

UNIT II

Energy transfer in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor.

General Analysis of Turbo machines: Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance. General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles

Learning Outcomes:

- Derive the Euler's turbine equation and explain the significance of components of energy transfer(L3)
- Define and discuss the significance of degree of reaction & derive an expression between utilization factor and degree of reaction. (L2)
- Learn how to draw velocity triangles diagram for axial flow compressors and pumps for different values of degree of reaction. (L2)
- Explain the general analysis of a turbo machine – effect of blade discharge angle on energy transfer and degree of reaction. (L3)

UNIT III

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, multi-stage impulse turbine, expression for maximum utilization factor.
Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging.

Learning Outcomes:

- Explain the construction, working, types and classification of a steam turbine. (L2)
- Explain the condition for maximum blade efficiency, stage efficiency. (L2)
- Explain compounding - Need for compounding, Method of compounding. (L2)
- Explain impulse staging – Condition for maximum utilization factor for multistage turbine with equiangular blades. L2)
- Explain Reaction turbine and Parson's reaction turbine, Discuss Condition for maximum blade efficiency, reaction staging. (L3)

UNIT IV
Hydraulic Turbines: Classification, various efficiencies.
Pelton Wheel – Principle of working, velocity triangles, design parameters, maximum efficiency
Franci's turbine – Principle of working, velocity triangles, design parameters
Kaplan and Propeller turbines - Principle of working, velocity triangles and design parameters. Theory and types of Draft tubes.
Learning Outcomes:

- Explain the construction, working and classification of water turbine. (L2)
- Explain design parameters of Pelton wheel. (L3)
- Explain Francis turbine, its velocity triangles, runner shapes for different blade speed and its design. (L3)
- Explain draft tubes and its types. (L2)
- Explain Kaplan and propeller turbines, its design parameters and velocity triangles. (L3)

UNIT V

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel.

Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging.

Axial Flow Compressors: Expression for pressure ratio developed in a stage – work done factor, efficiencies and stalling.

Learning Outcomes:

- Explain the construction, working and classification of Centrifugal pump. (L3)
- Explain suction, delivery and manometric heads, pressure rise in the impeller, and various efficiency terms like manometric efficiency, hydraulic efficiency, volumetric efficiency and overall efficiency. (L3)
- Explain multistage centrifugal pumps, minimum starting speed, slip, priming, cavitations (L3)
- Explain the construction and working of Centrifugal and an axial flow compressors. (L2)
- Analyze blade angles at impeller eye root and eye tip; slip factor and power input factor, width of the impeller channel. (L4)

Course Outcomes:

After learning the course, the students should be able to:

1. Understand the basics of turbo machines including dimensional analysis (L1)
2. To understand the principles and energy transfer process in turbo machines. (L2)
3. To understand the structural and functional aspects of major components of turbo machines. (L3)
4. Analyze the turbo machines to improve and optimize its performance (L4)
5. To understand control and maintenance aspects of turbo machines (L4)

Textbook(s)

1. Turbo Machines B.U.Pai Wiley India Pvt, Ltd 1st Edition
2. An Introduction to Energy Conversion, Volume III, Turbo machinery V. Kadambi and Manohar Prasad New Age International Publishers reprint 2008
3. Turbo machines M. S. Govind Gowda and A. M. Nagaraj M. M. Publications 7Th Ed, 2012
4. Fundamentals of Turbo Machinery B.K Venkanna PHI Publishers

Reference Book(s)

1. Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier 2005
2. Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002
3. Principals of Turbo machines D. G. Shepherd the Macmillan Company 1964

19EME343: POWER PLANT ENGINEERING
(Elective)

L	T	P	C
3	0	0	3

This course provides an introduction to the various layouts and working mechanisms of steam power plant, gas power plant, nuclear power plant, and hydroelectric power plant. Power Plant Economics concepts will also be dealt in this course. This course introduces the working concepts of power generating devices like turbines and their components. This course is having integrity with industrial problems as prime movers are main components of power plants. Thermodynamics and Applied Thermodynamics are prerequisite for this course.

Course Objectives

- Understand the basic knowledge of different types of thermal power plants.
- Design of chimney, cooling tower operation in thermal power plants
- Perform basic analyses associated with each subsystem.
- Improving skills to adopt modern methods in mechanical engineering as continuous improvement.

UNIT I **9 L**

Steam Power Plants: General layout, power plant cycles, coal-handling, storing, preparation and supply. Boiler Mountings and accessories, Draft systems, Flue gas testing and indicators (mechanical, electrical and chemical). Condensers and cooling towers,

Learning outcomes:

After completion of this UNIT, students will be able to

- Study the general layout of the steam power plants. (L_1)
- Acquaint with boiler mountings and accessories. (L_2)
- Utilize the knowledge of condensers and cooling towers. (L_3)

UNIT II **8 L**

Gas Turbine Power Plants: Introduction, gas turbine plant- classification and comparison of different types of gas turbine power plants, components and different arrangements of the gas turbine plants, Indian gas turbine power plants, governing system of gas turbine plant.

Learning outcomes:

After completion of this UNIT, students will be able to

- Study the general layout of the gas turbine power plants. (L_1)
- Summarize about different types of gas turbines. (L_2)
- Design a gas turbine for Indian scenario. (L_4)

UNIT III **9 L**

Nuclear Power Plants: Classification of reactors, thermal utilisation, fuels, fuel moderator and coolant, control and safety rods, special properties of structural materials required, induced radioactivity, gas cooled reactors, radiation hazards and shielding, radioactive waste disposal.

Learning outcomes:

After completion of this UNIT, students will be able to

- Acquaint with various nuclear reactors. (L_2)
- Summarize about the special properties of structural materials used. (L_4)
- Train about radiation hazards and shielding. (L_3)

UNIT IV **8 L**

Hydro Electric Plants: Selection of site, hydrology, hydrometric survey rainfall, catchment, reservoir, run-off flow and fall, storage and pondage. Mass- duration and flood discharge. Losses due to percolation, evaporation and transpiration. General layout of the plant. Different types of plants: Low, medium and high head plants and pump storage plants. Head works, spillways, canals, tunnels, governing, lubrication, penstock, anchorages and relief valves. Different types of surge tanks, intakes, gates and valves.

Learning outcomes:

After completion of this UNIT, students will be able to

- Study about the site selection of setting up a hydroelectric plant. (L_1)
- Outline about the losses due to percolation, evaporation and transpiration. (L_2)
- Acquaint with the layout of the plant. (L_1)
- Study about gates, valves, intakes and surge tanks which are necessary for a hydroelectric plant. (L_1)

UNIT V **8 L**

Power Plant Economics: Capacity factor, Load factor, Diversity factor, Peak load consideration, Factors governing capacity of plants. Cost of power plant, Cost of erection. Operating and maintenance expenses, Cost of production, distribution of power and determination of rates.

Learning outcomes:

After completion of this UNIT, students will be able to

- Study about different factors associated with power plant economics. (L_1)
- Acquaint with factors governing plant capacity. (L_2)
- Summarize about cost associated with plant erection, operating and maintenance. (L_4)

Course Outcomes

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

- Study the working of typical systems subsystems of a steam power plants.
- Acquaint with the knowledge about recent advances in gas turbine power plants and apply the knowledge in industries for enhancing productivity.
- Outline the knowledge about nuclear power plants and radioactive waste disposal.
- Choose appropriate site for plant and layout of hydroelectric power plant.

- Experiment with multi-disciplinary goals in the power plants.
- Utilize the concepts of power plant economics and understand costs involved in power plants.

Textbook(s):

1. P.K.Nag, Power plant engineering, Tata McGraw-Hill publishing Co., 2014
2. S.C. Arora and Domkundwar, A course in power plant engineering, DhanpatRai and Co, 2001
3. R.K. Rajput, A Textbook of Power Plant Engineering, 4/e, Laxmi Pub., 2007.

References:

1. B.S.Magal, Solar Power Engineering, 1/e, Tata McGraw-Hill publishing Co., 1999.
2. Joel Weisman, Roy Eckart, Modern Power Plant Engineering, Prentice Hall of India, 1985.
3. D.K. Singhai, Fundamentals of Nuclear Power Engineering, 4/e, Khanna Publishers, 2001.
4. G.R.Nagpal, Power Plant Engineering, 14/e, Khanna Publishers, 1996.

19EME345: VEHICLE TECHNOLOGY

L	T	P	C
3	0	0	3

Automobile engineering is the study of automotive mechanics and vehicle mobility systems that contribute the locomotion. This vehicle technology course deals with study of different power UNITs propelling the automobile as well as the transmission and steering systems and controls involved. This course also attempts to understand and analyse the vehicle dynamics and to learn about the vehicle structure and suspension system. Modern production and assembly methods are also discussed. The impact of artificial intelligence in automotive systems is discussed regarding the future scope of the course.

Course Objectives:

- Study about the various power UNITs propelling the automobile.
- Understand the transmission requirement and study various steering systems.
- Analyze vehicle dynamics and stability criterion of an automobile.
- To have knowledge about vehicle structure and suspension systems.
- To understand the modern production, assembly, and material logistics technologies in automobile sector.
- Identify and understand the scope of artificial intelligence in automotive systems.

UNIT - 1

Introduction: Study of power units like Gasoline**,** diesel, biodiesel, electrical, hybrids, solar, wind, compressed air, fuel cell, hydrogen etc. that propels the automobile

Learning Outcomes:

- Study the various I C engines to power the automobile (L2)
- Understand the scope of biodiesel and hybrid fuels (L2)
- Learn and illustrate the importance of renewable energy in the automotive sector. (L3)
- Understand the hybrid and electric vehicle technology (L2)

UNIT - 2

Transmission system: Transmission requirement, standard transmission system, fluid transmission system, automatic transmission, performance requirements and gear ratios, tractive resistance.
Steering System and Controls: Different types of steering systems, performance requirements, power steering. Controls of Clutch, gear, dashboard display, and automatic control

Learning Outcomes:

- Study and utilize the transmission requirements in an automobile. (L2)
- Understand the various transmission systems. (L2)
- Illustrate the performance requirements, gear ratios and tractive resistance. (L2)
- Study the different types of steering systems. (L2)

- Identify the performance requirement factors in steering system. (L3)
- Study and analyze the clutch control. (L4)
- Study various automatic control and dashboard display features. (L2)

UNIT – 3

Vehicle dynamics. Aerodynamics of vehicles, stability analysis of vehicle, stability on curved path

Learning Outcomes:

- Study and identify the aerodynamics of vehicles. (L2)
- Analyze the stability criterion of vehicles in static and dynamic conditions. (L4)
- Analyze the stability criterion of vehicles along curved path. (L4)

UNIT - 4

Vehicle structure and suspension - Loads on the frame, general consideration of strength and stiffness, engine mounting, chassis, monocoque, prestressed, sheet metal details & tooling. Various suspension systems including active suspension, shock absorbers.
Modern assembly (robotic) and finishing technologies. Metal fabrication (Press shop), metal surface engineering, paint shop, hard and soft trim process lines, final assembly and inspection; Material logistics.

Learning Outcomes:

- Study and analyze the loads on vehicle frame, strength and stiffness and engine mountings. (L4)
- Study different types of chassis frame, prestressed, sheet metal details & tooling (L2)
- Understand the various suspension systems and shock absorbers. (L2)
- Learn the different assembly techniques from press shop to final assembly and inspection of an automobile. (L2)
- Infer the various material logistics involved in manufacture of an automobile. (L2)

UNIT – 5

Artificial Intelligence in Automobile: Role in manufacturing domain as in design, supply chain, production, and post-production. In transportation domain as driver assistance and driver risk assessment systems for autonomous vehicle systems and aftermarket services such as predictive maintenance.

Learning Outcomes:

- Understand the role of artificial intelligence in the manufacturing of automobile. (L2)
- Study the scope of artificial intelligence in driver assistance and driver risk assessment systems for autonomous vehicle systems. (L2)
- Develop the ambit of artificial intelligence in automotive systems. (L4)

Course Outcomes:

After learning the course, the students should be able to:

1. Understand the different power UNITs in an automobile. (L2)
2. To understand the different transmission systems and steering system and controls in an automobile. (L2)
3. To study and analyze the different aspects of vehicle dynamics. (L4)
4. To understand the vehicle structure and the suspension system and study the modern assembly methods (L2)
5. To understand and develop the scope of Artificial intelligence in automotive systems (L4)

Textbook(s)

1. A Textbook of Automobile Engineering – R. K. Rajput, Laxmi Publ. (P) Ltd.
2. Automotive Mechanics – W. H. Crouse & D. Anglin, Tata McGraw Hill Publications 7Th Ed, 2012
3. Automotive Mechanics, Heitner, J 2nd Ed., East-West Press
4. Autonomous Vehicle, Driverless Self-Driving Cars and Artificial Intelligence: Practical Advances in AI and Machine Learning, Dr. Lance Eliot and Michel Eliot, Lbe Press Publishing; 1st edition (29 December 2017)

Reference Book(s)

1. Julian Happian-Smith; Transport Research Laboratory (TRL) Introduction to Modern Vehicle Design, Publisher: Elsevier, 2001
2. Brown J. C., Motor Vehicle Structure: Concepts and Fundamentals, Butterworth-Heinemann, 2002
3. Heinz Heisler; Advanced Vehicle Technology, Publisher: Butterworth-Heinemann, 2002

19EME353: ADVANCED STRENGTH OF MATERIALS

L	T	P	C
3	**0**	**0**	**3**

This course helps in understanding the strength of solid structures based on material and geometrical behaviour in depth. This course teaches the concepts with emphasis on mathematical formulation for defining material behaviour of structures such as pressure vessels, columns & struts and springs. This is a higher-level course which requires basic knowledge gained from the basic strength of material course and apply it to the study and design of advanced structures.

COURSE OBJECTIVES:

1). To enrich the student on the concept of Strain Energy due to different types of loading and to have good hold on the concepts of Mechanical Springs.
2). To enable students to gain good Knowledge on the stress analysis of thick cylinders, thin cylinders and Spherical Shells.
3). To make the student understand the concept of vertical compression loading on an engineering Column with different end conditions, analyzing and evaluating the critical loading condition.
4). To make the student understand the concept of stress analysis on circular rotating discs.
5). To enable the student, understand the concept of curved beams having different cross Sections.

UNIT 1 **9 L**
Strain Energy: Introduction, strain energy in a body when the load applied gradually, load applied suddenly, load applied with impact, strain energy due to shear.
Springs: Deflection of closed coil helical springs under axial pull and Leaf springs

Learning Outcomes:

(a). Student can determine strain energy value for mechanical members under gradually applied load. (L4)
(b). Student can determine strain energy value for members under Suddenly applied load. (L3)
(c). Student can determine strain energy value for members under load with an impact. (L3)
(d). Student can suggest suitable coiled spring for specific application based on the resilience analysis. (L3)
(e). Student can do deflection and stiffness analysis of the existing Leaf springs. (L3)

UNIT 2
Thin Cylinders and Spherical Shells: Stresses and strains (principal stress, principal strain, shear stress, shear strain and volumetric strain) in thin cylinders, thin spherical shell, wire wound cylinders.
Thick cylinders: thick cylinders coursed to internal and external pressure and compound cylinders; different stresses induced; Lames equation, stresses due to shrink fit.

Learning Outcomes:
(a). Student can analyze Hoop and longitudinal stresses in thin cylinder under pressure. (L4)
(b). Student can analyze Hoop and longitudinal stresses in Spherical shell under pressure. (L4)

(c). Student is capable of determining the stresses in wire wounded cylinder under different pressure conditions. (L3)
(d). Student can analyze different stresses in thick cylinder under various pressure conditions. (L4)
(e). Student is capable of determining the stresses in Compound cylinder under different pressure conditions and by taking shrink fit in to account. (L3)

UNIT 3
Columns and struts: Columns with one end free and the other fixed, both ends fixed, one end fixed and other hinged, Limitation of Euler's formula, Column with initial curvature, Column carrying eccentric load, laterally loaded columns, Empirical formulae.

Learning Outcomes:
(a). Student can find critical load for any column under compression load for various end conditions. (L4)
(b). Student can do the stress analysis of any column with initial curvature. (L3)
(c). Student can determine the safe working condition for column with eccentric loading. (L3)
(d). Laterally loaded column can be analysed for safe working conditions. (L4)
(e). Empirical formulae for column can be best utilized for the safe design of a column. (L3)

UNIT 4
Stresses due to rotation: Introduction, stresses in a rotating thin disc, disc of uniform thickness, disc of uniform strength, long cylinders.

Learning Outcomes:
(a). Student can do the stress analysis on a rotating disc.(L4)
(b). Disc for uniform strength can be designed. (L3)
(c). Student can do the analysis for a disc for uniform thickness. (L4)
(d). Student can analyse the wheel rim for different stresses. (L4)
(e). Can design a long cylinder based on the stress analysis. (L4)

UNIT 5
Bending of Curved Bars: Stresses in bars of circular, rectangular and trapezoidal sections.

Learning Outcomes:
(a). Stress analysis for curved bars can be carried out for different cross sections. (L3)
(b). Student can determine the critical loading condition based on the maximum bending condition. (L3)
(c). Student is capable of applying the concept in various applications like, Crane hooks etc., (L3, L4)

Course outcomes:
1). The student is capable of determining the strain energy in various mechanical members and can utilize the concept in analyzing the mechanical springs. (L3, L4)
2). The student is capable of calculating the radial and circumferential stresses for both Cylinders and Spherical shells under different pressurized conditions. (L3)
3). The student is capable of evaluating any engineering column or strut under different end conditions in various applications. (L3)
4). The student is capable of doing stress analysis of rotating discs under various conditions and can suggest the best for specific application. (L4, L6)
5). The student is capable of evaluating curved beams of different cross sections and can be able to evaluate the stresses across the cross-sections of the curved beam. (L3)

Textbook(s)

1.Strength of Materials by Dr. Sadhu Singh, Khanna Publishers, New Delhi.

References

1. Strength of Materials by Timoshenko, Part-I &II, 3rd edition, CBS Publishers & Distributors, New Delhi.

2. Mechanics of Solids by Popov, 2nd Edition, Pearson Education, 2003, New Delhi.

3. Mechanics of Materials by F.P.Beer, E.R. Johnston, Jr& John.T..Dewolf, 3rd edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

4. Strength of Materials by Dr.R.K.Rajput, First multi colour Revised Edition 2006, S.Chand& Company Limited, New Delhi.

5. Mechanics of solids by Crandal, Dahl and Lardner.

19EME355: PRODUCT DESIGN

L	T	P	C
3	0	0	3

Product design describes the process of imagining, creating, and iterating products that solve users' problems or address specific needs in each market. The key to successful product design is an understanding of the end-user customer, the person for whom the product is being created. Product designers attempt to solve real problems for real people by using both empathy and knowledge of their prospective customers' habits, behaviours, frustrations, needs, and wants.

Course objectives:

The aim of the Product Design course is to focus on consolidation of core industrial design capabilities central to creative professional practice. This is achieved through project-based learning that supports the following design skills:

- Effective use of modelling/prototyping techniques (2D and 3D) in the generation, manipulation, and presentation of design ideas.
- Identification of market opportunity, user needs and use context.
- Creative solution ideation (through conceptual design strategies).
- Time management and effective working practice.

UNIT I **9 L**

Introduction: Design methodology and philosophy, types of design, design models, development product life cycle. Product development process, reverse engineering and redesign of product development process, theory, and methodology in design.

Learning Outcomes:

- Able to define the design methodology and find the product development process (L1)
- Understand the philosophy, classify the types of design, and demonstrate the design models (L2)
- Build the development product life cycle and understand reverse engineering (L3)
- Analyze the redesign of product development process and examine the methodology in design (L4)

UNIT II **9 L**

Design Process: Need, analysis, scope of the product, mission statement, customer study, Kano-diagram. Establishing product function, functional decompositions, FAST and SOP, functions structures. Building up a design team. Designing quality into product, product discovery.

Learning Outcomes:

- Define the need and scope of the product (L1)
- Understand the mission statement, kano-diagram & FAST and SOP functions structure (L2)

- Identify the customer study, make use of establishing product function and organize the product discovery (L3)
- Examine the building up design team and designing quality into product (L4)

UNIT III **8 L**

Plan for Design: Product teardown, planning for deliverables, building a plan, product specifications-QFD, contradiction to generate ideas, theory of inventive machines-TRIZ, Decision matrix.

Learning Outcomes:

- Able to define the product teardown and choose the Decision matrix (L1)
- Develop the planning for deliverables and building a plan & product specification (L3)
- Take part of contradiction to generate ideas and discover the theory of inventive machines (L4)

UNIT IV **8 L**

Embodiment Design: Product architecture, configuration, parametric design, systems approach, and other consideration of embodiment design.

Learning Outcomes:

- Understand the product architecture, explain the configuration and parametric design (L2)
- Build the system approach and organize the other consideration of embodiment design (L3)

UNIT V **8 L**

Industrial Design: Human factor in design, design for easy operations, serviceability, aesthetics, and environment. Value Engineering: Cost evaluation, categories of cost, overhead cost, methods of development cost estimate, manufacturing cost, value analysis costing.

Learning Outcomes:

- Understand the human factor in design, Serviceability, aesthetics, and environment (L2)
- Choose the design for easy operations and select the cost evaluation & categories of cost (L3)
- Analyze the value engineering, compare the methods of development cost and manufacturing cost, simply the value analysis costing (L4)

Coarse Outcomes:

Students will

- Use the Product Design and Development Process, to manage the development of an idea from concept through to production.

- Employ research and analysis methodologies as it pertains to the product design process, meaning, and user experience.
- Apply creative process techniques in synthesizing information, problem-solving and critical thinking.
- Demonstrate and employ hand drawing and drafting principles to convey concepts.
- Use basic fabrication methods to build prototype models for hard-goods and soft-goods and packaging.
- Demonstrate, apply, explain, and recognize basic engineering, mechanical, and technical principles.
- Demonstrate, apply, explain, and recognize basic family of materials used in soft-goods and hard-goods, including sustainable materials and manufacturing processes.

Textbook (s)

1. Kevin Otto and Kristin Wood, Product Design, Pearson, 2004.
2. Karl T. Ulrich and Steven D. Eppinger, Production Design and Development, Tata McGraw Hill, 2007.

References

1. David G. Ullman, The Mechanical Design Process, McGraw Hill, 2003.
2. George E. Dieter, Engineering Design, McGraw Hill, 2000.

19EME 363: INDUSTRIAL ENGINEERING AND MANAGEMENT

L T P C
3 0 0 3

The course is suitable to fit into all functional areas of business in different sections of the economy from manufacturing to the service sector and the process industry and fit into managerial positions in all organizations like Manufacturing, service, IT, Logistics & Apparels. It is helpful to train students to rigorously make use of quantitative techniques in analyzing and designing service operations and also to train students who will have the passion to engage in improving the service and its delivery. The individual should be creative, inquisitive, analytical, and detail-oriented, and able to work in a team and communicate well, both orally and in writing.

COURSE OBJECTIVES

1. Understand the basic concepts of management, planning, organizing and staffing.
2. Acquire the knowledge to become an entrepreneur.
3. Comprehend the requirements towards the small-scale industries and project preparation.

UNIT I **10 L**

Definition of Industrial Engineering: Objectives, work study, method study, method study procedure - various charts, THERBLIGS, work measurement – various methods of work measurements. Factors affecting productivity, strategies for improving productivity.

Learning Outcomes: -

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (L3).
- An ability to communicate effectively with a range of audiences (L5).

UNIT II **10 L**

Materials Management: Strategic importance of materials in manufacturing industries, inventory control models, inventory control systems, safety stock, selective Inventory control – ABC, FSN, and VED analysis.
Quality Management: Definition of quality, various approaches, concepts of quality assurance systems, statistical quality control, variables & attributes, charts, acceptance sampling, OC curve, introduction to TQM & ISO-9000.

Learning Outcomes:

- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies (L4).
- Able to learn the difference between quality management and types (L2).

UNIT III **10 L**
Production Planning and Control: Objectives, types of productions, production cycle, product design and development, process planning, forecasting, functions of production control.

Plant Layout and Material Handling: Plant layout and location, types of layouts, principles, concept of UNIT load, selection of material handling equipment.

Learning Outcomes:

- Professional Responsibility - an understanding of professional and ethical responsibility by using the concept production planning and control (L3).
- Multidisciplinary Teamwork- an ability to function on multidisciplinary teams and learn the plant layout design (L2).

UNIT IV **6 L**

Industrial Management: Concepts, principles of management, growth of management thought, functions of management, principles of organization, types of organizations.

Learning Outcomes:

- An understanding of the need for and an ability to engage in self-directed continuing professional development in managing the organization (L2).
- An ability to function effectively as a member of a technical team (L2).

UNIT V **6 L**

Industrial Relations: Industrial disputes, settlement of industrial disputes, trade unions, industrial dispute act 1947, and factories act 1948. Conflict management in organizations.

Learning Outcomes:

- Describe and critique the concept of employee engagement (L4).
- Identify problems associated with both over-engagement and disengagement (L3).

COURSE OUTCOMES

1. Explain about the management and planning. (L2)
2. Apply the knowledge on planning, organizing, staffing, directing, and controlling. (L3)
3. Describe the requirements for small-scale industries and project preparation. (L2)

Textbook(s)

1. ILO, Introduction to Work Study, 3/e, Oxford and IBH Publishing, 2008.
2. O.P. Khanna, Industrial Engineering and Management, 14/e, Dhanpat Rai Publications, 2011.

References

1. Chary, S. N., Production and Operations Management, 4/e, Tata McGraw Hill Publications, 2009.
2. M.T. Telsang, Industrial Engineering and Production Management, 2/e, S Chand and Co., 1999.

19EME346: CAD/CAM

L	T	P	C
3	0	0	3

The concept of CAD/CAM is a computer aided design and manufacturing approach of using computers to control the entire production process from the beginning. The integration of all elements of CAD/CAM environment allows individual processes to exchange information with each other and initiate actions. These activities encompass all functions necessary to translate customer needs into a final product. It includes computer aided design (CAD), computer aided manufacturing (CAM), computer aided process planning (CAPP), computer numerical control machine tools, robots, computer integrated production management system and a business system integrated by a common data base.

Course Objectives

- To understand principles of CAD/CAM, including engineering drawing, geometric and surface modelling and feature-based design.
- To apply engineering mathematics related to geometry to understand CAD/CAM concepts.
- To analyze computer aided manufacturing principles to perform manual and computer aided numerical control programming.
- To evaluate the CAD/CAM concepts and apply those in product design and manufacturing.
- To create new systems using concepts of Group Technology, FMS and CIM.

UNIT I **10 L**

Introduction: CAD/CAM/CIM, CAD/CAM input devices, CAD/CAM output devices, CAD/CAM software, Graphics standards and benefits of CAD. Transformations of geometry: Translation, scaling, rotation and mirroring. Homogeneous transformations, concatenation of transformations.

Learning outcomes

At the end of this UNIT, the student will be able to

- describe basic structure of CAD workstation, Memory types, input/output devices and display devices and computer graphics **(L2).**
- apply geometric transformations on the created wireframe, surface and solid models **(L3).**

UNIT II **8 L**

Geometric Modelling of Curves: Bezier and B-spline curves in two dimensions and three dimensions; Geometric Modelling of Surfaces: Basic surfaces entities, sweep surfaces, surface of revolution, blends, intersections; Geometric Modelling of Solids: Solid entities, Boolean operations, B-rep of Solid Modelling, CSG approach of solid modelling.

Learning outcomes

At the end of this UNIT, the student will be able to

- use parametric 3D CAD software tools in the correct manner for making geometric part models, assemblies and automated drawings of mechanical components and assemblies **(L3).**
- acquire the knowledge of geometric modelling andexecutee the steps required in CAD software for developing 2D and 3D models and perform transformations **(L2).**

UNIT III **8 L**

Computer Aided Manufacturing (CAM): Introduction to Computer Numerical Control (CNC) and direct numerical control (DNC), structure of NC machine tools, designation of axes, drives and actuation systems, feedback devices, CNC tooling, automatic tool changers and work holding devices, Functions of CNC and DNC systems.

Learning outcomes

At the end of this UNIT, the student will be able to

- apply the concepts of machining for the purpose of selection of appropriate machining centers, machining parameters, select appropriate cutting tools for CNC milling and turning equipment, set-up, program and operate CNC milling and CNC drilling **(L3).**
- create and validate NC part program data using manual data input (MDI) and automatically using standard commercial CAM package for manufacturing of required component using CNC milling or turning applications **(L4).**

UNIT IV **8 L**

Robotics: Anatomy and configuration of robot, characteristics of robots, grippers, application of robots in manufacturing, robot programming languages.

Learning outcomes

At the end of this UNIT, the student will be able to

- understand robot configuration, structures, basic components, workspace and generations of robots**(L2).**
- understand the present and future applications of a robot **(L1).**

UNIT V **8 L**

Group Technology: Introduction to group technology, part classification and coding systems: OPITZ, MICLASS. Computer aided process planning (CAPP): Introduction to CAPP, variant and generative methods of CAPP, advantages of CAPP, computer integrated manufacturing (CIM): Elements of CIM, CIM case studies.

Learning outcomes

At the end of this UNIT, the student will be able to

- examine the importance of Group Technology, CAPP and CIM concepts**(L4).**

Course Outcomes

After completing the course, the student will be able to

- apply engineering knowledge, techniques, skills and modern tools to analyze problems in both design and manufacturing **(L3).**
- apply geometric transformation techniques in CAD **(L4).**
- develop mathematical models to represent curves, surfaces and solids **(L4).**
- develop manual and APT part programs for 2D complex profiles and test the programs through simulation **(L3).**
- demonstrate knowledge of industrial robots, CAPP, GIT and CIM systems **(L2).**

Textbook (s)

1. Mikell P. Groover and Emory W. Zimmers Jr, CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education Inc., 1984.
2. P. N. Rao, CAD / CAM Principles and Applications, 3/e, Tata McGraw Hill, 2014.

References

1. Ibrahim Zeid and Sivasubramanian, R., CAD/CAM Theory and Practice, 2/e, Tata McGraw Hill, 2009.
2. M. M. M. Sarcar, K. Mallikarjuna Rao, K. Lalit Narayan, Computer Aided Design and Manufacturing, 2/e, Printice Hall of India, 2012.

19EME373: FUNDAMENTALS OF ELECTRIC AND HYBRID VEHICLES TECHNOLOGY

L	T	P	C
3	0	0	3

This course introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cell vehicles. This course is an intended for learning the Fundamentals of Automobile Hybrid vehicles. This course is giving the brief ideas of Hybrid vehicles propulsion methods- Hybrid architecture Hybrid power plant specifications- Fuel cell technology - and Non electric Hybrid propulsion systems.

Pre-requisites: Thermodynamics, Basic Electrical and Electronics engineering

Course Objectives

- To introduce different configurations of electric vehicles
- To familiarize knowledge of hybrid electric vehicles
- To impart basic analyses associated with batteries and its types.
- To enable hybrid vehicle configuration and its components, performance analysis
- To explain the concepts learnt for project work, higher studies and industry.

UNIT I

Introduction to Electric Vehicles: History of Electric Vehicles, Types of Electric Vehicles in use today – Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles, Social and environmental importance of hybrid and electric vehicles

Learning outcomes:

After completion of this unit, students will be able to

- acquaint knowledge of hybrid vehicles. (L2)
- study the costing of hybrid vehicle. (L4)
- outline the dependency of oil market (L3)

UNIT II **8 hrs**

Architecture of Hybrid and Electric Vehicles: Vehicle Power Plant and Transmission Characteristics, Basic Architecture of Hybrid Drive Trains and Analysis of Series and parallel Drive Train, Power Flow in HEVs, Basic Architecture of Electric Drive Trains, Advantages and Disadvantages of Series-Parallel Combination.

Learning outcomes:

After completion of this unit, students will be able to

- acquaint types of hybrid vehicles. (L2)
- select hybrid vehicles for practical applications. (L3)
- experiment in vehicles like all-terrain vehicles. (L3)

UNIT III **8 hours**

Energy Source: Battery**-** Battery Basics, Lead-Acid Battery, Nickel-Cadmium Battery, Nickel-Metal-Hydride (NiMH) Battery, Li-Ion Battery, Li-Polymer Battery, Zinc-Air Battery, Battery Parameters, Battery Capacity.

Fuel Cells: Fuel Cell Characteristics, Fuel Cell Types- Alkaline Fuel Cell (AFC) Proton Exchange Membrane (PEM), Direct Methanol Fuel Cell (DMFC), Phosphoric Acid Fuel Cell (PAFC), Molten Carbonate Fuel Cell (MCFC), Solid Oxide Fuel Cell (SOFC, ITSOFC), Fuel Cell EV

Learning outcomes:

After completion of this unit, students will be able to

- outline different energy sources. (design new systems in practical applications. (L5)
- utilize energy sources for proper application. (L3)

UNIT IV **8 hours**

Electric Machines and their Controllers: DC-DC converters-Classification, DC-AC inverter-classification, Induction motors and Permanent Magnet Motors for HEV/EVs,

Learning outcomes:

After completion of this unit, students will be able to

- choose different controllers and drive train systems. (L2)
- utilize for new systems in practical applications. (L3)
- design vehicles like all-terrain vehicles. (L3)

UNIT V **8 hours**

Design of Hybrid and Electric Vehicles: Hybridness: parallel hybrid, series, mixed and range extender (plug-in) hybrids, Range extender, Techniques to enhance hybrid performance, Mild or micro hybrid features, Plug-in hybrid, All-wheel drive hybrid, Sizing of Electric machine, Brake System of EVs and HEVs, case study of HEV.

Learning outcomes:

After completion of this unit, students will be able to

- outline different electric vehicles. (L2)

- develop new systems for practical applications. (L5)
- test on-road vehicles. (L3)

Course outcomes:

At the end of the course student able to

- explain the need and advantages of electric vehicles in present scenario (L2)
- compare hybrid vehicle with IC engines (L2)
- analyse the modern trends in identifying energy sources in the form of fuel cells (L4)
- interpret different types of controllers and drive train systems (L2)
- define various DC and AC electrical machines for vehicle applications (L2)

Textbook(s)

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, CRC Press, 2010.
2. A. E. Fuhs, *Hybrid Vehicles and the Future of Personal Transportation*, CRC Press, 2009

Reference Books:

1. James Larminie, Electric Vehicle Technology Explained, second editon, John Wiley & Sons, 2012.
2. Sandeep Dhameja, “Electric Vehicle Battery Systems”, Newness, 2000.
3. Iqbal Hussain, Electric & Hybrid Vehicles – Design Fundamentals, Second Edition, CRC Press, 2011

Web references:

1. https://nptel.ac.in/courses/108/103/108103009/

PROGRAM ELECTIVE – II

19EME340: HEATING VENTILATION AND AIR CONDITIONING

L	T	P	C
3	0	0	3

Students undergoing this course are expected to understand the air-conditioning systems used in automotive application and building applications. The concept of psychometric process will be applied to design HVAC systems and function to maintain the comfort and safety of the occupants in automobile and building applications. HVAC system controls the indoor climate and proper air flow, ensure that the human neither freeze nor sweat and several health benefits are probable with a well-maintained HVAC system.

Course Objectives

- To understand the fundamentals of heating, ventilation and air conditioning and prepares students to become industry ready by providing a foundation of knowledge.
- To become familiar with the codes and standards from ASHRAE handbook(s).
- To impart knowledge to design, install and troubleshoot residential and commercial HVAC systems.
- To study the science and technology of low temperatures and provides instruction in fundamental principles of refrigeration, developing these into tools that can be utilized in laboratory and industrial applications**.**
- To develop skills for designing components like compressors, evaporators, coolers in HVAC systems and gain the knowledge of instrumentation.

UNIT I **9 L**

Introduction: Purpose, applications, definition and components of air conditioning, need and methods of ventilation.
Psychrometry: Evolution of air properties and psychrometric chart, basic processes such as sensible heating/cooling, humidification/dehumidification and their combinations.

Learning outcomes

At the end of this UNIT, the student will be able to

- Know the need and application of air-conditioning. (L3)
- Know the use of psychometric charts and describe various psychometric processes involved. (L3)
- Explain how the temperature, humidity, and air motion affects human comfort. (L3)

UNIT II **9 L**

Summer and Winter A/c: Simple summer and winter A/c process, SHF (sensible heat factor), load concepts of RSHF (Room sensible heat factor), CSHF (Coil sensible heat factor),GSHF
(Gross sensible heat factor) - problems, concept of ESHF (Effective room sensible heat factor) and ADP temperature, cooling load calculations.

Human Comfort: Concept of human comfort, thermal response, comfort factors, environmental indices, indoor air quality.

Learning outcomes

At the conclusion of this UNIT, the student will be capable to

- Know the understanding of working summer and winter air conditioning systems. (L2)
- Know the necessity of SHF, RSHF, CSHF, GSHF, and ESHF for the calculation cooling loads. (L4)
- Explain the factors that influence the rate of heat loss and gain for a house. (L4)
- Be acquainted with the need of comfort factors of human related to air-conditioning. (L2)

UNIT III **9 L**

Air Conditioning Equipment: Types of filters: Dry, viscous, wet and electric filters, types of blowers: axial flow and centrifugal of parallel and series configurations, air washer, heated and cooled, cooling tower, noise control.
Air Distribution: Methods of ducting and its arrangements, air flow, friction chart, methods of sizing, air diffusion, throw, and drop.

Learning outcomes

At the end of this UNIT, the student will be able to

- Understand the description and working principles of various air conditioning components and use of various parts of A/C. L3
- Understand the air distribution methods, class of ducts for air distribution and conditioned air flow to the space to be cooled or heated. L3
- Describe what constitutes good airflow through a duct system. L2

UNIT IV **8 L**

Heating Systems: Warm air systems, hot water systems, steam heating systems, panel heating systems, central heating systems, heat pump circuit, heat sources for heat pump. Heating of high building with electric infrared systems.

Learning outcomes

At the end of this UNIT, the student will be able to

- Grasp the knowledge about working of heating system for the space to be conditioned. L2
- Describe the control sequence of operation for various heat pumps L2
- Perform precautionary maintenance on a variety of equipment used in the lab. L3

UNIT V **8 L**

Basics of Ventilation - Need, threshold limits of contaminants, estimation of ventilation rates, air flow round buildings.

Methods of Ventilation: Natural, wind effect, stack effect, combined effect- mechanical, forced, exhaust, combined - displacement ventilation. Industrial Ventilation: Steel plants, car parks and mines.

Learning outcomes

At the end of this UNIT, the student will be able to

- Identify components and discuss the different ventilation techniques. (L1)
- Explain the different industrial ventilation systems. (L1)
- Know the different effects of wind. (L2)

Course Outcomes

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

- Understand the psychometric properties and processes, cooling and heating load calculations and recognize components and design principles used in air distribution systems. (L1)
- Articulate the purpose and operation of HVAC system components, the operation of HVAC systems, diagnose, repair faults and perform maintenance on HVAC systems. (L3)
- Identify and apply the principles and strategies necessary for hands-on installation, troubleshooting of HVAC systems. (L3)
- Design the cooling and heating systems with proper ventilation methods. (L4)
- Be industry ready with the knowledge of the functions, working principles of insulations. (L3)

Textbook(s):

1. Robert McDowall, Fundamentals of HVAC Systems, 2nd Edition, Elsevier, 2009.
2. S C Arora and S Domkundwar, A Course in Refrigeration and Air conditioning, Dhanpat Rai & Co, 2002.

References:

1. Faye C. McQuiston, Jerald D. Parker, Jeffrey D. Spitler, Heating, Ventilating and Air Conditioning: Analysis and Design, 6/e, Wiley India, 2011.
2. Stoecker, W.F., and Jones, J.W., Refrigeration and Air Conditioning, 2/e Edition, Tata McGraw Hill, 1982.
3. Arora, C.P., Refrigeration and Air Conditioning, 3/e, Tata-McGraw-Hill, 2008.

19EME342: RENEWABLE ENERGY TECHNOLOGY

L	T	P	C
3	0	0	3

The course introduces energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application. It helps in exploring society's present need and future energy demands, examine conventional energy sources and systems. The course will also help in assessing the procedures in terms of technical, financial and social, in the context of training as an Mechanical Engineer.

Course Objectives

- To understand the basic knowledge of conventional and non-conventional energy sources.
- To design and optimization of solar, wind, OTEC and Geothermal power plants,
- To perform basic analyses associated with each subsystem.
- To apply the same in their project works as well as higher studies or in their job.

UNIT I **9 L**

Introduction: Role and potential of new and renewable sources.
Solar Energy: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Solar energy storage-Different methods, sensible, latent heat and stratified storage, solar ponds. Solar applications, solar heating/ cooling techniques, solar distillation and drying, nano materials used in solar photovoltaic cells. Next generation photovoltaic systems- Solar Ink, photovoltaic energy conversion.

Learning Outcomes:

At the end of this UNIT, the student will be able to
- acquaint basic knowledge of renewable sources. **[L1]**
- understand of different solar energy storage. **[L2]**
- acquire fundamental concepts of photovoltaic systems. **[L1]**

UNIT II **8 L**

Wind Energy: Sources and potentials, classification of windmills, horizontal and vertical axis windmills, effect of wind speed on power generation, site evaluation, wind turbine subsystems-rotors, drive trains, yaw control systems, electrical systems.
Biogas: Properties, principles of production, classification- fixed dome-floating type, comparison, site selection, water removing device, environmental effect. Plant models in India: floating gas holder-KVIC, fixed dome - janata type, pragati model, deenbandhu model, constraints for implementation.

Learning Outcomes:

At the end of this UNIT, the student will be able to
- acquaint with sources and potentials of wind energy. **[L1]**
- understand the effect of wing speed on power generation. **[L2]**

- study the properties of biogas. **[L2]**
- design the structure of Biogas in India. **[L4]**

UNIT III **8 L**

Fuel cells: Principle of fuel cells, Faradays laws, thermodynamic aspects. Performance limiting factors of fuel cells-reactivity-invariance, electrode losses-chemical polarization-concentration polarization-resistance polarization, types of fuel cells-hydrogen-oxygen fuel cells-biochemical cells-regenerative cells.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- study the principle of fuel cell and laws governing it. **[L1]**
- acquaint with losses i fuel cells. **[L1]**
- summarize different fuel cells available. **[L2]**

UNIT IV **9 L**

Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India. OTEC: Principles, utilization, setting of OTEC plants, thermodynamic cycles.
Tidal and Wave Energy: Potential and conversion techniques, tidal barrage, modes of operation-ebb generation- flood generation-two-way generation. Latest techniques used in TIDAL energy generation.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- understand the resources of geothermal energy. **[L1]**
- acquaint with the principles and utilization of otec. **[L2]**
- study about tidal and wave energy. **[L2]**
- outline modes of operation of ebb generation. **[L2]**
- choose the latest techniques in tidal energy generation. **[L3]**

UNIT V **8 L**

Direct Energy Conversion: Need for DEC, limitations, principles of DEC. Thermoelectric generators, seebeck, Peltier and Joule Thompson effects, figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD engine, power generation systems, electron gas dynamic conversion, economic aspects.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- understand and acquire the need for DEC. **[L1]**
- acquaint basic knowledge of thermoelectric generators. **[L1]**
- understand the performance of MHD generators. **[L2]**

Course Outcomes

At the end of the course, Students will be able to

- understand the different types of conventional and non-conventional energy sources, their parts, working, and will be able to sort out realistic application to society. (L2)
- analyse different set of operational parameters and constraints of solar energy systems for direct and indirect methods of usage, (L4)
- improve the efficiency of the wind and biogas l energy systems. (L4)
- understand concepts of fuel cells. (L2)
- understand and analyze geothermal, tidal and wave energy conversion systems (L4)

Textbook(s):

1. G.D. Rai, Non-conventional Energy Sources, 6/e, Khanna Publishers, 2004.
2. R.K.Rajput, Non-Conventional Energy Sources and Utilization, 2/e, S. Chand Publishing, 2014.

References:

1. G.Boyle, Renewable Energy: Power for a Sustainable Future, 3/e, Oxford University Press India, 2012
2. D.P.Kothari, K.C.Singal, Ranjan Rakesh, Renewable Energy Sources and Emerging Technologies, 2/e, Prentice Hall India, 2011.
3. B.H.Khan, Non-Conventional Energy Resources, 2/e, McGraw Hill India, 2009.

9EME350: MATERIAL CHARACTERIZATION

L	T	P	C
3	0	0	3

This course provides basic understanding of Material Characterization such as crystal structure determination, Microstructural studies and Phase transformation etc. This is an important course with respect to Material Science point of view and very helpful for those who want to excel in research. This is a prerequisite course for some advanced courses such as Advanced Phase Transformation, X-ray and Electron Diffraction techniques and Advanced Thermodynamics in Materials etc.

Course objectives:

- To teach basic principles of optical microscope in understanding materials characterization.
- To impart basic understanding of the electron microscopy and its techniques.
- To teach various diffraction methods and their application in material characterization.
- To explain the basics of thermal analysis.
- To impart basic knowledge of corrosion, its types and methods to measure corrosion.

UNIT I **8 L**

Introduction: Need of materials characterization and various characterization techniques available.
Optical microscope - Basic principles and components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Polarized light, Hot stage, Interference techniques), Stereomicroscopy, Photo-microscopy, Color metallographic, Specimen preparation, Applications.

Learning Outcomes:

At the end of this UNIT, the student will be able to
- Understand the significance of Optical microscopy in Material Characterization. [**L-1**]
- Understand the working principle of Microscopes. [**L-1**]
- Learn the procedure of Metallography: Sample preparation, Polishing, Etching etc. [**L-2**]
- Learn to use an optical microscope to study the microstructure of given metal/alloy. [**L-3**]

UNIT II **8 L**

Electron Microscopy: Interaction of electrons with solids, scanning electron microscopy Transmission electron microscopy and specimen preparation techniques, Scanning transmission electron microscopy, Energy dispersive spectroscopy, Wavelength dispersive spectroscopy.

Learning Outcomes:

At the end of this UNIT, the student will be able to
- Have a basic understanding of interaction of electron with atoms and electrons. [**L-1**]
- Learn the fundamentals of SEM and TEM. [**L-3**]

- Learn the specimen preparation techniques for TEM and SEM analysis. [**L-2**]

UNIT III **8 L**

Diffraction Methods: Fundamental crystallography, Generation and detection of X-rays, Diffraction of X-rays, X-ray diffraction techniques, Residual stress measurement.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- Learn the basic concept of X-ray generation and interaction with atoms. [**L-1**]
- Determine the crystal structure of crystalline solids. [**L-2**]
- Analyze XRD Peaks for Phase identification. [**L-2**]
- Have basic understanding of Residual stress analysis from XRD-Peaks. [**L-3**]

UNIT IV **8 L**

Thermal Analysis: Thermo gravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermo mechanical analysis and dilatometry.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- Analyze phase transformations and phase transition in materials. [**L-2**]
- Identify crystallinity and non-crystallinity of materials. [**L-2**]

UNIT V **8 L**

Electrochemical characterization techniques: Introduction to corrosion, types of corrosion. DC Polarization, linear polarization method, AC Impedance. Taffel analysis, Electrochemical impedance spectroscopy, potentio dynamic polarization techniques.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- Understand the concept of corrosion and its types [**L-1**]
- Understand of corrosion measurement methods [**L-1**]
- Understand corrosion analysis techniques. **[L-1]**

Course Outcome:

By the end of the course, the learners will be able to:

- Explain the principles of optical microscope in understanding materials characterization. **[L-2]**
- Apply appropriate characterization technique for microstructure examination at different magnification level and use them to understand the microstructure and phases of various materials. **[L-4]**
- Explain various diffraction methods and their application in material characterization. **[L-2]**

- Apply thermal analysis techniques to determine thermal stability of and thermodynamic transitions of the specimen. **[L-4]**
- Explain the concept of corrosion, its types and methods to measure corrosion. **[L-2]**

Textbook(s):

1. B.D.Cullity and S.R.Stock, "Elements of X-Ray Diffraction" Third edition, Prentice Hall, NJ , 2001.
2. David B. Williams, C. Barry Carter, " Transmission Electron Microscopy: A Textbook for Materials Science", Springer, pub. 2009.

References:

1. Brown, Michael Ewart, "Introduction to Thermal Analysis", Second edition, Springer, pub. 2001,
2. Zaki Ahmad, Principles of Corrosion Engineering and Corrosion Control, Butterworth-Heinemann, 2006.
3. Christopher Hammond, The Basics of Crystallography and Diffraction, Oxford University Press, 2015.

19EME352 - FINITE ELEMENT ANALYSIS (Elective)

L	T	P	C
3	**0**	**0**	**3**

Pre-requisites: *Engineering Mathematics, Strength of Materials, Dynamics of Machinery*
This course exposes the students to deal with various modelling techniques and uses different numerical methods for solving a system of governing equations over the domain of a continuous physical system, which is discredited into simple geometric shapes called finite element. This course also capitalizes on knowledge of mechanics and solves problems that can only be tackled numerically on the computer.

Course Objectives

1. Introduce the basic principles of finite element analysis.
2. Teach the theory and characteristics of finite elements that represent engineering structures.
3. Discuss the finite element solutions to static and dynamic structural problems.
4. Demonstrate the methodology to model and to solve complex problems in engineering.
5. Familiarize the students with the knowledge and skills needed to effectively use commercial finite element software.
6. Impart Advanced FEA knowledge and techniques for solving complex problems in engineering.

UNIT I **8L**

Introduction: General description of the FEM, comparison of FEM and other methods and engineering applications of FEM. **Fundamental Concepts:** Stresses and Equilibrium, Boundary conditions, Strain-Displacement relations, Stress-Strain relations, Plane stress, Plane strain, Temperature effects, Potential energy and Equilibrium. Raleigh-Ritz method, Galerkin's method, Saint Venant"s principle.

Learning Outcomes:

At the end of this UNIT, the student will be able to
Understand the significance of FEM (L1)
Comprehend the concept of plane stress and strain (L3)
Utilize the concept of energy methods (L3)

UNIT II **10 L**

One-dimensional Problems: Finite element modeling coordinates and Shape functions. Potential energy approach. Galerkin approach, Assembly of the global stiffness matrix- mass matrix and load vector, Treatment of boundary conditions, Quadratic shape functions, Temperature effects. Analysis of Plane trusses.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- Comprehend the concept Finite element modelling (L2)
- Utilize the concept of energy methods (L3)
- Analyze the bars and trusses by treatment of boundary conditions. (L4)

UNIT III **8 L**

Two-dimensional Problems Using Constant Strain Triangles: Finite element modelling, Constant strain triangle, in plane and bending, problem modelling and boundary conditions. **Axisymmetric Solids subjected to Axisymmetric Loading:** Axisymmetric formulation, Finite element modelling -triangular element, Problem modelling and boundary conditions.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- Comprehend the concept of two-dimension elements (L2)
- Analyze the CST and Axisymmetric Solids by problem modeling and boundary conditions. (L4)

UNIT IV **8 L**

Two-dimensional Isoparametric Elements and Numerical Integration: Four-node quadrilateral, Numerical integration, Higher-order elements. **Beams:** Finite element formulation, Load vector, Boundary considerations, Shear force and bending moment, Beams on elastic supports.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- Comprehend the concept Higher order elements (L2)
- Acquaint with concept of numerical integration (L2)
- Analyze the beams and frames and evaluate shear force and bending moment of the given continuum. (L4 & L5)

UNIT V **8 L**

Dynamic considerations: formulation, element mass matrices, consistent and lumped mass matrices, free vibration analysis and evaluation of Eigen values and Eigen vectors., **Scalar field problems:** Basic equations of heat transfer, Steady state heat transfer and straight uniform fin analysis.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- Comprehend the concept of Dynamics and Heat transfer in FEM (L2)
- Develop the Consistent and lumped mass matrices(L3)
- Evaluate the Eigen values and Eigen vectors. (L5)

Course Outcomes

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

1 Gain knowledge to have a clear understanding of how to solve basic real-world problems (L1)

2 Comprehend the solution path to engineering problems. (L2)

3 Apply the theoretical FEA concepts in solving simple to complex multi-physics FEA problems using advanced software's. (L3)

4 Infer and analyze the results obtained from finite element analysis software. (L4)

5 Make transparent judgments` with regards to the design or issues related to engineering problems. (L5)

Textbook(s):

1. Tirupathi.R.Chandrupatla, Ashok.D.Belegundu "Introduction to Finite Elements in Engineering", Pearson Education Limited, fourth edition ,2015
2. OC Zienkiewicz, Rl Taylor, Jz Zhu," Finite Element Method Its Basis & Fundamentals" Reed Elsevier India Pvt.Ltd, 2015 edition.

References:

1. S.S.Rao, "Finite element method in engineering", Elsevier Butterworth-Heinmenn publications, fourth edition, 2011.
2. JN Reddy, "An Introduction to the Finite Element Method" McGraw-Hill, 3rd edition, 2006.
3. P.Seshu ,"Finite element Analysis", PHI Learning Pvt. Ltd, first edition, 2003.

19EME356: ENTERPRISE RESOURCE PLANNING

L	T	P	C
3	0	0	3

This course exposes the students with content that contains business process reengineering, ERP life cycle and ERP related Technologies. This course will also offer the technologies involved in business UNITs in ERP packages. It also covers the emerging trends in ERP case studies.

Course Objectives

- To explain the technical aspects and life cycle of ERP systems.
- To expose the steps and activities in ERP.
- To explain, identify and describe different types of ERP system.
- To analyze the ERP Packages in manufacturing, textile, and e-commerce.
- To expose the concepts, tools and methodology used for designing ERP for an Enterprise.

UNIT I **8 L**

Introduction: Concept of Enterprise, ERP Overview, Integrated information system, The role of Enterprise, Business Modeling, Myths about ERP, Basic ERP Concepts, Intangible benefits of ERP, Justifying ERP investment, Risks of ERP, Benefits of ERP

Learning Outcomes:

At the end of this UNIT, the student will be able to

- understand the concept of enterprise resource planning. [**L2**]
- apply and interpret basic summary and modelling techniques of business modelling in ERP. [**L3**]
- recognize the myths, risks and benefits of ERP. [**L2**]
- knowledge in the areas where ERP has significance. [**L1**]

UNIT II **8 L**

Implementation: Life Cycle, Methodologies, Strategy, Business Case and Return on Investment Analysis for ERP, Selecting Consulting Partner, ERP Package Selection, ERP Project Team and Project Organization Structure, ERP Project Management, Managing Requirements, Business Process Re-engineering, Business Process Modeling and Business Modeling.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- understand the concept of life cycle and strategies involved in ERP. [**L2**]
- compile the ideas of any project team and develop modelling techniques in the structure of ERP.[**L5**]
- identify the process of selecting consulting partner and package selection. [**L1**]
- analyze wide knowledge in business process re-engineering. [**L4**]

UNIT III **8 L**

Post ERP Implementation: Post-Implementation Review of ERP Systems, Post-Implementation Support, Maintenance and Security of ERP, Gaps Identification and Strategies to Bridge the Gap, Configuring and Testing of the Solution, Data Migration, Cutover Planning and Go Live Preparation, Training, Change Management, Success or Failure of ERP Implementation.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- identify the gaps in the maintenance and security of ERP systems. [**L1**]
- test the solutions in data migration. [**L3**]
- extend wide knowledge in the success and failure of ERP. [**L3]**

UNIT IV **8 L**

ERP Functional UNITs: Human Capital Management, Financial Management Procurement, Inventory Management through ERP, Supplier Relationship Management, Production Planning, Execution, Supply Chain Planning, Sales and Service, Logistics Execution, Warehouse and Transport Management, Customer Relationship Management, Quality Management, Maintenance Management, Enterprise Asset Management, Product Lifecycle Management.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- understand the concept and distinguish the features between capital management, financial management and inventory management. [**L2**]
- recognize the execution of logistics, warehouse and transport management. [**L1**]
- Interpret the difference between customer relationship management, quality management and enterprise management. [**L1**]
- identify the features of product life cycle management. [**L1**]

UNIT V **8 L**

ERP Applications: Portal, Content Management, Knowledge Management, Data Warehousing, Data Mining, Business Intelligence and Analytics, ERP and Enterprise Applications, Emerging Trends, ERP for Industries- ERPs for Different Manufacturing Industries, ERPs for Different Service Industries, Case Studies.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- identify the gaps in the maintenance and security of ERP systems. [**L1**]
- configure and test the solutions in data migration. [**L2**]
- obtain the process of cutover planning, preparation, and training. [**L1**]
- enhance wide knowledge in the success and failure of ERP. [**L2**]

Course Outcomes:

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

- obtain a basic understanding of the concept of ERP. **[L1]**
- comprehend the significance of the ERP implementation Procedure. **[L2]**
- apply design principles for various business UNITs in ERP. **[L4]**
- learn various ERP UNITs and software's related to ERP. **[L3]**
- analyze security issues in ERP. **[L4]**
- compare ERP UNITs for Industries and Service org. **[L2]**

Textbook(s):

1. Rajesh Ray, Enterprise Resource Planning, 1stEdition, McGraw Hill Education, 2010.
2. Robert D.Hisrich, Michael P.Peters, Mathew J. Manimala and Dean A. Shepherd, Entrepreneurship, 9thEdition, McGraw Hill Education, 2010.

References:

1. D. P. Goyal, Enterprise Resource Planning a Managerial Perspective, 1stEdition, McGraw Hill Education, 2011.
2. L.Wagner, Concepts in Enterprise Resource Planning, 4th Edition, engage Learning India Pvt. Ltd, 2014.
3. A. leon, Enterprise Resource Planning, 3rdEdition, McGraw Hill Education, 2014.
4. P. C. Reddy,Enterprise Resource Planning, 1stEdition, S. K. Katarina& Sons, 201

19EME358: STATISTICAL QUALITY CONTROL

L	T	P	C
3	**0**	**0**	**3**

Quality control is a process by which entities review the quality of all factors involved in the production. Quality control emphasizes testing of products to uncover defects and reporting to management to enable them to decide to allow or deny the release. Quality assurance attempts to improve and stabilize production, and associated processes, to avoid, or at least minimize, issues that led to the defects. This course introduces the various statistical tools which aid in the process of quality control.

Course Objectives:

- To recognize the purpose of various tools used in quality control.
- To determine costs associated with quality.
- To familiarize students with various control charts for attributes and variables.
- To investigate the process capability and methods to improve the capability.
- To understand the acceptance sampling plans.

UNIT I **8 L**

Quality Basics and History: Meaning of quality, Factors affecting quality, Quality Principles, Quality function, Quality control, Aims and objectives of quality control, Characteristics, Cost of Quality, Value of quality, Seven QC tools, Need of management of product quality, Historical perspective of quality control.

Learning Outcomes:

After completing this UNIT, the student will be able to

- define quality and familiarize terms**[L1]**
- list factors effecting quality**[L1]**
- summarize objective of quality**[L2]**
- list quality tools. **[L1]**

UNIT II **10 L**

Modeling Process Quality: Variation: Stem-leaf Plot, Frequency distribution Histogram, Box Plot, Discrete Distributions Hyper Geometric Distribution, Binomial distribution, Poison Distribution, Continuous Distributions- Normal, Gamma, Exponential and Weibull's distribution.

Learning Outcomes:

After completing this UNIT, the student will be able to

- distinguish various distributions continuous and discrete distributions**[L4]**
- generalize and analyze the the distributions **[L4]**
- analyze the distribution **[L4]**

UNIT III **8 L**

Statistical Quality Control: Introduction, Concept of variability , Common vs. Special Causes, Types of Control charts, Measurement of control limits, Control charts for variables -large sample data, Warning limits, Revised control limits, Group control chart, Control chart with line trend.

Learning Outcomes:

After completing this UNIT, the student will be able to

- define variability **[L1]**
- list common and special causes of variability **[L1]**
- apply control c hart technique to solve problem**[L3]**
- analyze the causes for variations for variable chart**[L4]**

UNIT IV **10 L**

Control Charts for Attributes: Control charts for non-confirming Models, control charts for fraction non- conforming.

Process and Measurement System Capability Analysis: Using Probability plot, process capability ratios, specification limits and Tolerances.

Learning Outcomes:

After completing this UNIT, the student will be able to

- apply control Chart technique to solve problem for attributes**[L3]**
- analyze the causes for variations **[L4]**
- estimate the process capability ratio**[L2]**
- calculate the limits and Tolerances**[L3]**

UNIT V **8 L**

Acceptance Sampling: Introduction, Advantages and Disadvantages of Sampling methods, Sampling techniques, Sampling Risks and indices, Operating characteristic curves, Average outgoing quality Limit. Sampling plans Single, Double, Multiple and Sequential Sampling Plans Tightened Inspection, Dodge-Rooming system, Sequential plans.

Learning Outcomes:

After completing this UNIT, the student will be able to

- List advantages and disadvantages of sampling methods**[L1]**
- Selection of sampling plans for given situation **[L2]**
- Apply sampling plan **[L3]**

COURSE OUTCOMES:

- assess and estimate costs of quality. **[L5]**
- use tools of quality to quantify quality costs. **[L3]**
- graph control chart and control limits and revise the limits. **[L3]**
- estimate the capability of a process. **[L2]**
- state a sampling plan for a given scenario. **[L1]**

Textbook(s):

1. E. L. Grant Richard, R.S. Leavenworth, Design Statistical Quality Control, 7th Edition, McGraw-Hill Pvt Ltd New Delhi, 2011.
2. D. C. Montgomery, Statistical Quality Control,7th Edition, John Wiley Sons, 2012.

References:

1. M. Mahajan, Statistical Quality Control, Revised Edition, Dhanapat Rai & Co, 2007.
2. W.W.Hines, D. C.Montgomery, Probability and Statistics in Engineering and Management Science, John Wiley and Sons, New York, 1990.

19EME369 AUTOMATION IN MANUFACTURING

L	T	P	C
3	0	0	3

Automated manufacturing systems operate in the factory on the physical product. They perform operations such as processing, assembly, inspection and material handling. Manufacturing automation is the use of control systems, such as computers and information technologies for handling different processes and machines in an industry to replace a human being. Students will get exposure to automated manufacturing systems and their importance in the modern automated factory.

Pre-requisites:

Manufacturing Processes, Introduction to CAD, CAM and Practical CNC Machining, Measurements and Metrology

Course Objectives

- To learn various concepts of automation and work part transport mechanisms.
- To study the assembly systems and their applications.
- To understand the importance of handling systems and identification systems.
- To apply the concepts of part families and machine cells into various production systems
- To recognize the importance of automated inspection and to distinguish the various control systems.

Unit-I **10 hours**

Manufacturing and Automation-Overview: Production systems, Automation in production systems, Automation principles and strategies, Reasons for Automation, Manufacturing operations, Functions in Manufacturing, Information processing in Manufacturing plant layout, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers and personal computers. Automation for machining operations.

Learning outcomes:

At the end of this unit, the student will be able to

- recognize the significance of automation in production[L2]
- examine the various configurations of transfer lines, features and how they work[L2]

Unit-II **10 hours**

Assembly Systems and Line Balancing- Assembly Process-Assembly lines-manual single stations assembly, Manual assembly line, automated assembly system-Line balancing. **Automated Assembly Systems** – Design for automated assembly-Types of automated assembly systems-Parts feeding devices.

Learning outcomes:

At the end of this unit, the student will be able to

- explain the basic concepts of assembly process and the systems[L2]
- solve the line balancing problems[L3]

Unit-III **9 hours**

Automated Material Handling and storage system: Material Handling and Identification Technologies: Material handling, equipment, Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Functions, material handling equipment-Conveyors, AGVS, Industrial Robots-Anatomy, Robot configurations, work volume-AS/RS. Automatic identification methods, Barcode technology, RFID.

Learning outcomes:

At the end of this unit, the student will be able to

- recognize the importance of various automated material storage and handling systems (AS/RS)[L2]

- understand the role of identification systems in AS/RS[L2]

Unit-IV **8 hours**

Manufacturing Systems and Automated Production Lines: Manufacturing systems: components of a manufacturing system, Single station manufacturing cells, Automated production lines, Applications, Transfer lines.

Learning outcomes:

At the end of this unit, the student will be able to

- understand the fundamentals of automated production lines[L2]
- recognize the applications of transfer lines[L2]

Unit-V **8hours**

Control Systems-Process Industries Versus Discrete Manufacturing Industries, Continuous Versus Discrete Control: Continuous Control Systems, Discrete Control Systems, Computer Process Control: Control Requirements, Capabilities of Computer Control, Forms of Computer Process Control

Quality Control and Support Systems-Quality in Design and manufacturing, inspection principles and strategies, Automated inspection, contact and non-contact, CMM and machine vision techniques.

Learning outcomes:

At the end of this unit, the student will be able to

- examine the principles of automated inspection and sensor technologies[L2]
- recognize various control systems used in automation[L2]

Pedagogy tools: Lecture, PPTs

Texbook(s)	Topics
1. 1. Milkell P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Kindle Edition, Prentice Hall of India, 2016.	1,2,3,4,5

References	
1. C. Roy, “Robots and Manufacturing Automation”, Asfahl John Wiley & Sons.	
2. Krishna Kant, “Computer Based Industrial Control”, EEE-PHI, 2nd edition, 2010.	

Course Outcomes:

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

- understand various concepts of automation and work part transport mechanisms.
- select and identify suitable transfer mechanisms and assembly systems for the given application.
- recognize the importance of handling systems and identification systems.
- understand various production systems and transfer lines and their applications.
- differentiate various quality control aspects and automatic inspection techniques in automation

19EME375: FUEL CELL TECHNOLOGY AND HYDROGEN STORAGE SYSTEMS

L	T	P	C
3	0	0	3

Hydrogen storage is a key enabling technology for the advancement of hydrogen and fuel cell technologies in applications including stationary power, portable power, and transportation.

Course Objectives:

- To help students gain essential and basic knowledge of various types of Fuel cells, so as to equip them with knowledge required for the design of components of Fuel cells.
- To train the students with the performance evaluation of alternative energy systems.
- To provide comprehensive and logical knowledge of hydrogen production, storage, and utilization.
- To understand the working of Standalone Fuel cells and hydrogen storage devices
- To emphasize hydrogen energy safety techniques.

Module – 1

Introduction: Basic structure, critical functions of components –fuel cell stacking- fuel cell systems -types advantages and disadvantages – applications and status

Fuel Cell Performance: Thermodynamic aspects of Electrochemical Energy conversion- Cell efficiency – Factors affecting the efficiency of Electrochemical Energy conversion.

Learning Outcomes:

- Understand the basic concepts of fuel cell (L2)
- Evaluate the performance of fuel cells under different operating conditions (L1)

Module - 2

Alkaline Fuel cells (AFC): Principle of operation – modules- fuel cell stacks-general performance characteristics- Attempts towards advancements-Ammonia as AFC fuel System issues Electrodes: materials and manufacturing- Factors affecting the performance of PAFC.

Learning Outcomes:

- Demonstrate the basic concepts of types of Fuel Cell (L1)
- Design the Fuel cells. (L3)
- Evaluate the cost of generation and economics of Fuel cells (L2)

Module - 3

Types of fuel cells: Solid Oxide Fuel Cells (SOFC) and Molten Carbonate Fuel Cells: Cell components- Anode and Cathode materials- Interconnects seals- Configurations and performance- Environmental impacts - General principle- Cell components- Mechanisms of Electrode reactions.

Direct Methanol Fuel cells and Proton Exchange and Membrane Fuel Cells (PEM): Catalyst and Non catalyst aspects- Methanol cross over- Catalyst aspects and scale up-Engineering aspects - Scientific aspects and challenges- Modelling- Milestones in technology development- Approaches and challenges to high temperature operations.

Learning Outcomes:

- Select and defend appropriate fuel cell technology for a given application (L2)
- Illustrate the application of Fuel Cells (L1)

Module - 4

Hydrogen production technologies: Hydrogen as a future energy carrier, Properties, Chemical production of hydrogen, steam reforming of methanol, natural gas, coal gas etc, shift conversion and thermal decomposition, purification (removal of CO and CO_2), desulphurization, Electrolytic hydrogen production, Electrolyser Configurations.

Learning Outcomes:

- Demonstrate the basic concepts of Hydrogen Energy. (L3)
- Illustrate the various hydrogen storage & transportation techniques. (L2)
- Usage of Hydrogen Energy in Advanced Applications. (L1)
- Design and develop suitable hydrogen storage system to be used along with fuel cell system (L2)

Module - 5

Hydrogen storage technologies: Basic principles, compressed gas storage, Cryogenic liquid storage, Solid state Storage, Adsorption in compounds and metal hydrides, hydride heat pumps and compressors.

Learning Outcomes:

- Minimize environmental hazards associated with the use of hydrogen storage and fuel cell technology (L3)
- Examine the usage of Hydrogen Energy in various day to day applications. (L2)
- Analyze the safety issues related to the use of hydrogen as fuel. (L1)

Course Outcomes: Upon Successful Completion of this course, Students will be able to

- Analyse the energy scenario of our country.
- Describe the working principles of Fuel cells and their components.
- Develop clear understanding about functioning and types of Fuel cells.
- Design structural & thermo-chemical subsystems of Fuel cells.
- Assess environmental impact of Fuel cells.

Textbook/s

1. Viswanathan.B and Aulice Scibion (2008), Fuel Cells: Principles and applications, CRC Press

2. Ryan O'Hayre, Suk-Won Cha, Whitney Colella, Fritz B. Prinz (2016), Fuel Cell Fundamentals, John Wiley & Sons. Print ISBN:9781119113805

3. Principles of Fuel Cells by Xianguo Li, Taylor & Francis

4. Fuel Cells: From Fundamentals to Applications by S Srinivasan, Springer

5. Fuel Cells for automotive applications – professional engineering publishing UK. ISBN 1-86058 4233, 2004.

Reference Books

1. Bent Sorensen (2011) Hydrogen and Fuel cells, Academic Press

2. Noriko Hikosaka Behling (2012), Fuel cells, Elsevier Publi

HSMCH102 UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY

L-T-P-C
2-1- 0- 3

Pre-requisites: None. Universal Human Values 1 (Desirable)

Human Values Courses: 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.

OBJECTIVE: 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:

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

5. Purpose and motivation for the course, recapitulation from Universal Human Values-I.
6. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration.
7. Continuous Happiness and Prosperity- A look at basic Human Aspirations
8. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
9. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
10. 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.

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

11. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
12. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
13. Understanding the Body as an instrument of 'I' (I am being the doer, seer and enjoyer).
14. Understanding the characteristics and activities of 'I' and harmony in 'I'.
15. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
16. 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.

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

17. 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.
18. Understanding the meaning of Trust; Difference between intention and competence
19. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
20. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
21. 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.

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence.

22. Understanding the harmony in the Nature
23. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature.
24. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
25. Holistic perception of harmony at all levels of existence.
26. Include practice sessions to discuss human beings as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

27. Natural acceptance of human values
28. Definitiveness of Ethical Human Conduct
29. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
30. 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.

31. Case studies of typical holistic technologies, management models and production systems
32. Strategy for transition from the present state to Universal Human Order:
33. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
34. At the level of society: as mutually enriching institutions and organizations 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.

READINGS: Textbook

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

Reference Books

36. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
37. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
38. The Story of Stuff (Book).
39. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
40. Small is Beautiful - E. F Schumacher.
41. Slow is Beautiful - Cecile Andrews
42. Economy of Permanence - J C Kumarappa
43. Bharat Mein Angreji Raj - PanditSunderlal
44. Rediscovering India - by Dharampal
45. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
46. India Wins Freedom - Maulana Abdul Kalam Azad
47. Vivekananda - Romain Rolland (English)
48. Gandhi - Romain Rolland (English)

Course outcome

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

Program Core
19EME439 ADDITIVE MANUFACTURING

L T P C
3 0 0 3

The course is to acquaint students with the concept of 3D-printing / Additive Manufacturing (AM), various 3D-printing / AM technologies, selection of materials for 3D-printing / AM, modeling of 3D-printing / AM processes, and their applications in various fields. Applications for 3D printing are rapidly expanding in a broad set of industries and the technology is being used as a complementary tool in many professions. 3D printing being not only a field of learning itself but being used to enhance other fields of study by generating student engagement and drawing concepts and digital literacy elements into the broader curriculum.

COURSE OBJECTIVES

The student will be able to
1. To gain knowledge and skills related to 3D printing technologies.
2. To learn the selection of material, equipment and development of a product for Industry 4.0 environment.
3. To understand the various software tools, process and techniques for digital manufacturing.
4. To apply these techniques into various applications.

UNIT I **10 L**

Introduction to Additive Manufacturing (3D Printing): Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM, Applications.

Learning Outcomes:

- Able to describe additive manufacturing and explain its advantages and disadvantages(L5).
- Can explain the processes used in additive manufacturing for a range of materials and applications (L3).

UNIT II **10 L**

Vat Photopolymerization AM Processes: Stereolithography (SL), Materials, Process Modeling, SL resin curing process, Process Benefits and Drawbacks, Applications of Vat Photopolymerization, Material Jetting and Binder Jetting AM Processes.

Learning Outcomes:

- Candidate will know the process of how Stereolithography (SL) works (L2) .
- Will know how to make a differentiation of material jetting and Binder jetting process (L1).

UNIT III **10 L**

Extrusion-Based AM Processes: Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Contour Crafting, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.

Learning Outcomes:

- An ability to design and create own model using FDM process (L6).
- A knowledge on industry oriented applications used for the process (L1).

UNIT IV **5 L**

Sheet Lamination AM Processes: Bonding Mechanisms, Laminated Object Manufacturing (LOM), LOM Process Preparation, Advantages and Disadvantages of LOM, Applications of LOM Ultrasonic Consolidation (UC), UC applications.

Learning Outcomes:

- Candidate will know the modeling process of preparing geometric data LOM method (L3).
- Understand the role of bonding mechanisms in the design process (L2).

UNIT V **6 L**

Powder Bed Fusion AM Processes: Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.

Post Processing: Requirement and Techniques: Support Removal, Sanding, Acetone treatment, polishing,

Learning Outcomes:

- An ability to function on SLS method (L1).
- Able to conclude the best methods in 3D printing techniques (L3).

COURSE OUTCOMES

After completion of this course, the students will be able to:

49. Develop CAD models for 3D printing. (L2)
50. Import and Export CAD data and generate. stl file. (L4)
51. Select a specific material for the given application. (L2)
52. Select a 3D printing process for an application. (L2)
53. Produce a product using 3D Printing or Additive Manufacturing (AM). (L1)

LIST OF SUGGESTED BOOK (S)

1. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
3. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.

19EHS405: Operations research

L	T	P	C
3	0	0	3

This course is to aid decision-making and improve the efficiency of the system by applying advanced analytical methods. This course addresses a few quantitative and qualitative tools and techniques and provides students with the knowledge and skills needed to apply these tools and techniques for decision-making in organizations.

Course Objectives:

- To Introduce the basics of Operations research, formulation and solution of Linear Programming Problems using different methods
- To Learn Formulation and solve problems of optimization problems in transportation and assignment of jobs.
- To explore different sequencing techniques for optimal schedule of jobs on machines
- To impart knowledge on the concept lean manufacturing tools and replacement policies
- To introduce basic inventory models to optimize inventory costs and Project scheduling techniques – CPM & PERT for optimum time and costs.

UNIT- I **10 Hrs**

Basics of Operations Research: History, definition, operations research models, phases of implementing operations research in practice.
Linear Programming: Introduction, formulation, graphical method, simplex method, Big M and Two-Phase methods, concept of duality.
Learning Outcome:
After completion of Module-I, the students will be able to:

- **recognize** the significance of Operations Research and mathematical modelling while analyzing the practical problems in industry [**L1]**
- **formulate** the various linear Programming Models [**L6]**
- **evaluate** the optimal solution to simple linear programming problems [**L4]**

UNIT-II **8 Hrs**
Transportation Model: Formulation, methods for initial feasible solution, optimal solution – MODI method, unbalanced transportation problems, degeneracy in transportation problems.
Assignment Model: Formulation, optimal solution, Hungarian method, travelling salesman problem.
Learning Outcome:
After completion of Module-II, the students will be able to:

- **formulate** the linear programming problem as a Transportation model [**L6**]
- **formulate** the linear programming problem as an Assignment model [**L6]**
- **evaluate** the optimal solution to Transportation Problems [**L4]**
- **evaluate** the optimal solution to Assignment Problems [**L4]**

UNIT-III **8Hrs**
Sequencing Models: Introduction, assumptions, processing n-jobs through two machines, n-jobs through three machines, n-jobs through m-machines, graphic solution for processing 2 jobs through n machines with different order of sequence.
Learning Outcome:
After completion of Module-III, the students will be able to:

- **define** the various queuing models(**L1**)

- **evaluate** the optimal sequence of the jobs on machines for minimum cycle time(**L4**)

UNIT-IV **8Hrs**

Lean manufacturing Techniques: Introduction to lean manufacturing, tools - Waste Identification and Elimination, Just-in-Time (JIT) Production, Continuous Flow and Cellular Manufacturing, Total Productive Maintenance (TPM), Kaizen and Continuous Improvement.

Replacement Models: Introduction, replacement of items that deteriorate with time - value of money unchanging and changing, simple probabilistic model for replacement of items that fail completely.

Learning Outcome:

After completion of Module-IV, the students will be able to:

- **analyze** the replacement and maintenance costs of items under various replacement policies [**L4]**
- **evaluate** the optimal replacement policy of items [**L4]**
- **Practise** the various lean manufacturing tools [**L3**]

UNIT-V **8Hrs**

Inventory Models: Introduction, inventory costs, purchase and manufacturing models, inventory models with quantity discounts.

Project Management: Introduction, phases of project management, network construction, numbering the events-Fulkerson's rule, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT)

Learning Outcome:

After completion of Module-V, the students will be able to:

- **recognize** the significance of Inventory models & Project Management in real world industrial scenarios [**L1]**
- **differentiate** between the critical and non-critical activities of a given project [**L4]**
- **propose** the optimal schedule of the activities involved in a project [**L6]**
- **evaluate** the optimal order/batch quantity for minimum inventory cost [**L4]**

Course Outcomes:

After successful completion of this course, the students will be able to

- **develop** the mathematical models and **propose** the optimal resource allocation [**L3&L6]**
- **formulate** and **solve** transportation & assignment models for optimum resources [**L6&L3]**
- **propose** the optimal sequence of jobs on machines [**L4 & L6]**
- **evaluate** the optimal replacement policy of the equipment and to **practise** lean manufacturing techniques [**L6&L4]**
- **design** the inventory systems and to **plan** the project activities [**L6]**

Textbook(s)

1. Paneerselvam R., Operations Research, 2/e, Prentice Hall of India, 2010.
2. James P.Womack and Daniel T. Jones., Lean Thinking: Banish Waste and Create Wealth in Your Corporation, Simon & Schuster UK, 2013.

References

1. Gupta P K. & Hira D.S., Operation Research, 6/e, S Chand Publishers, 2006.
2. Harvey M. Wagner, Principles of Operations Research: With Applications to Managerial Decisions, 2/e, Prentice Hall of India, 1975.
3. David Mann., Creating a Lean Culture: Tools to Sustain Lean Conversions, productivity press, 2014.
4. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7/e, Tata McGraw Hill, 2009.

19EME495: COMPREHENSIVE SKILL DEVELOPMENT VI

Stream	Course Code	Course Title	Category	L	T	P	A	C	Marks
Comprehensive Skill Development	Department specific	Soft Skills and Quantitative Aptitude	PW	0	0	0	6	1	50
		Domain skills				3			50
Total number of hrs per week						* 6			100

Soft skill

Unit	Module/ Topics	Hrs
1.	GRE-Oriented Tests and Discussions	4
2.	CAT-Oriented Tests and Discussions	4
3.	TCS, Infosys-Oriented Tests and Discussions	4
4.	Other Company-Specific Tests & Discussions	3
	Total	15

Verbal skills

Unit	Module/ Topics	Hrs
1.	Resume Writing & Acing Job Interviews	**4**
2.	Corporate Readiness 1	**3**
3.	Mock Tests with Solutions 1	**5**
4.	Company-Specific Tests with Solutions 1	**3**
	Total	**15**

Domain skills
60 hours of training in any of the following courses

S.No	Specialization	Name of the Course	No of Hours
1	All Branches	Introduction to Digital technologies	20
2	MECH	Simulation technologies and python programming	30
3	MECH	AI in mechanical Engineering	30
4	MECH	Robotics and Automation	30
5	MECH	Electrical Vehicle Design/ Batteries Technology.	30
6	MECH	3-D Printing in Mechanical Engineering	30
7	MECH	Industry 4.0	20
8	MECH	MATLAB Python and CFD using Solid works for Mechanical Engineering Application	60
9	MECH	Introduction to Automotive Cyber security and Vehicle Networks	60
10	MECH	Introduction to Structural Analysis using ANSYS Workbench	60

11	MECH	Certification in Hybrid Vehicle Design & Analysis	60
12	ECE, Mech	Industrial IoT	60
13	Mech	Design tools - Autodesk / hyper mesh etc	60
14	All Branches	Project Management Skills	60
15	Mech	Augmented Reality - Human & Automation	60

Program Elective III

S. No	Course Code	Course Name	Category	L	T	P	C
1	19EME362	Solar Energy	PE	3	0	0	3
2	19EME364	Automotive transmission systems	PE	3	0	0	3
3	19EME368	Manufacturing of Automobile Components	PE	3	0	0	3
4	19EME370	Non-Destructive Testing (NDT)	PE	3	0	0	3
5	19EME376	Inventory control	PE	3	0	0	3
6	19EME378	Plant Layout and Facilities Planning	PE	3	0	0	3
7	19EME447	Computer Integrated Manufacturing	PE	3	0	0	3
8	19EME474	Autonomous vehicles	PE	3	0	0	3

19EME362: SOLAR ENERGY

L	T	P	C
3	0	0	3

To understand the fundamentals of solar energy and its conversion techniques for both thermal and electrical energy applications. Solar energy is the most secure of all energy sources. It is abundantly available. Renewable Power generation including Solar Photovoltaic (PV) and Solar Thermal (ST) power / steam / hot water generation offer an environmentally safe and sustainable alternative.

Course Objectives:

- Summarize the basic fundamental concepts of the solar radiation and analyze the future scope of solar energy and their utilization.
- Explain the working principle of solar cells and their modern manufacturing techniques
- Elaborate the students with various solar Thermal systems and their utilization
- Demonstrate the workings of various solar photovoltaic systems.
- Appraise the knowledge related to latest life cycle analysis of solar Energy Systems

UNIT I **9 L**

Introduction: Basic Heat Transfer Principles- Availability of Solar Energy- Nature of Solar Energy- Solar Energy & Environment- Sun as the source of radiation- Solar radiation- Measurement of solar radiation Irradiance- Solar constant- Insolation- Radiosity- Emissive power- Earth‟s equator- Meridian Longitude- Sun earth angles- Sunrise, sun set and day length- Solar time- Equation of time Various Methods of using solar energy- Photo thermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- summarize the availability of Solar Energy and nature of Solar Energy [L2]
- demonstrate the basic measurement of solar radiation [L2]
- illustrate the different methods of using solar energy [L2]

UNIT II **10 L**

Solar cells: Various generations- Semiconductor materials- Doping- Fermi level- PN junction and characteristics- Photovoltaic effect- Photovoltaic material- Parameters of solar cells- Effects of cell temperature on cell efficiency- Types of solar cells- Solar UNITs and arrays- Advantages and limitations of solar energy system- Solar cell power plant- Silicon, thin film and polymer processing- Silicon wafer based solar cells.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- summarize various solar cell characteristics and their materials.[L2]
- analyze different types of solar cells and their UNITs and arrays. [L4]
- assess solar power plant with silicon, thin film and polymer processing. [L4]

UNIT III **10 L**

Solar Thermal Energy: Stationary collectors- FPC- CPC- ETC- Sun tracking concentrating collectors- PTC- PDR- HFC Fresnel collectors- Solar thermal power plants- Solar chimney power plant- Solar pond- Solar water heater- Solar cooker- Types- SODIS- Thermal energy storage- Solar cooling- Limitations of solar thermal energy.

Learning Outcomes:

At the end of this UNIT, the student will be able to
- summarize the principles underlying in working different types stationary collectors [L2]
- analyze working principle of solar thermal power plants [L4]
- analyze the limitations of thermal energy storage in solar system. [L4]

UNIT IV **9 L**

Solar Photovoltaics: Photovoltaic cell function- Types of PV system- Design of PV system- Grid connected PV system Standalone PV system- Efficiency of PV UNIT- MPPT- Applications of PV system- SPV lighting system- Solar water pumping system- Solar vehicles- Solar dryer- BIPV- Features of SPV system Case study- Solar water pumping system in Punjab- Performance study on solar drying system in Nepal.

Learning Outcomes:

At the end of this UNIT, the student will be able to
- interpret the photovoltaic cell function. [L2]
- design and study the different types of PV system[L5]
- develop the solar dryer, solar pump and solar vehicle. [L3]

UNIT V **7 L**

Economic analysis: Life cycle analysis of Solar Energy Systems – Time Value of Money – Evaluation of Carbon Credit of Solar Energy Systems.

Learning Outcomes:

At the end of this UNIT, the student will be able to
- infer the need of life cycle analysis of solar energy system.[L1]
- develop economic analysis system for solar energy system. [L3]
- evaluate Carbon Credit of Solar Energy Systems.[L4]

Course Outcomes:

Upon successful completion of the course, the students will be able to
- summarize the basic concept of solar radiation calculations. [L2]
- demonstrate the working principle solar cells and their importance[L2]
- analyze the solar collectors and their limitations [L4]
- explain the function of solar photovoltaic and modern techniques of using solar energy in different application. [L2]
- analyze economic analysis and life cycle of solar thermal systems.[L4]

TEXTBOOK

1. Soteris A. Kalogirou,Solar Energy Engineering: Processes and Systems, 2/e, Academic Press, 2013
2. Tiwari G.N, Solar Energy – Fundamentals Design, Modelling and applications, Alpha Science, 2002

REFERENCES

1. John W. Twidell,Anthony D Weir,Renewable Energy Resources,Taylor&Francis,2005
2. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4/e, John Wiley and Sons, 2013
3. S P Sukhatme, J K Nayak, Solar Energy, 4/e,McGraw-Hill Education, 2017.

19EME364: AUTOMOTIVE TRANSMISSION SYSTEMS

L	T	P	C
3	0	0	3

To acquire knowledge about the designing of automotive transmission system and to make the student understand the working of automotive transmission system and emphasize the need for maintenance of transmission equipment.

Course Objectives

- To familiarize concepts of transmission system for power transfer from engine to wheels.
- To explain different mechanisms and working of transmission system.
- To teach the concepts of clutches and gears
- To introduce the concept of automatic transmission.
- To familiarize Special transmission systems.
- To provide fundamental concepts of driveline used in automobiles.

UNIT 1 **8 L**

Clutch: Necessity of clutch in an automobile, different types of clutches, friction clutches namely Single plate clutch, multi plate clutch, cone clutch, centrifugal clutch, electromagnetic clutch, hydraulic clutches, Clutch - adjustment, Clutch troubles and their causes, requirements of a clutch, Clutch materials, clutch lining Vacuum operated clutch. Fluid coupling

Learning outcomes

At the end of this UNIT, the student will be able to

- identify different types of clutches. (L2)
- explain the different mechanisms and materials used for clutches . (L2)
- develop clutches for torque requirement problems. (L4)

UNITII **8 L**

Gear box: Various Resistances to Motion of the Automobile, Traction, tractive effort Performance curves, acceleration grade ability, draw bar pull. The need for transmissions, Necessity of gear box, Desirable ratios of 3-speed & 4-speed gear boxes, Constructional details of sliding-mesh gear
box, constant-mesh gear box, synchromesh gear box, automatic and semi-automatic transmission, overdrive.

Learning outcomes

At the end of this UNIT, the student will be able to

- apply various performance curves.(L3)
- explain the efficiency of different gear systems.(L2)
- enumerate the causes for poor performance transmission systems. (L3)

UNIT III **8 L**

Torque Converter and Automatic Transmission: Principal of torque conversion, single, multistage and polyphase torque converters, performance characteristics, constructional and operational details of typical hydraulic transmission drives. Automatic transmission: relative merits and demerits when compared to conventional transmission epicyclic and hydromantic transmission continuously variable transmission.

Learning outcomes

At the end of this UNIT, the student will be able to

- apply principle of torque conservation for enhanced performance of systems. (L3)
- evaluate performance characteristics of automatic clutches. (L4)
- explain different unconventional transmission systems. (L3)

UNIT IV **8 L**

Special transmission systems: Hydrostatic drives: advantages and disadvantages, principles of hydrostatic drive systems, construction and working of typical hydrostatic drives, Janney Hydrostatic drive. Electrical drives: advantages and limitations, principles of Ward Leonard system of control Modern electric drive for buses and performance characteristics.

Learning outcomes

At the end of this UNIT, the student will be able to

- apply principals of hydrostatic systems. (L3)
- examine hydraulic and electrical drives. (L4)
- evaluate the performance of modern electric drives. (L4)

UNITV **8 L**

Drive line: Effects of driving thrust and torque reaction. Hotchkiss drive. Torque tube drive, radius rods. Propeller shaft. Universal joints. Final drives – different types, double reaction final drive. Two speed rear axles. Rear axle construction – full floating, three quarter floating and semi-floating.
arrangements. Differential conventional type, no-slip type. Differential locks.

Learning outcomes

At the end of this UNIT, the student will be able to

- explain the driving thrust and torque reaction. (L3)
- relate different types of drives. (L3)
- examine different types of rear axle construction. (L4)

Course Outcomes

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

- select proper transmission system for a vehicle, L2
- identify and solve problems related to transmission system. L3
- Use of advanced technology in automobiles L3
- Choose a particular drive line for an application L4

Textbook:

1. Fischer and Pollack, “The automotive transmission book”, Springer, 2014

References:

1. Newton K and Steeds. W. “The Motor Vehicle”, Butter Worth’s & Co., Publishers Ltd, 2001
2. Automatic vehicle transmission, John Wiley Publications 1995
3. Crouse. W.H., Anglin. D.L., "Automotive Transmission and Power Trains construction ", McGraw-Hill 4 Heldt P.M - Torque converters- Chilton Book Co.-1992

19EME368: MANUFACTURING OF AUTOMOBILE COMPONENTS

L	T	P	C
3	0	0	3

This course provides an insight to the basic concepts and techniques of metal casting processes, joining & deformation processes and various types of plastic parts used as automotive components. The course aims at giving adequate exposure to select materials and manufacturing techniques for automotive component development that are used in real-life to realize successful products.

Course Objectives

- Understand the knowledge in various manufacturing methods in developing automotive components.
- Remember the underlying concepts and methods behind Automobile materials and manufacturing.
- Apply a problem oriented in depth knowledge of Automobile materials and manufacturing.
- Analyze the suitability of different manufacturing methods.
- Create suitable materials for automobile components.

UNIT I **9 L**

Casted Engine Components - Introduction to manufacture of automobile components material selection and foundry pattern making. Production of Cylinder block, Cylinder head, wet and dry liners, engine head, oil pan, carburetors, piston and piston rings and testing. Thermal barrier coating of Engine head and valves.

Learning outcomes

At the end of this UNIT, the student will be able to
- understand the suitable materials for casting of automobile components (L2).
- able to define the sequence of operations for production of automobile components (L2).
- apply the required pattern allowances as per components requirements (L3).

UNIT II **8 L**

Forged Engine Components: Material selection and manufacturing methods of automobile components using forging and metal working process. Different process of steels making and machine forging. Production of Crank shaft, Connecting rod, Cam shaft, valve, Piston pin, Push rod, Rocker arm, tappets, spark plug.

Learning outcomes

At the end of this UNIT, the student will be able to
- understand the suitable materials for forging of engine components (L2).
- apply different processes of steel making used in manufacture of automotive components (L3).
- apply the machine forging methods for production of specific parts (L3).

UNIT III **10 L**

Transmission System - Material selection and Manufacturing methods for Clutch – Clutch lining – Gear Box – Gear – Propeller Shaft – Differential – Axle Shaft – Bearing – fasteners – Wheel drum. Methods of Gear manufacture – Gear hobbing and gear shaping machines – gear generation – gear finishing and shaving – Grinding and lapping of hobs and shaping cutters – gear honing – gear broaching.

Learning outcomes

At the end of this UNIT, the student will be able to
- Understand the suitable materials for elements of transmission system (L2).
- Create models for Clutch – Clutch lining – Gear Box – Gear – Propeller Shaft – Differential – Axle Shaft – Bearing – fasteners – Wheel drum to select appropriate manufacturing methods (L6).

UNIT IV **8 L**

Vehicle Chassis - Material selection and manufacturing methods for chassis, dead axle, leaf spring, coil spring and shock absorbers – wheel housing – steering system, Brake shoes, wheel rim, Tyres. Heat treatment procedures.

Learning outcomes

At the end of this UNIT, the student will be able to
- understand vehicle chassis configuration, structures, basic components, materials and manufacturing methods (L2).
- apply and demonstrate the need for heat treatment procedures in production of chassis (L3).

UNIT V **10 L**

Recent Developments - Surface treatment – Plastics – Plastics in Automobile vehicles – Processing of plastics – Emission control system – catalytic converter – Hydro forming of exhaust manifold and lamp housing – stretch forming of Auto body panels – MMC liners – Selection of materials for Auto components. Use of Robots in Body weldment.

Learning outcomes

At the end of this UNIT, the student will be able to
- analyze the importance of Surface treatment (L4).
- evaluate the usage of Emission control system (L5).

Course Outcomes

After completing the course for a given automotive components Student will be able to
- remember the concepts and methods for manufacturing automobile materials and components. L1.
- understand the proper sequence of manufacturing process and produce them. L2
- apply the basic principle and production methods of automotive components. L3
- analyze different areas of automobile materials and manufacturing. L4

- Evaluate the suitability of manufacturing materials for automobile components. L5
- Create applications of all the areas in day to day life. L6

Textbook(s):

1. Heldt.P.M, “High speed combustion engines”, Oxford publishing Co., New York, 1990.
2. SeropeKalpakjian and Steven R. Schmid, “Manufacturing Processes for Engineering Materials”, Fourth Edition, Pearson Education publications – 2003

References:

1. Kirpal Singh, ‘Automobile Engineering”, Vol. I & II, Standard Publishers, New Delhi, 1997.

Newton and steels, the motor vehicle, ELBS, 1990

1. Gupta K.M. “Automobile Engineering” Vol.I& II, Umesh Publishers, 2000.

19EME370: NON-DESTRUCTIVE TESTING

L	T	P	C
3	0	0	3

This course is very helpful for real time evaluation of both surface and volume defects generated in materials either during manufacturing process or while in service life. A student can get acquainted or trained on certain set of NDT testing Principle and Method those are popularly being practiced by Production Industry. In addition to some basic techniques on NDT, advanced technology in this field can be practiced by the student.

Course Objective:

- Explains the concept of detecting defects in material without damaging the structure.
- Understanding special techniques to detect micro-cracks responsible for fatigue failure.
- Learning of detecting volumetric defects within materials by using magnetic and ultrasonic method.
- Understanding certain advanced NDT technique using concept of Eddy current, Thermal Infrared and Acoustic techniques.

UNIT I **8 L**

Introduction to NDT: Introduction, non-destructive versus destructive tests, conditions for effective non-destructive testing, personnel consideration, certification summary
Discontinuities Origins and Classification: Primary production of metals, castings, cracks, welding discontinuities, discontinuities from plastic deformation, corrosion – induced discontinuities, operationally induced discontinuities, fatigue cracking, creep, brittle fracture, geometric discontinuities

Learning Outcomes:
- Understands the technique of Destructive and Non-destructive technique. **[L-1]**
- Recognizes the conditions for NDT testing. **[L-2]**
- Learns the technique of finding surface defect during welding, casting and corrosion etc. **[L-1]**

UNIT II **9 L**

Penetrant Testing and Magnetic Particle Testing: Penetrant testing: Introduction, theory and principles, penetrant equipment and materials, penetrant procedures, penetrant procedures, techniques and variables, evaluation and disposition, penetrant testing applications. Magnetic Particle Testing: Introduction, theory and principles, equipment and accessories, techniques, variables, evaluation of test results and reporting, applications.

Learning Outcomes:
- Understanding of theory of penetrating test. **[L-1]**
- Uses of Equipment related to penetration test. **[L-2]**
- Learns the concept of Magnetic Particle testing. **[L-3]**

UNIT III **9 L**

Radiography Testing and Radiation Safety: Introduction, theory and principles, geometric exposure principles, shadow formation, shadow sharpness, radiographic equipment and accessories, variables, techniques and procedures, radiographic evaluation, applications, compendium of radiographs.
Radiation Safety: Special and SI UNITs of radiation, principles of radiation detectors – ionization chamber, proportional counter, G.M. counters, scintillation counters, solid state detectors, biological effect of ionizing radiation, operational limits of exposures, radiation hazards evaluation and control, design of radiography installation and shielding calculations.

Learning Outcomes:

- Explains the concept of Radiography technique. **[L-1]**
- Understand the experimental use of Radiography Testing. **[L-2]**
- Learns the Safety aspect of Radiation safety. **[L-3]**

UNIT IV **8 L**

Ultrasonic Testing: Introduction, theory and principles, equipment for ultrasonic applications, techniques, variables, evaluation of test results, applications, basic instrument calibration, calibration blocks (IIW block, ASTM blocks, distance amplitude block, area amplitude block), cables, 157 connectors, test specimens. Reference reflectors for calibration (side drilled holes, notches, etc.,), inspection calibration, comparison with reference blocks, reference for planned tests (straight beams, angle beam), transmission factors – factors affecting the performance of ultrasonic test.

Learning Outcomes:

- Understanding the concepts of Ultrasonic methods in testing. **[L-1]**
- Explains the calibration technique of equipment related to Ultrasonic testing. **[L-1]**
- Assessing factors responsible for the performance of Ultrasonic test. **[L-3]**

UNIT V **8 L**

Other NDT Techniques: Eddy current testing; Introduction, theory and principles, alternating current principles, eddy current, test equipments, eddy current applications and signal display, advantages and limitations.
Thermal Infrared Testing: Introduction, theory and principles, equipment and accessories, techniques, variables, data storage, applications, advantages and limitations, thermal chalks
Acoustic Emission Testing: Introduction, principles of acoustic emission testing, advantages and limitations of acoustic emission testing.

Learning Outcomes:

- Understands the concept of Eddy current technique for detecting defect. **[L-1]**
- Learns the theory of Thermal Infrared Testing. **[L-1]**
- Explains the concept of Acoustic Emission Testing. **[L-1]**

Textbook(s)

1. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, 2/e, Tata McGraw Hill, 2011.

References

1. C. Hellier, Handbook of Non-Destructive Evaluation, 1/e, McGraw Hill Professional, 2001.
2. B. Raj, T. Jayakumar and M. Thavasimuthu, Practical Non-Destructive Testing, 3/e, Alpha Science International, 2002.
2. Non-Destructive Examination and Quality Control, 9/e, ASM

19EME376: INVENTORY CONTROL

L	T	P	C
3	0	0	3

The course exposes the students to understand the concepts of Supply chain, manufacturing planning and Control systems. It mainly focuses on the inventory management very much essential for the students who work with the industries in the future and familiarizes the inventory management techniques.

Course Objectives:

- To explain the fundamental concepts of materials management.
- To familiarizes the basic inventory control systems.
- To compare different manufacturing operations in a firm
- To select the best combination of materials-handling and storage equipment.

UNIT- I **8 L**

Introduction: Operating Environment. Supply Chain Concept, Material Flow, Supply Chain Metrics.
Production Planning System: Manufacturing Planning and Control System. Sales and Operations Planning, Manufacturing Resource Planning. Enterprise Resource Planning. Making
the Production Plan.

Learning Outcomes:

After completing this UNIT, the student will be able to

- apply logistics and purchasing concepts to improve supply chain operations**[L3]**
- evaluate complex qualitative and quantitative data to support strategic and operational decisions. **[L4]**
- analyze systematic planning of production activities to achieve the highest efficiency in production of goods/services**. [L4]**

UNIT II **8 L**

Inventory Fundamentals: Aggregate Inventory Management, Item Inventory Management, Inventory and Flow of Material, Supply and Demand Patterns, Functions of Inventories, Objectives of Inventory Management, Inventory Costs, Financial Statements and Inventory, ABC Inventory Control.
Order Quantities: Economic Order Quantity (EOQ), Variations of EOQ Model. Quantity Discounts, Use of EOQ when Costs are not known, Period Order Quantity (POQ).

Learning Outcomes:

After completing this UNIT, the student will be able to

- identify the role of information technology in managing inventories. **[L2]**
- categorize the ABC analysis of inventory items**[L4]**
- Describe the continuous or periodic review inventory-control system. **[L1]**

UNIT III **8 L**

Independent Demand Ordering Systems: Order Point System, Determining Safety Stock. Determining Service Levels, Different Forecast and Lead Time Intervals, Determining when Order Point is reached, Periodic Review System, Distribution Inventory.

Learning Outcomes:

After completing this UNIT, the student will be able to

- determine different inventory performance measures and relevant costs **[L3]**
- analyze the warehouse/Distribution Centre Management**[L4]**
- apply quality management tools for process improvement**[L3]**

UNIT IV **6 L**

Purchasing: Establishing Specifications, Functional Specification Description, Selecting Suppliers, Price Determination, Impact of MRP on Purchasing, Organizational Implications of SCM.

Learning Outcomes:

After completing this UNIT, the student will be able to

- apply the sales and operations planning, MRP and lean manufacturing concepts**[L3]**
- examine the methods used by organizations to obtain the right quantities of stock or inventory, **[L1]**

UNIT V **8 L**

Physical Inventory and Warehouse Management: Warehousing Management, Physical Control and Security, Inventory Record and Accuracy.
Physical Distribution: Physical Distribution System, Interfaces, Transportation. Legal Types of Carriage. Transportation Cost Elements, Warehousing, Packaging, Materials Handling. Multi-Warehouse Systems.

Learning Outcomes:

After completing this UNIT, the student will be able to

- familiarize themselves with inventory management practices. **[L2]**
- assess the different levels of transportation costs, warehouse utilization metrics and productivity improvement methods**[L4]**

Course Outcomes:

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

- analyze systematic planning of production activities to achieve the highest efficiency in production of goods/services. **[L4]**
- evaluate problems pertaining to inventory by choosing right models**. [L4]**
- identify different inventory models to reduce inventories costs in real life situations. **[L2]**
- compute the problems in price discounts and multi-level inventory also**[L3]**
- apply latest emerging concepts like ABC and MRP for business organizations. **[L4]**

Textbook:

1. Steve Chapman & Tony Arnold, Introduction to Materials Management, 7Th edition, Pearson,2016.
2. P Gopalakrishnan& M Sundaresan, Materials Management: An Integrated Approach,18th Printing, PHI, 2012.

References:

1. A K Dutta, Materials Management: Procedures, Text and Cases, 2nd edition, PHI, 2009.
2. S D Sharma, Operations Research, 4th edition, 2009.
3. KantiSwarup, PK Gupta & Man Mohan, Operations Research, S Chand, 2014.

19EME378: PLANT LAYOUT AND FACILITIES PLANNING

L	T	P	C
3	0	0	3

The workspace is one of the main resources to deliver products/services with the expected level of quality with minimum cost. To achieve the organizational effectiveness and efficiency proper utilization of the workspace has to be ensured. This course has been designed to highlight the basic issues, concepts and the techniques related to Plant layout and assembly lines.

Course Objectives:

- To impart knowledge on plant layout and plant location Theories.
- To understand and introduce SLP procedure for plant layout preparation.
- To learn the basics of material handling techniques.
- To understand the line balancing techniques and labour optimization in industry.

UNIT –I **8 L**

Plant Engineering: Plant Layout, Introduction, Types of Plant Layout, Phases of Layout Planning, Plant Location, Urban v/s Rural Location, Single facility location problems, Multi facility location Problems.

Learning Outcomes:
After completing this UNIT, the student will be able to

- familiarize the characteristics of product, process layouts. **[L1]**
- expose various factors that influence the location of a plant in urban vs rural area. **[L3]**
- know different phases of layout planning. **[L2]**
- study a facility location problem for single and multiple facilities. **[L2]**

UNIT-II **10 L**

Systematic Layout Planning: P-Q Analysis, Flow of Materials Analysis, Activity Relationship Analysis, Space Requirements & Availability, Modifying Considerations, Practical Limitations, Selection of Layout, Installation of Layout, CORELAP, CRAFT, ALDEP Algorithms Procedure and application, Problems.

Learning Outcomes:

After completing this UNIT, the student will be able to

- study the material flows in a manufacturing industry. **[L2]**
- adapt the knowledge in REL chart. **[L4]**
- employ various computer algorithms in designing a layout. **[L3]**
- teach the students for selecting a layout process**. [L3]**

UNIT–III **8 L**

Material Handling: Functions, Principles of Material Handling, MH Equipment-Conveyors, MH Equipment-Cranes, MH Equipment-Trucks, Systematic Handling Analysis, Classification of Materials.

Learning Outcomes:

After completing this UNIT, the student will be able to

- familiarize various functions and principles of material handling systems. **[L1]**
- introduce various MH equipment used in the manufacturing industry. **[L1]**
- expose various materials used in the manufacturing industry. **[L3]**
- enumerate some numerical problems for selection of MH equipment for a given material. **[L1]**

UNIT–IV **8 L**

Mass Production Management (Line Balancing): Basic idea of assembly line balancing, Optimization of number of stations with given production rate, Minimization of cycle time with fixed number of stations.

Learning Outcomes:

After completing this UNIT, the student will be able to

- learn the concept of line balancing in assembling a product. **[L1]**
- acquaint knowledge in minimum number of work stations in a production line. **[L1]**
- solve numerical problems in calculating the minimum cycle time of an assembly line**.** **[L3]**
- Recognize the importance of assembly line balancing through a case study. **[L1]**

UNIT –V **8 L**

Line Balancing Algorithms: Kilbridge and Wester, Rank Positional Weight method, COMSOAL, Moodie and Young method.

Learning Outcomes:

After completing this UNIT, the student will be able to

- evaluate algorithmic approach to balance the assembly line. **[L5]**
- explain various methods for assembly line balancing in mass production. **[L2]**
- examine existing software methods for solving assembly line problems. **[L4]**
- solve practical line balancing problems through research papers. **[L3]**

Course Outcomes:

At the end of the course the student will be able

- effectively design and analyze facility layouts. **[L4]**
- apply and evaluate appropriate facility location models. **[L3]**
- design, measure, and analyze material flow systems. **[L6]**

- apply algorithms for layout Preparation. **[L3]**
- apply algorithms for line balancing**[L3]**

Textbook(s)

1. R.L Francis and J.A White, Facilities layout and location-An analytical approach, Prentice Hall, 1992.
2. R. Panneerselvam, Production and operations management,3rd Edition, Prentice Hall Inc, 2012.

Reference:

1. J.M. Apple, Plant Layout and Material Handling, McGraw Hill, 1972.
2. P. Rama Murthy, Production and operations management, 2nd Edition, New Age International, 2006.

19EME447: COMPUTER INTEGRATED MANUFACTURING

L	T	P	C
3	0	0	3

This course provides basic knowledge about computer integrated manufacturing, and it deals with grouping technology which is one of the most important technologies followed in leading industries.

It provides the basic knowledge of Computer aided process planning, Artificial Intelligence, Integrative Manufacturing Planning and Control. CIM combines various technologies like computer-aided design (CAD) and computer-aided manufacturing (CAM) to provide an error-free manufacturing process that reduces manual labour and automates repetitive tasks.

Pre-requisites:

Introduction to CAD, CAM and Automation knowledge.

Course Objectives

- To introduce the concepts of automation, group technology integrated to Computer aided design and manufacturing.
- To obtain an overview on computer aided process planning
- To impart the knowledge of forecasting, scheduling capacity planning, shop-floor control in manufacturing systems and the concept of JIT manufacturing.
- To impart the basic knowledge of quality control, inspection methods and computer-aided testing.
- To classify and summarise the manufacturing systems, and integration of CAQC with CAD/CAM.
-

Unit-I

10 Hrs

Introduction: Scope of computer integrated manufacturing, product life cycle, production automation. Group technology: Role of group technology in CAD/CAM integration, methods for developing part families, classification and coding, examples of coding systems, facility design using group technology, economics of group technology.

Learning outcomes:

At the end of this unit, the student will be able to know the

- understand importance and scope of CIM in fabrication/ manufacturing industry. [L1]
- demonstrate automated production and assembly lines. [L2]
- identify the stages of the product life cycle and related challenges. [L2]
- learn the importance of group technology. [L1]
- applying the types of coding system to different part designs. [L3]

Pedagogy tools:

Lecture, PPTs, Few Videos

Unit-II **10 Hrss**

Computer Aided Process Planning: Role of Process Planning, Approaches to process planning- manual, variant, generative approach, Implementation techniques, process planning systems – CAM-I'S CAPP system, MI Plan system, criteria for selecting a CAPP system, benefits and advantages of CAPP.

Learning outcomes:
At the end of this unit, the student will be able to know the

- demonstrate automated storage/retrieval system. [L1]
- understand the computer aided process planning. [L1]
- acquiring the knowledge of different forms of learning. [L3]

Pedagogy tools:
Lecture, PPTs

Unit-III **9 Hrs**

Integrative Manufacturing Planning and Control: Role of integrative manufacturing in CAD /CAM integration, overview of production control, forecasting, master production schedule, capacity planning, MRP, order release, shop-floor control, quality assurance, planning and control systems, cellular manufacturing, JIT manufacturing philosophy.

Learning outcomes:
At the end of this unit, the student will be able to know the

- application of industrial engineering theory and practice to the area of operations management and production planning/control. [L3]
- analysis and understanding of forecasting, aggregate planning, capacity planning, materials requirement planning, inventory management, short-term scheduling and sequencing. [L2]
- ability to use and compare various statistical forecasting models [L2]
- knowledge of lean manufacturing, tools, techniques and implementation outcomes. [L1]
- understanding of just-in-time systems. [L1]

Pedagogy tools:
Lecture, PPTs, Few Videos

Unit-IV **8 Hrs**

Computer Aided Quality Control: Terminology in quality control, Automated inspection principles and methods, computer aided inspection, computer aided testing, contact inspection methods, noncontact inspection methods, integration of CAQC with CAD/CAM.

Learning outcomes:

At the end of this unit, the student will be able to

- demonstrate automated inspection system. [L2]
- apply the knowledge of inspection techniques. [L3]
- understand the concept of integration of CAQC with CAD/CAM. [L2]
- apply knowledge about computer aided quality control and process planning. [L3]

Pedagogy tools:

Lecture, PPTs, Few Videos

Unit-V
8 Hrs

Computer Integrated Manufacturing Systems: Types of manufacturing systems, machine tools and related equipment, material handling systems, computer control systems, FMS.

Learning outcomes:

At the end of this unit, the student will be able to

- demonstrate flexible manufacturing system. [L2]
- demonstrate automated material handling system. [L2]
- understand processing stations and material handling systems used in FMS environments. [L1]
- implement FMS concept in a manufacturing environment [L3]
- identify the various elements and their activities in the Computer Integrated Manufacturing Systems. [L1]

Pedagogy tools:

Lecture, PPTs and Few Videos

Texbook(s)	**Topics**
. Mikell P. Groover, Automation, Production Systems, and Computer Aided Manufacturing, 2/e., Prentice Hall, 2001	1,2,3,4,5
Mikell P. Groover, and Zimmers, CAD/CAM: Principles and Applications, 3/e, Tata-McGraw hill, 2010.	1,2,3,4,5
Dr.Sadhu Singh, Computer Aided Design and Manufacturing, Khanna Publishers	2

References	
1 M.M.M. Sarcar, K. Mallikarjuna Rao, K. Lalit Narayan, Computer Aided Design and Manufacturing, 2/e, Prentice Hall of India, 2008.	

CO-PO Mapping

Subject code	**PROGRAMME OUTCOMES**												**PSO1**	**PSO2**	**PSO3**
EME447 : COMPUTER INTEGRATED MANUFACTURING	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		2	
CO1						2									
CO2		2				1							2		
CO3		3											1		
CO4			2										1		
CO5		2											1		

Course Outcomes:

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

- To understand the concepts of Production Automation, Process Planning & Quality control in Computer Integrated Manufacturing Systems.
- To acquire the knowledge on quality control, computer aided testing and inspection methods.
- To analyse the Computer Aided Process Planning &Control, Material handling, and Artificial intelligence in FMS.
- To design and solve the problems of Forecasting, Scheduling, and capacity planning in manufacturing and assembling.
- To integrate computer aided design and computer aided manufacturing protocols to manufacture products.

19EME474 AUTONOMOUS VEHICLES

L	T	P	C
3	0	0	3

Course Description:

This course is designed with fundamentals of Autonomous vehicles and study of mechanical, electrical, and computer engineering systems and their controls. These systems have the overall impact of automating various driving functions, connecting the automobile to sources of information that assist with this task, and allowing the vehicles to make autonomous intelligent decisions.

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Course Educational Objectives:

- To understand the basic concepts of Autonomous vehicles and systems
- To impart and analyze the computational skills of motion planning and drive systems in Autonomous vehicles.
- To develop the algorithms of Autonomous vehicle navigation and their control systems
- To acquire knowledge on vision-based sensors and localization systems and apply the concepts in a real-time environment.
- To offer knowledge of advanced driver assistance systems

Unit 1 Introduction to Autonomous Vehicle 8 hours

Automated guided vehicles, trucks, drones, or different types of special vehicles, such as mobile robots, autonomous fighting vehicles, automated highway systems.

Unit 2 Autonomous Vehicle Technology 8 hours

The basic control system, operation of ecus, surroundings sensing systems and autonomy, wireless data networks and autonomy, autonomous driving technology, motion planning, feedback control, path and trajectory.

Unit 3 Autonomous Vehicle Navigation 8 hours

Path planning algorithms, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP), intelligent motion planner.

Unit 4 Computer vision for Perception and localization 8 hours

Introduction, building computer vision hardware, computing, calibration target, multiple camera calibration, VSLAM overview, Running stereo datasets, Perception, and localization interface

Unit 5 Advanced Driver Assistance Systems 8 hours

Radar Technology and Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems, Troubleshooting and Maintenance.

Textbooks

1. R. Siegwart, I. R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, The MIT Press, 2011
2. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, Principles of Robot Motion: Theory, Algorithms and Implementations, PHI Ltd., 2005
3. Autonomous Vehicle edited by Andrzej Zak September 7th, 2016

References:

1. Michael E. McGrath: Autonomous Vehicles: Opportunities, Strategies, and Disruptions, second edition, 2018.
2. Modern automotive technology 2009, Goodheart-Willcox Co.7th edition

Course Outcomes (COs):

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

1. Illustrate different types of Autonomous vehicles and gain knowledge on autonomous systems.
2. Understand the operation of Autonomous vehicle technologies.
3. Compute and predict the navigation of Autonomous systems.
4. Apply the concepts of localization and Perception of Autonomous vehicles.
5. Become familiar with the various types of advanced driver assistance systems.

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**P08**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	3	1	1	1		1			2	1	3	3	2
CO2	1	2	3	1	1	1		2			2	1	3	3	2
CO3	2	2	3	1	2	1					2	1	3	3	2
CO4	3	2	3	2	2	3		1			2	1	3	3	2
CO5	3	2	3	2	2	3		2			2	1	3	3	2

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

Program Elective IV

S. No	Course Code	Course Name	Category	L	T	P	C
1	19EME441	Computational Fluid Dynamics	PE	3	0	0	3
2	19EME443	Wind Energy	PE	3	0	0	3
3	19EME451	Mechanics of Composite Materials	PE	3	0	0	3
4	19EME455	Advanced mechanics of solids	PE	3	0	0	3
5	19EME457	Production Planning and Control	PE	3	0	0	3
6	19EME459	Logistics and Supply Chain Management	PE	3	0	0	3

19EME441: COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

COURSE DESCRIPTION

This course helps to understanding the importance of governing equations while solving fluid flow problems. It explains the importance of Navier-Stokes equation, boundary conditions and various types of boundary conditions. Also, it explains essence of boundary conditions while solving the realistic physics involved in the engineering problems. The course helps to acquire the knowledge on formulation of mathematical model and its solution using finite difference and finite volume method. In addition to, various errors come across during simulation and importance of convergence, consistency of the solution. Moreover, it provides various grid generation and FVM methods to solve fluid flow problems. It explains the introduction to turbulence modelling and various models used in fluid flow.

Pre-requisites: Fluid Mechanics

Course Objectives

- To provide the students with essential background to understand the mathematical representation of the governing equations for fluid flow problems.
- To equip the students to formulate fluid flow problems by approximating the governing differential equations with boundary conditions through Finite difference and finite volume discretization methods.
- To acquire the knowledge of various grid generation methods and approximation of errors while solving problems subsequently suitability for different engineering applications.
- To introduce various turbulence for solving engineering problems.

Module I **8 Hrs**

CFD overview, importance of CFD in modelling the engineering problems, application of CFD in various engineering field. Conservative and Non-conservative form, Governing equations-Mass, Momentum and Energy.

Learning Outcomes

Upon completion of Unit 1, the student will be able to

- Understand the importance of CFD in various engineering applications L2
- Derive governing equations and deduce them according to physics involved in the problem L1
- Comprehend the difference between conservative and non-conservative forms L1

Module II **6 Hrs**

Numerical solution of PDE: Classification of PDEs- elliptic, parabolic and hyperbolic
Boundary conditions: Classification of boundary conditions, explain with suitable example, definition of BVP and IVP
Finite difference method (FDM): Basic aspects of Discretization- Comparison of finite difference, finite volume, and finite element techniques

Learning Outcomes

Upon completion of Unit 2, the student will be able to

- Classify PDEs and identify them through examples L1

- Acquire the knowledge of boundary conditions used in CFD and implementation in governing equations L2
- Understand the discretization aspects of computational domain L2

Module III **8 Hrs**

Finite difference method (FDM): Forward, Backward and Central difference schemes, Transient 1D and 2D conduction - Explicit, implicit. Stability analysis and error estimation

Learning Outcomes

Upon completion of Unit 3, the student will be able to

- Understand various FDM schemes L2
- Apply FDM schemes to both 1D and 2D problems L3
- Acquire the knowledge of stability analysis and estimation of error L3

Module IV **8 Hrs**

Finite volume method (FVM): Concept of discretization, methods of deriving discretization equations, finite volume method for one dimensional steady state diffusion, conservativeness, boundedness, transportiveness, four basic rules for FV discretization, assessment of central and upwind differencing schemes.

Learning Outcomes

Upon completion of Unit 4, the student will be able to

- Understand the basic rules of finite volume method and FVM discretization methods L2
- Analyze 1D steady state diffusive problems using FVM method L4
- Understand and learn various FVM schemes to discretize the pressure velocity coupling terms L2

Module V **6 Hrs**

Incompressible Fluid Flow: Discretization of the momentum equation. Primitive variable approach, staggered grid and collocated grid, SIMPLE algorithm, SIMPLER algorithm. Introduction to turbulence models.

Learning Outcomes

Upon completion of Unit 5, the student will be able to

- Understand the SIMPLE and SIMPLER algorithms L2
- Apply and analyze both SIMPLE and SIMPLER algorithms to 1D steady diffusive problems. L4
- Learn elementary treatment of turbulence models L1

Textbook(s)

1. J.D.Anderson Jr., Computational Fluid Dynamics, 2/e, McGraw Hill, 2012.
2. H.K.Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Pearson, 2007 2.

References

1. Gautam Biswas, Somenath Mukherjee, Computational Fluid Dynamics, Narosa, 2013.
2. T.J.Chung, Introduction to Computational Fluid Dynamics, Cambridge University Press, 2010.
3. J.H.Ferziger, M.Peric, Computational Methods for Fluid Dynamics, Springer, 2002.

CO-PO MAPPING

	POs												PSOs		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	0	0	2	0	0	0	0	0	0	0	0	3	0	0
2	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0
3	0	0	0	2	0	0	0	1	0	0	0	0	2	0	0
4	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0
5	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0

1-Low, 2- Medium and 3- High Correlation

Course Outcomes (COs)

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

1. Apply mathematics and engineering fundamentals to formulate mathematical problem by imposing appropriate boundary conditions and governing equations.
2. Solve 1D and 2D governing equations using FDM schemes.
3. Adopt appropriate grid generation methods for solving engineering problems accurately.
4. Solve fluid flow and heat transfer problems using commercial CFD tools.
5. Comprehend the application of turbulence models used in incompressible fluid flow analysis.

19EME443: WIND ENERGY

L	T	P	C
3	0	0	3

Pre-requisite: None

This course introduces the fundamental concepts, principles, analysis, and design of wind turbine in different regions. This course is an intended for learning the Fundamentals of aerodynamics for wind turbines. This course is gives the brief ideas of power in wind -Design of rotor – Wind Energy Conversion Systems techniques-monitoring techniques-testing methods with safety aspects.

Course Objective:

- To Understand the basic knowledge of how wind is generated
- To Improve skills to visualize energy extraction from the sources with help of aerodynamics
- Learn how to design and estimate the potential of resource area
- Learn basic principles of modern wind electric turbines
- A brief idea about principal operation of wind farms and monitoring techniques

Course Outcomes:

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

- Identify global and Indian wind energy scenario in terms of applications
- Apply the fundamentals of aerodynamics designs to wind turbine rotor
- Analyse the operation of a wind turbine principle in different applications
- Identify different components involved in Electrical aspects of wind turbine
- Analyse techniques related safety and monitoring of wind turbines

Module I **8 Hrs**

Introduction: Historical Perspectives on Wind Turbines, Indian Energy Scenario, Global Energy Scenario, Introduction to Indian Wind Industry, Wind Energy potential of India and Global Wind Installations

Power in the wind, Wind Characteristics, Measurement of wind using anemometers (cup anemometer, propeller anemometer, pressure plate anemometer, pressure tube anemometer, sonic anemometer and other remote wind speed sensing techniques), Turbulence, Wind Power Density. Average wind speed calculation, Statistical models for wind data analysis (Weibull and Rayleigh distribution), Energy estimation of wind regimes, Wind Rose, Wind Monitoring Station Siting and Instrumentation.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- acquaint basic knowledge of Indian energy scenario. [L1]
- understand different wind measurement methods. [L2]
- acquire fundamental concepts of wind calculations. [L2]

Module II: 8 Hrs

Aerodynamics: Introduction to Aerofoil design, NACA profiles, Lift and drag principle, Lift and drag co-efficient, Axial Momentum theory, Momentum theory for rotating Wake, Blade element theory, Strip theory, Tip losses.

Learning Outcomes:
At the end of this UNIT, the student will be able to
- ● acquaint with aerofoil design. [L1]
- ● understand the effect of wing speed on power generation. [L2]
- ● study the blade element theory. [L2]
- ● design the structure of NACA profiles. [L4]

Module III: 8 Hrs

Rotor Design and Performance: Design of rotor, Wind Machine parameters (swept area, power co-efficient, torque co-efficient, thrust, solidity, tip-speed ratio, angle of attack etc.), Power Curve, Energy Estimation, Capacity Factor
Learning Outcomes:
At the end of this UNIT, the student will be able to
- ● study the principle of rotor design. [L2]
- ● acquaint with power co-efficient, torque co-efficient. [L2]
- ● summarize different Energy Estimation. [L2]

Module IV: 8 Hrs

Wind Energy Conversion Systems: Types, Components of Modern Wind Turbine (HAWT and VAWT), Fixed and Variable Speed operations, Power Control (Passive stall, Active pitch, Passive pitch and Active stall), Electrical aspects of wind turbine, Safety of wind turbines

Learning Outcomes:
At the end of this UNIT, the student will be able to
- ● understand the Components of Modern Wind Turbine. [L1]
- ● acquaint with the principles and power control. [L2]
- ● study about Electrical aspects of wind turbine. [L2]

Module V: 8 Hrs

Wind Farm Design and Health (Condition) Monitoring: Planning of wind farm, Site selection, Micrositing, Grid Integration, Power evacuation, Wind Farm Feasibility Studies, Preparation of DPR, Environmental Benefits and Impacts.
Small Wind Turbines: Water pumping windmills, offshore wind energy, Wind turbine testing, future developments.

Learning Outcomes:
At the end of this UNIT, the student will be able to
- ● understand and acquire the need for monitoring .[L1]
- ● acquaint basic knowledge of Environmental Benefits and Impacts. [L1]
- ● understand the performance of Wind turbine testing. [L2]

Textbook(s):
1. Wind Energy Fundamentals, Resource Analysis and Economics, Sathyajith Mathew, Springer Publications, ISBN 978-3-540-30906-2, 2006 edition

References:

1. A Guide to Small Wind Energy Conversion Systems, John Twidell, CAMBRIDGE UNIVERSITY PRESS, 2011, ISBN 10: 0521281628
2. Offshore Wind Power, Edited by John Twidell and Gaetano Gaudiosi, 2009 Edition, ISBN 978-0906522-639
3. Robert Gasch and Jochen Twele, Wind Power Plants. Fundamentals, Design, Construction and Operation. 2012

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

19EME451: MECHANICS OF COMPOSITE MATERIALS

L	T	P	C
3	0	0	3

This course primarily focusses on the design, processing, and behavior of composite materials. Concepts such as linear elastic analysis, anisotropic material behavior, damage criteria are also discussed in this course.

Prerequisite:
Mechanics, Strength of Materials

Course Objectives:

- To introduce the concept of composite materials with more emphasis on fiber-reinforced composite materials.
- To explain the response of a unidirectional lamina under applied stresses.
- To conduct stress analyses using laminated plate theories and appropriate strength criteria
- To Familiarize with the basic expressions and methods used in the mechanics of composite structures
- To explain different failure theories

Unit I

Introduction: Composite materials, classification and characteristics of composite materials-fibrous composite materials, laminated composite materials, particulate composite materials, mechanical behavior of composite materials, basic terminology of laminated fiber-reinforced composite materials, manufacturing of laminated fiber-reinforced composite materials - Layup, curing, advantages of laminated fiber-reinforced composite materials, applications of composite materials

Learning outcomes
After completion of this unit, students will be able to

- differentiate composite and alloy [L2]
- understand basic terminology of laminated fiber-reinforced composite materials [L2]
- fabricate composite materials [L4]

Unit II

Macromechanical behavior of a lamina: Introduction, Stress strain relations for anisotropic materials, stiffness, compliance matrix and engineering constants for orthotropic materials, relations, Stress strain relations for plane stress in a unidirectional orthotropic material and arbitrary oriented orthotropic material.

Learning outcomes
After completion of this unit, students will be able to

- understand stress strain relations for anisotropic materials [L2]
- understand stress strain relations for orthotropic materials [L2]

Unit III

Micromechanical behavior of a lamina: Introduction, mechanics of materials approach to stiffness, mechanics of materials approach to strength, comparison of approaches to strength.

Learning outcomes

After completion of this unit, students will be able to

- explain mechanics of materials approach to stiffness [L3]
- explain mechanics of materials approach to strength [L3]

Unit IV

Macromechanical behavior of a laminate: Classical Lamination Theory: Lamina stress-strain behavior, stress and strain variation in a laminate, resultant laminate forces and moments. Special Cases of Laminate Stiffness: Single-layered, symmetrical laminates, anti-symmetrical laminates, unsymmetrical laminates.

Learning outcomes

After completion of this unit, students will be able to

- evaluate stresses and strains in a laminate [L4]
- explain classical lamination theory [L3]

Unit V

Performance of composite materials: Strength Criteria of Orthotropic Lamina: Maximum stress failure, criterion, maximum strain failure criterion, Tsai-Hill failure criterion, Hoffman failure criterion and Tsai-Wu failure criterion.

Learning outcomes

After completion of this unit, students will be able to

- explain different failure creteria [L3]

Text Book(s)

R M Jones, Mechanics of Composite Materials, 2/e, Taylor and Francis, 1999.

References

Nicholas J. Pagano, Reddy J.N, Mechanics of Composite Materials, Kluwer Academic Publishers, 1994.

Agarwal. B. D, Broutman. L. J, Chandrasekhara K, Analysis and Performance of Fiber Composites, 3/e, John Wiley and Sons, 2006.

Mallick P.K, Fiber Reinforced Composites, 3/e, CRC Press, 2013.

Autar K Kaw, Mechanics of Composite Materials, 2/e, Taylor and Francis, 2013.

Course Outcomes:

- Understand the basics of composite materials, classification, and the fabrication techniques.
- Apply constitutive equations of composite materials and understand mechanical behavior at micro and macro levels.
- Perform stress and strain analysis in anisotropic and orthotropic materials having continuous fiber reinforcement
- Use classical lamination theory to predict strains, displacements bending and twisting deformation of laminates.
- Predict the failure in laminates using failure theories.

19EME455: ADVANCED MECHANICS OF SOLIDS

L	T	P	C
3	0	0	3

This course aims at finding deflections, stresses for various beams at different loading conditions. The pre-requisite for this course is basics of strength of materials. The knowledge gained from this course also helps in designing pressure vessels.

Course Objectives:

- To introduce the concept of columns and struts
- To demonstrate the calculation of bending moments and deflections of fixed and continuous beams.
- To explain the concept of shear center and unsymmetrical bending
- To analyze open and close coiled and laminate springs.

Unit I

Columns and Struts: Euler’s theory, equivalent length, limitations of Euler’s theory, Rankine formula, strut with eccentric loading, strut with initial curvature- Simple problems.

Learning Outcomes:

After completing this unit, the student will be able to

- contrast between a column and strut [l2]
- analyze columns at different loading conditions [L4]

Unit II

Fixed and continuous beams: Moment-area method, Macaulay’s method, Clapeyron’s three-moment equation, moment distribution method.

Learning Outcomes:

After completing this unit, the student will be able to

- explain different types of beams [L3]
- analyze fixed and continuous beams [L4]

Unit III

Springs: Close coiled helical springs, springs in series and parallel, concentric springs, open-coiled helical springs, laminated springs- Simple problems.

Learning Outcomes:

After completing this unit, the student will be able to

- differentiate closed and open coiled springs [L2]
- analyze closed and open coiled springs [L4]

Unit IV

Shear centre: Bending axis and shear center-shear center for axi-symmetric and unsymmetrical sections.

Unsymmetrical bending: Bending stresses in beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending.

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

- find the shear center [L4]
- determine the stresses in beams due to nonsymmetrical bending [L4]

Unit-V

Cylinders and Spheres: Thin cylinder, thin spherical shell, thin cylinder with spherical ends, volumetric strain, thick cylinders- lame's theory, compound tubes.
Learning Outcomes:
After completing this unit, the student will be able to

- differentiate thin and thick cylinder [L2]
- evaluate stresses in cylinders [L4]

Text books:
1. S S rattan, Strength of Materials, 2nd Edition, McGraw Hill, 2013.

References:
1. M. H. Sadd, Elasticity: theory, applications, and numeric, 3rd edition, Academic Press, 2014.
2. L. S. Srinath, Advanced mechanics of solids, 3rd Edition, McGraw-Hill, 2009.
3. R. G. Budynas, Advanced Strength and Applied Stress Analysis, 2nd Edition, McGraw Hill, 1999.
4. P. Boresi, R. J. Schmidt, Advanced Mechanics of Materials, 6th Edition, John Willey and Sons, 2009.

Course Outcomes:
After successful completion of this course student will be able to
- Design and analyze a column/strut for different loading conditions [L4].
- Evaluate the moments, deflections in fixed and continuous beams [L4].
- Evaluate the stresses, deflections and strain energy in springs [L4].
- Locate shear center and evaluate the stresses for different cross-sections subjected to unsymmetrical bending [L4].
- Analyze cylinders and spheres and design steam boilers, reservoirs, pressure vessels [L5].

19EME457: PRODUCTION PLANNING AND CONTROL

Production Planning and Control helps manufacturers in allocating resources such as people, materials, machines, and money for their efficient and optimum utilization to meet the product demand from customers

L	T	P	C
3	0	0	3

Pre-requisites: No pre-requisites are required

Course Objectives

- Know the importance of Production Planning and Control, Forecasting and Master Production Schedule.
- Acquaint with deterministic inventory models.
- Evaluate costs of production and inventory.
- Familiarize with planning procedure, seasonal and non-seasonal demand, make or buy decisions.
- Understand types of production control, applications of computers in production planning and control

Course Outcomes

After successful completion of this curse the student will be able to:

- acquaint with basic concepts of production planning and control and apply appropriate forecasting models to predict the demand.
- solve problems pertaining to inventory by choosing the right models.
- acquire fundamentals of cost accounting and evaluate the inventory models to reduce inventories costs.
- apply planning strategies and scheduling, loading, and other functions for smooth running of the organization.
- Apply controlling functions to manage manufacturing processes effectively.

Module I
10 Hrs

Introduction: Objectives of production planning and control, definition,functions of production planning and control, organization of production planning and control department, the internal organization of the department.
Forecasting: Forecasting models, aggregate production planning, master production scheduling, materials requirements planning.

Learning outcomes:

At the end of this module, the student will be able to

- recognize the importance of Production Planning and Control [L2]
- understand the various planning methods and forecasting[L2]

Pedagogy tools:

Lecture, PPTs

Module II **10 Hrs**

Inventory Control: Objectives, economic and social complications of inventory management, limitations of inventory control. Functions of inventory, demand, and production characteristics. Measures of inventory performance.
Systematic Control of Inventory: Fixed order quantity systems, fixed interval systems, (s, S) systems, classification of items in inventory. Computer-based inventory control systems.

Learning outcomes:
At the end of this module, the student will be able to
- recognize the significance of Inventory Control[L2]
- understand Inventory systems[L2]

Pedagogy tools:
Lecture, PPTs

Module III **9 Hrs**

Cost Factor: The importance of costs, elements of costs, principles of cost determination and accounting systems, production and inventory cost factors, other costs to the firm.
Economic Quantities of Manufacture or Purchase: Lot size problems, finite production rates in manufacturing, quantity discounts.
Uncertainty: Effects of uncertainty, demand, and supply, safety stock, role of forecasting in production and inventory control. Uncertainty in production cycling.

Learning outcomes:
At the end of this unit, the student will be able to
- understand the significance of various costs associated with production and inventory[L2]
- solve lot size and discount quantity problems[L3]

Pedagogy tools:
Lecture, PPTs

Module IV **8 Hrs**

Production Planning: Scope of planning, types of production planning, demand analysis, seasonal and non-seasonal demand. Planning procedures, short term, and long term planning - make and buy decisions, product design and process selection, Scheduling, Loading

Learning outcomes:
At the end of this unit, the student will be able to
- understand planning procedure, seasonal and non-seasonal demand[L2]
- recognize the importance of make or buy decisions[L2]

Pedagogy tools:
Lecture, PPTs

Module V **8 Hrs**

Production Control: Control objectives, problems in production control, types of production and production control systems, controlling production, Dispatching, Controlling. The layout of the physical system, design of production planning, and control systems. Application of computers in production planning and control.

Learning outcomes:
At the end of this unit, the student will be able to
- understand Production control and associated problems[L2]
- recognize the role of computers in Production Planning and Control[L2]

Pedagogy tools:
Lecture, PPTs

Text Book(s)
1.O. P Khanna, Industrial Engineering and Management, 4/e, Dhanpat Rai Publications, 2011.
2. Samuel Eilon,Elements of Production Planning and Control, Universal Publishing Corporation, 1999.

References
1.Magee and Boodman, Production Planning and Inventory Control, 2/e, McGraw Hill, 1967.
2.John E Biegal, Production Control: A Quantatative Approach, 2/e, Prentice Hall, 1971.
3. EH Mac Niece, Production Forecasting, Planning and Control, 3/e, John Wiley and Sons, 1961.
4. Seetharama L Narasimhan, Dennis W, McLeavey, Peter J Billington, Production Planning and Inventory Control, 2/e, PHI, 2004.

19EME459: LOGISTICS AND SUPPLY CHAIN MANAGEMENT

L	T	P	C
3	0	0	3

This course emphasizes on the existing logistical and supply-chain practices within the private and public sector industries. Students will be able to plan and coordinate the forward and backward flow of services and goods from one place to another in industry. ideas related to business strategy, project management, risk management, trade-off analysis and economics, as well as tools from probability/statistics, and optimization. Students will gain knowledge on applying logistics and supply-chain principles to achieve competitive advantage

Course Objectives:

- Introduce the major building blocks, functions, business processes, performance metrics and decisions (Strategic, tactical and operational) in the Supply chain.
- Analyze the inventory management methodologies to improve the performance of the supply chain.
- Explore three fundamental design concepts: component commonality, modularity vs. integral design, and universality, and a cost/benefit framework.
- Compare various procurement strategies and the Impact of technology on supply chain optimization in procurement strategy.
- Acquire knowledge on Risks and issues in Local and Global supply chains.

UNIT I **8 Hrs**

Introduction to Supply Chain Management (SCM):
Concept of supply management and SCM, the importance of supply chain flows, core competency, value chain, elements of supply chain efficiency, key issues in SCM, decision phases, supply chain integration, process view of a supply chain, competitive strategy and supply chain strategies, uncertainties in the supply chain, supply chain drivers.

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

- Explain operations and supply chain management issues in a firm. **[L-2]**
- Predict the importance of critical thinking skills in business situations**. [L-2]**
- analyze the manufacturing operations of a firm**[L-4]**
- apply logistics and purchasing concepts to improve supply chain operations**[L-3]**
- analyze the global business environment. **[L-4]**

UNIT II **8 Hrs**

Inventory Management: Introduction, selective control techniques, cost involved in the inventory system, single-stage inventory control, economic lot size models, application to economic production quantity, the effect of demand uncertainty, single-period models, initial inventory, multiple order opportunities, deterministic models, quantity discounts. periodic and quantity review policies, mathematical modelling under known stockout costs and service levels, joint replenishment for multiple items, inventory system constraints, working capital restrictions, and storage space restrictions.

Learning Outcomes:
After completing this unit, the student will be able to
- interpret inventory tracking system **[L-2]**
- classify Effective Inventory Management systems **[L-4]**
- analyze the satisfactory levels of customer service while keeping inventory costs within reasonable bounds. **[L-4]**

UNIT III **8 Hrs**

Designing Supply Chain Network: Introduction, network design, factors influencing network design, data collection, data aggregation, transportation rates, warehouse costs, capacities and locations, models and data validation, key features of a network configuration, impact of uncertainty on network design, network design in an uncertain environment, the value of information: Bullwhip effect, information sharing, information and supply chain trade-offs, distribution strategies, direct shipment distribution strategies, transhipment and selecting appropriate strategies.

Learning Outcomes:
After completing this unit, the student will be able to
- Recognize supply chain management in all its diverse aspects and applicability **[L-1]**
- Infer comprehensive strategic and tactical plans for an organization **[L-2]**
- associate supply chain design facilitates network integration**[L-2]**
- apply the main network design and implementation steps with case studies. **[L-3]**
- identify the factors that are to be taken into account during network design and in locating facilities**. [L-2]**

UNIT IV **8 Hrs**

Supply Chain Integration: Introduction, push, pull and push-pull supply chains, identifying appropriate supply chain strategy, sourcing and procurement, outsourcing benefits, the importance of suppliers, evaluating a potential supplier, supply contracts, competitive bidding and negotiation. Purchasing, objectives of purchasing, relations with other departments, centralized and decentralized purchasing, purchasing procedure, types of orders, e-procurement, tender buying, the role of business in supply chains.

Learning Outcomes:
After completing this unit, the student will be able to
- identify the components of an integrated logistics management system. **[L-2]**
- discuss the decisions involved in transportation management. **[L-2]**
- analyze suitable methodologies to design a solution for an LSM problem. **[L-4]**

UNIT V **10 Hrs**

Issues in Supply Chain Management: Introduction, risk management, managing global risk, issues in the international supply chain, regional differences in logistics. Local issues in the supply chain, issues in a natural disaster and other calamities, issues for SMEs, organized retail in India, reverse logistics.

Learning Outcomes:

After completing this unit, the student will be able to

- describe fundamental issues in supply chain management. **[L-1]**
- apply knowledge to evaluate and manage an effective supply chain by minimizing the risk factors. **[L-3]**
- associate supply chain management goals with corporate goals and strategies. **[L-2]**
- analyze the issues and search for methodologies to improve supply chain processes. **[L-4]**

Course Outcomes:

After successful completion of this course, the students will be able to

- explain strategic and operational frameworks to analyze supply chains. **[L-2]**
- interpret the concepts of inventory management in improving the performance of the supply chain. **[L-3]**
- categorize inventory control models and develop inventory control systems under deterministic and constrained scenarios **[L-4]**
- simulate the design of a supply chain network. **[L-3]**
- analyze the role of collaborative planning method in supply chain performance enhancement**[L-4]**

Text Books

1. Simchi-Levi, D. Kaminsky, P.Simchi-Levi, E. and Ravi Shankar, Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies, 3/e, Tata McGraw-Hill, 2008.
2. Chopra, S. and Meindl, Supply Chain Management: Strategy, Planning and Operations, 2/e, Pearson Education, 2004

References

1. Doebler, D.W. and Burt, D.N, Purchasing and Supply Management-Text and Cases, 6/e, McGraw-Hill, 1996.
2. Tersine, R.J, Principles of Inventory and Materials Management, 4/e, Prentice Hall, 1994.

Course Outcomes	Programme Outcomes														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	0	1	0	0	0	0	0	1	0	2		2	0	1
2	2	0	3	0	0	0	0	0	1	0	2		2	0	1
3	2	0	3	0	0	0	0	0	1	0	2		2	1	1
4	2	0	2	0	0	0	0	0	1	0	2		2	1	1
5	2	0	2	0	0	0	0	0	1	0	2		2	0	1

Program Elective V

S. No	Course Code	Course Name	Category	L	T	P	C
1	19EME461	Energy Conservation and Management	PE	3	0	0	3
	19EME463	Bioenergy	PE	3	0	0	3
2	19EME469	Mobile Robotics	PE	3	0	0	3
4	19EME475	Product Life Cycle Management	PE	3	0	0	3
5	19EME479	Management Information Systems	PE	3	0	0	3
6	19EME456	Optimization techniques	PE	3	0	0	3
7	19EME446	Modern manufacturing Methods	PE	3	0	0	3

19EME461: ENERGY CONSERVATION AND MANAGEMENT

L	T	P	C
3	**0**	**0**	**3**

Course Objectives

1. To impart the knowledge of energy resources, scenario and the importance of energy conservation techniques.
2. To identify various components and processes where possibility of energy recovery is possible like power plants.
3. To know the energy efficient methods in power production sector and to know the means of reducing loses in transmissions.
4. To impart the need of energy auditing in various industries even in domestic appliances. Also to identify energy efficient methods to reduce (optimize) energy input.

Course Outcomes

After successful completion of this course, the students will be able to

1. understand the need of energy conservation in the present scenario in the households and industries and need to perform energy audit and to perform above all the need of managing skills.
2. apply energy conservation tools and auditing techniques to bring efficient mechanism.
3. analyse the possible areas of energy conservation in the industries and process.
4. test the performance of the industrial components and processes using various methods available.
5. suggest methods to save valuable currency and foreign exchange by proper management of energy systems

UNIT I **7 Hrs**

Introduction

Introduction: Energy kinds: Indian energy scenario. Energy needs, energy security, energy conservation importance, energy conservation potential, industries and commercial establishments, energy conservation Act.

Learning Outcomes:

At the end of this **UNIT** , the student will be able to

- Understand the significance of energy conservation and energy conservation Act. [L1]
- Understand the energy consumption scenario in India [L1]

UNIT II **8 Hrs**

Energy Efficiency in Thermal Systems

Energy Efficiency in Thermal Systems: Boilers: Performances evaluation, analysis of losses, feed water treatment; blow down, energy conservation opportunities. FBC boilers- mechanism and advantages.

Steam System: Assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, energy savings.; Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.

Learning Outcomes:

At the end of this **UNIT** , the student will be able to

- Understand the analysis of various losses in thermal systems [L1]
- Acquire the mechanism and advantages of FBC boilers [L2]
- Estimate the various losses in steam supply systems [L2]

UNIT III **8 Hrs**

Energy Efficiency in Electrical Utilities Energy Efficiency in Electrical Utilities: Electrical load management and maximum demand control, power factor improvement and its benefit, transformers, distribution and transformer losses, analysis of electrical power systems; Lighting System: Light source, choice of lighting, luminance requirements, and energy conservation

Learning Outcomes:
At the end of this **UNIT** , the student will be able to

- Understand the energy efficient mechanisms in electrical and lighting systems [L1]
- Acquire the knowledge to chose energy efficient lighting system [L1]
- Comprehend the lighting system luminance requirements for energy conservation. [L2]

UNIT IV **8 Hrs**

Energy Conservation in Utilities: Energy Conservation in Utilities: Fans, blowers, pumps, compressed air systems, refrigeration and air conditioning systems and cooling towers: Performance evaluation, efficient system operation and energy conservation

Learning Outcomes:

At the end of this **UNIT,** the student will be able to

- understand energy star rating for various rotodynamic appliances [L1]
- acquaint with the principles and design of efficient performance system [L2]
- Acquire the knowledge of performance evaluation [L3]

UNIT V **9 Hrs**

Biogas
Energy Conservation and Auditing: Definition, need, and types of energy audit, energy management (audit) approach, understanding energy costs, bench marking, energy performance, optimizing the input energy requirements, energy audit instruments; Preliminary and detailed energy audit, energy conservation act, Duties and responsibilities of energy managers and auditors.

Learning Outcomes:
At the end of this **UNIT,** the student will be able to

- Understand various types of energy audits.[L1]
- Comprehend the energy audit instruments and detailed analysis [L1]
- Apply energy audit procedure and propose strategies to conserve energy. [L2]

Text Books

1 Energy Manager Training Manual (4 Volumes) Bureau of Energy Efficiency: http://www.beeindia.in/energy_managers_auditors/ema.php?id=4
2 Y.P. Abbi, Shashank Jain, Handbook on Energy Audit and Environment Management, The Energy and Resources Institute, TERI, 2009

Reference Books

1 Steve Doty, Wayne C. Turner Energy Management Handbook, 7/e, the Fairmont Press, Inc., 2009
2 F Kreith, D. Y Goswami, Energy Management and Conservation handbook, CRC Press, 2008
3 YP Abbi and Shashank Jain. Handbook on Energy Audit and Environment Management, TERI Publications, 2006

19EME463: BIOENERGY

L	T	P	C
3	0	0	3

This course introduces the basic principles and different technologies of converting bioenergy. Student will be able to appropriately identify the methods and build biomass gasification systems of different capacities depending on application requirements, and Life cycle analysis.

Course Objectives

- Identify potential biomass feedstocks including energy crops;
- Have an understanding of the existing and emerging biomass to energy technologies;
- Have an understanding of LCA and applications;
- Develop a critical thinking about sustainability & resilience; and
- Determine potential solutions for energy needs and problems by incorporating the bioenergy technologies being explored.

Module 1

Bioenergy Concepts- Introduction: Biomass, Bio-Energy and Bio-Refinery, Basic concepts of circular economy based on organics. Biomass: Properties and types, Systems thinking, Biopower, bioheat, Biofuels, advanced liquid fuels, drop-in fuels, Biobased products.
Biofuels: liquid (biodiesel, bioethanol), gaseous (syngas, biogas), solid (charcoal and biochar).

Learning Outcomes:
After the completion of this unit, the student will be able to
- distinguish different types bio energy sources (L1)
- classify different methods of fuel production (L3)
- identify different bio mass properties (L4)

Module 2

Bioenergy conversion: Physical conversion: Dewatering, drying, size reduction, steam explosion, densification, pelleting, chipping, oil extraction.
Chemical conversion: Oil trans-esterification (biodiesel production), Hydrolysis, Pyrolysis - Other thermochemical conversion technologies.
Biochemical conversion: Anaerobic digestion (biogas production from organic waste and wastewater) and Fermentation (bioethanol production).

Learning Outcomes:
After the completion of this unit, the student will be able to
- distinguish different types conversion techniques (L1)
- classify different methods for biodiesel production (L3)
- identify different biochemical conversion techniques (L4)

Module 3

Biomass storage and feeding systems: Combustion plants for heat generation: wood and pellet burning stoves; wood, pellet and wood chips boilers; plant schemes for heat generation; control, protection and safety systems. Gasification plants, Pyrolysis plants. Innovative bioenergy plants: biomass to synthetic natural gas; biomass to liquid biofuels through Fisher

Tropsch; absorption enhanced reforming. Hydrothermal processes: carbonization, liquefaction, gasification.

Learning Outcomes:
After the completion of this unit, the student will be able to
- classify the different types of biomass storage methods (L1)
- describe the different methods of hydrothermal processes (L2)
- explain the process of gasification plants (L2)

Module 4

Bioenergy & Environment: Criteria Pollutants, Carbon Footprint-Emissions of biomass to power generation applications -Emissions from biofuels, Emission control strategies.
Algal biofuels: Growth/harvest rates, transesterification

Learning Outcomes:
After the completion of this unit, the student will be able to
- explain different power generation techniques from biomass (L2)
- classify different emission control techniques (L3)
- describe the pollution criteria from biomass (L2)

Module 5

Life Cycle Analysis: General understanding of LCA - Cradle-to-grave, field to wheels concepts -Goal and scope determination, defining LCA boundaries, Life Cycle Inventory - Life Cycle Assessment.

Learning Outcomes:
After the completion of this unit, the student will be able to
- explain the understanding of LCA (L2)
- classify different LCA Inventory techniques (L3)
- describe the LCA assessment (L2)

Text Books
1. Biomass for renewable energy, fuels, and chemicals. D.L.Klass, Academic Press,
2. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
3. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
4. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
5. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

References
1. Advanced Biofuels and Bioproducts, J. W. Lee,
2. Algae for Biofuels and Energy, M.A. Borowitzka, N.R. Moheimani,
3. Biomass Conversion, C. Baskar, S. Baskar, R.S. Dhillon, https://link.springer.com/book/10.1007%2F978-3-642- 28418-2
4. Recycling of Solid Waste for Biofuels and Bio-chemicals, O.P. Karthikeyan, K. Heimann, S.S. Muthu, http://www.springer.com/cn/book/978981100148

Course Outcomes:
After the successful completion of the course, the student will be able to
- classify different types bioenergy production methods(L3)

- describe the biomass pyrolysis and transesterification process (L2)
- outline the different biomass gasification processes and their construction arrangements(L3)
- explain the types storage methods and emission control strategies (L2)
- analyze the Life cycle analysis (L5)

19EME469: MOBILE ROBOTICS

L	T	P	C
3	0	0	3

Course description

This course is designed with fundamentals of mobile robots and study of algorithms for mobile robots. This course provides a general understanding of mobile robotics and related concepts such as kinematics and dynamics of mobile robots, sensing perception, localization, motion control, and planning. The unifying themes of this course are how mobile robots can navigate in known and unknown worlds and how to structure software to control a mobile robot.

Pre-requisites: Kinematics, and dynamics of Machinery, linear algebra, calculus, and differential equations

Co-requisites: Robotics and its Automation

Course Objectives

- To understand the basic concepts of robot locomotion and control systems of mobile robots.
- To impart and analyse the computational skills of robot kinematics and drive systems in mobile robots.
- To develop the ability to solve the problems and approaches of dynamic models in mobile robotics.
- To acquire the knowledge on vision-based sensors and localization systems and apply the concepts in robotic operation/environment.
- To offer knowledge on path planning algorithms to develop a robot for a given real-life application.

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Unit 1 8Hrs

Robot Locomotion: Types of locomotion wheeled and legged mobile robots, stability of mobile robots (non-holonomic, omnidirectional) - controllability and manoeuvrability.

Learning Outcomes

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

Identify different types of robot locomotion and gain knowledge on mobile robots.	L2
Apply the concepts of stability control on real time mobile robots.	L4
Design the robot wheels and the mobile platform that can be controlled by the system.	L5

Pedagogy tools:

Video, Lecture, Practical

Unit 2 **10 Hrs**

Mobile Robot Kinematics: Forward and inverse kinematics, holonomic and nonholonomic constraints (unicycle, differential drive, tricycle, and car-like wheeled mobile robots (WMRs)) - kinematic models of 3-wheel, 4-wheel, and multi-wheel omni-directional WMRs.

Learning Outcomes

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

Practice and solve the problems on Forward kinematic and inverse kinematics	L3
Gain the knowledge on differential drive wheeled robots	L1
Develop the kinematic models and analyse the computational skills to solve the problems	L4

Pedagogy tools: Video, Lecture, Practical

Unit 3 **8 Hrs**

Mobile Robot Dynamics: Dynamic modelling concepts and techniques of robots, dynamic models of simple car and legged robots, dynamic model of mecanum wheels and omni-directional robots, and dynamics simulation of mobile robots.

Learning Outcomes

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

Gain the knowledge on Dynamic modelling concepts of mobile robots	L1
Analyse the dynamics models of mobile robots for various drive systems	L4
Compare and interpret the simulation models and applying the concepts on robotic systems.	L2

Pedagogy tools:

Video, Lecture, Practical

Unit 4 **8 Hrs**

Perception and Localization: Passive and active sensors, sensors for mobile robots like global positioning system (GPS), Doppler effect-based sensors, vision-based sensors. Odometric position estimation, probabilistic mapping, Markov localization, Bayesian localization, and positioning beacon systems

Learning Outcomes

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

Demonstrate the types of sensors and their working principles based on applications.	L2
Identify the position and orientation of the robots with the help of Odometric application.	L3
Apply the concepts of localization and positioning systems in robotic environment.	L4

Pedagogy tools:

Video, Lecture, Practical

Unit 5 **10 Hrs**

Introduction to planning and navigation: Path planning algorithms based on A-star, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP)

Learning Outcomes

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

Develop path planning algorithms for mobile robots to move in the robotic environment.	L3
Identify best suitable path planning algorithms for given mobile robots	L2
Apply the concepts of dynamic programming on real time robots with better navigation	L4

Pedagogy tools:

Video, Lecture , Practical

Texbook(s)	**Topics**
3. R. Siegwart, I. R. Nourbakhsh, "Introduction to Autonomous Mobile Robots", The MIT Press, 2011	All
4. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, Principles of Robot Motion: Theory, Algorithms and Implementations, PHI Ltd., 2005	4,5
5. Peter Corke , Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011	3,4,5

Additional Reading(s)	**Topics**
1. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, Industrial Robotics, Technology programming and Applications, McGraw Hill International Edition, 2014	1,2,3
2. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics Control, Sensing Vision and Intelligence, McGraw Hill Book Company, 2008	1,2,3

Journal(s)	**Topics**
1. S. Thrun, D. Hahnel, D. Ferguson, M. Montemerlo, R. Triebel, W. Burgard, C. Baker, Z. Omohundro, S. Thayer, W. Whittaker, A system for volumetric robotic mapping of abandoned mines, in: Proceedings of the IEEE International Conference on Robotics and Automation, 2003 2. W. Burgard, D. Fox, D. Henning, Fast grid-based position Tracking for mobile robots, in: KI—Kunstliche Intelligenz, 1997, pp. 289–300	All

Website(s)	**Topics**
1. S. M. LaValle, "Planning Algorithms", Cambridge University Press, 2006. (Available online http://planning.cs.uiuc.edu/)	All

CO-PO MAPPING

POs													PSOs		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2	1	3	0	0	1	1	2	1			2
2	3	3	3	2	1	2	0	0	1	1	2	1		3	
3	3	2	3	2	1	3	0	0	1	1	2	1	3		
4	3	3	3	2	1	1	0	0	1	1	2	1			2
5	3	3	3	2	1	2	0	0	1	1	2	1	2		

1-Low, 2- Medium and 3- High Correlation

Course Outcomes (COs)

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

6. Illustrate different types of robot locomotion and gain knowledge on mobile robots **[L2].**
7. Predict and solve the problems on Forward kinematic and inverse kinematics of mobile manipulators **[L3].**
8. Compute and analyse the equations of dynamics models of mobile robots for various drive systems **[L4].**
9. Apply the concepts of localization and positioning systems in robotic environment **[L5].**
10. Develop path planning algorithms for mobile robots to move in the robotic environment **[L2].**

19EME475: PRODUCT LIFE CYCLE MANAGEMENT

L T P C
3 0 0 3

Leading manufacturing firms aim to base their product realisation processes on the use of digital models of the product and the IT-systems that support the product throughout its lifecycle. Information Technology (IT) supports a wide range of tasks throughout a product's lifecycle including managing requirements, generating concepts, defining geometry, simulating function and properties, planning production, managing spare parts, maintaining, recycling and, retirement of the product. Industry has a strong need for engineers who are competent in using and adapting modern IT tools for product development and manufacturing. This requires knowledge and skills ranging from understanding the overall business down to the adaptation of IT tools. The course Product Lifecycle Management (PLM) aims to develop these skills.

Pre-requisites:
Before taking up this course, the student is expected to have the knowledge of :

- Product design
- Management concepts

Co-requisites:
Course Objectives:

- Familiarize with various strategies of PLM
- Understand the concept of product mapping and simulation.
- Develop New product development, product structure and supporting systems
- Interpret the technology forecasting and product innovation and development in business processes.
- Understand product building and Product Configuration.

UNIT I **8L**

INTRODUCTION TO PRODUCT LIFE CYCLE MANAGEMENT
Product life cycle – Introduction, growth, maturity & decline, Product Lifecycle Management-Definition & Overview, Background for PLM-corporate challenges, Need of PLM, Components/Elements of PLM, Emergence of PLM, Significance of PLM - life cycle problems to be resolved, product development problems to be resolved.

Learning Outcomes:

At the end of this unit the student will be able to

- Understand meaning of product life cycle management.(L1)
- Learn about CAD and EDM . (L4)
- Learn the PLM characteristics.(L3)

Pedagogy tools:

While teaching this module, the teacher may use power presentation of pictures and play Videos and can use black board for lectures.

UNIT II **10L**

DIGITAL LIFE CYCLE

Collaborative Product Development, Mapping Requirements to specifications. Part Numbering, Engineering Vaulting, Product reuse, Engineering Change Management, Bill of Material and Process Consistency. Digital Mock up and Prototype development. Virtual testing and collateral. Introduction to Digital Manufacturing.

Learning Outcomes:
At the end of this unit the student will be able to
- Understand meaning of product development.(L1)
- Learn about requirements of mapping . (L4)
- Learn the digital manufacturing.(L3)

Pedagogy tools:
While teaching this module, the teacher may use power presentation of pictures and play Videos and can use black board for lectures.

UNIT III **8L**

PRODUCT LIFE CYCLE MANAGEMENT SYSTEM
Product life cycle management system- system architecture, Information models and product structure, Information model, the product information data model, the product model, functioning of the system. Reasons for the deployment of PLM systems.

Learning Outcomes:
At the end of this unit the student will be able to
- Understand meaning of PLM system.(L1)
- Learn about system architecture . (L4)
- Learn the information model.(L3)

Pedagogy tools:
While teaching this module, the teacher may use power presentation of pictures and play Videos and can use black board for lectures.

UNIT IV **10L**

P**RODUCT LIFE CYCLE ENVIRONMENT**
Product Data issues – Access, applications, Archiving, Availability, Change, Confidentiality. Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Company’s PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection.

Learning Outcomes:
At the end of this unit the student will be able to
- Understand the product data issues.(L1)
- Learn about PLM strategy . (L4)
- Learn how to prepare PLM strategy.(L3)

Pedagogy tools:
While teaching this module, the teacher may use power presentation of pictures and play Videos and can use black board for lectures.

UNIT V **9L**

COMPONENTS OF PRODUCT LIFE CYCLE MANAGEMENT

Different phases of product lifecycle and corresponding technologies, Foundation technologies and standards e.g. visualization, collaboration and enterprise application integration, Core functions e.g., data vaults, document and content management, workflow and program management, Functional applications e.g., configuration management. Human resources in product lifecycle. PLM Case Study.

Learning Outcomes:

At the end of this unit the student will be able to

- Understand different phases of product life cycle.(L1)
- Learn about core functions of PLM . (L4)
- Learn the functional applications of PLM.(L3)

Pedagogy tools:

While teaching this module, the teacher may use power presentation of pictures and play Videos and can use black board for lectures.

Course Outcomes:

CO1: Explain the various strategies of PLM and Product Data Management
CO2: Describe decomposition of product design and model simulation
CO3: Apply the concept of New Product Development and its structuring.
CO4: Analyze the technological forecasting and the tools in the innovation.
CO5: Apply the virtual product development and model analysis

Text Books:

1. Stark, John. Product Lifecycle Management: Paradigm for 21st Century ProductRealisation, Springer-Verlag, 2004. ISBN 1852338105
2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006

Reference Books:

1. Product Lifecycle Management, Michael Grieves, Tata McGraw Hill, 2006.
2. Antti Saaksvuori, Anselmi Immonen, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003).

CO-PO MAPPING

	POs												**PSOs**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	0	0	2	2	2	1	0	1	1	1	0	0	1
2	1	1	0	0	2	2	2	1	0	1	1	1	0	0	1
3	1	1	0	0	2	2	2	1	0	1	1	1	0	0	1
4	1	1	0	0	2	2	2	1	0	1	1	1	0	0	1
5	1	1	0	0	2	2	2	1	0	1	1	1	0	0	1

19EME479 : MANAGEMENT INFORMATION SYSTEMS (Elective)

L	T	P	C
3	0	0	3

The course is a unified approach on computer-based information systems in business firms and government agencies. MIS combines the work of computer science, management science, and operations research with a practical orientation toward developing system solutions to real-world problems and managing information technology resources. It is also concerned with behavioral issues surrounding the development, use, and impact of information systems, which are typically discussed in the fields of sociology, economics, and psychology.

Course Objectives:

- To Provide overall understanding of the fundamental concepts of information systems, and to highlight the importance of information systems in modern organizations and societies.
- Understand the information processing pertaining to achieving goals, objectives and targets of business organization.
- To understand how Decision Support Systems (DSS) use models to process data and information.
- To impart knowledge on basic components of information technology infrastructure.
- To Gain insight of concepts of Business process reengineering (BPR) and process improvement, business value of systems.

Module I **10 Hrs**

Organizations, Management and the Networked Enterprise: Managing digital firm; Necessity of information systems (IS); New Role of IS in organizations; New opportunities with technology for IS. IS in the Enterprise: Major types, functional perspective and enterprise applications. IS, organizations, management and strategy.

Learning Outcomes:

After completion of this unit, the learners will be able to

- Understand Necessity of information systems (IS) in business environment.
- Assess the impact of the Internet and Internet technology on business and government.
- Integrate the organization business relationships with customers, suppliers, and employees in digital form.
- Explain how enterprise applications promote business process integration and improve organizational performance.
- Identify and describe important features of organizations that managers need to know about in order to build and use information systems successfully.
- Analyze how information systems support various business strategies for competitive advantage.

Module II **8 Hrs**

Information Technology Infrastructure: Categories of computer systems, types of software, managing hardware and software assets. Managing data resources; Telecommunications and networks.

Learning Outcomes:

After completion of this unit, the learners will be able to

- Define IT infrastructure and describe the components and levels of IT infrastructure.
- Assess contemporary computer hardware platform trends.

- Describe how a database management system organizes information and compare the principal database models.
- Describe the features of a contemporary corporate network infrastructure and key networking technologies.
- Evaluate alternative transmission media, types of networks, and network services.

Module III **8 Hrs**

Management and Organizational Support Systems for Digital Firm: Managing knowledge for the digital firm; Information and knowledge work systems, artificial intelligence, other intelligence techniques. MIS and decision support system (DSS).

Learning Outcomes:
After completion of this unit, the learners will be able to
- Assess the role of knowledge management and knowledge management programs in business.
- Evaluate the business benefits of using intelligent techniques for knowledge management.
- Describe different types of decisions and the decision-making process.
- Evaluate the role of information systems in helping people working individually and in a group make decisions more efficiently.

Module IV **8 Hrs**

Building Information Systems in the Digital Firm: Redesigning the organization with IS; Systems as planned organizational change; Business process reengineering (BPR) and process improvement. Understanding the business value of systems.

Learning Outcomes:
After completion of this unit, the learners will be able to
- Demonstrate how building new systems produces organizational change.
- Explain how a company can develop information systems that fit its business plan.
- Identify and describe the core activities in the systems development process.
- Evaluate alternative methods for building information systems and alternative methodologies for modeling systems.

Module V **8 Hrs**

Managing Change: Importance of change management in IS success and failure; Managing implementation.

Learning Outcomes:
After completion of this unit, the learners will be able to
- Evaluate models for understanding the business value of information systems.
- Analyze the principal causes of information system failure.
- Assess the change management requirements for building successful systems.
- Select appropriate strategies to manage the system implementation process.

Course Outcomes:
After successful completion of this course student will be able to
Assess role of MIS in ever evolving complex business scenario.
- Assimilate knowledge obtained in core concepts like Decision support systems and AI.
- Appreciate the role of MIS in organizations related to service and manufacturing sectors.

- Analyze real cases study by studying BPR (business process reengineering) to manage resources effectively and incorporating latest-cutting edge technology.
- Develop IT skills to become a successful IT and Business managers.

EME452	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1					2			2		1	1				
CO2		3		3		3		1			1				
CO3				3				3	3						
CO4				3	3	3			3						
CO5				3				3	3						

Text Book(s):

K.C.Laudon and J.P.Laudon, Management Information Systems - Managing the Digital Firm, 8/e, PHI, 2004.

References:

1. Data C.J, An introduction to Data Base Management System, Narosa Publication House,, 1985.
2. Murdic, Ross and Clagget, Information Systems for Modern Management, PHI, 1985.
3. Davis Gordon, Management Information Systems – Conceptual Foundations, McGraw Hill, 1993.

INTERDISCIPLINARY ELECTIVES

Interdisciplinary Elective I

S. No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**Remarks** Offered by
1	19EEC477	Machine to Machine Communication	ID	3	0	0	3	EECE
2	19EEE477	Electric Vehicle Technology	ID	3	0	0	3	EECE
3	19EHS475	Entrepreneurship Development	ID	3	0	0	3	MANAGEMENT

19EEC477: MACHINE TO MACHINE COMMUNICATION

L	T	P	C
3	0	0	3

Course Objectives:

1. To acquaint the different applications of M2M communications
2. To impart the fundamentals concepts and principles of machine-to-machine communication
3. To discuss the architecture, services provided by M2M protocols

Course Outcomes

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

1. Enumerate the different applications of M2M communications
2. describe the standards, protocols, and algorithms in M2M Communication
3. choose the M2M Communication protocols in a prototype
4. design new protocols for different application scenarios
5. elaborate the different hardware and software interfaces used in M2M communications

Unit – I 8 Hours

Introduction to M2M, Description of M2M Market Segments/Applications – Automotive, Smart Telemetry, Surveillance and Security, M2M Industrial Automation.

Unit – II 8 Hours

ETSI M2M Services Architecture – Introduction, High-Level System Architecture, Introducing REST Architectural Style for M2M, Applying REST to M2M, Additional Functionalities. ETSI TC M2M Resource-Based M2M Communication and Procedures - Resource Structure, Interface Procedures.

Unit – III 8 Hours

M2M over a Telecommunications Network - Mobile or Fixed Networks, Network Optimizations for M2M, 3GPP Standardization of Network Improvements for Machine Type Communications, 6LoWPAN.

Unit – IV 8 Hours

M2M Terminals and Modules - Access Technology, Physical Form Factors, Hardware Interfaces, Power Interface, USB (Universal Serial Bus) Interface, UART (Universal Asynchronous Receiver/ Transmitter) Interface, Antenna Interface, UICC (Universal Integrated Circuit Card) Interface

Unit – V 8 Hours

GPIO (General-Purpose Input/Output Port) Interface, SPI (Serial Peripheral Interface) Interface, I2C (Inter-Integrated Circuit Bus) Interface, ADC (Analog-to-Digital Converter) Interface, PCM (Pulse Code Modulation) Interface, PWM (Pulse Width Modulation) Interface, Software Interface, AT Commands, SDK Interface

Textbook

1. D. Boswarthick, O. Elloumi, and O. Hersent, M2M communications: A systems approach, Wiley, 1st edition, 2012, ISBN: 978-1119994756.

References

1. J. Holler et al., From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Academic Press, 1st edition, 2014, ISBN: 978-0124076846.
2. C. Anton-Haro and M. Dohler, Machine-to-machine (M2M) Communications: Architecture, Performance and Applications, Woodhead Publishing, 1st edition, 2015, ISBN: 978-1782421023.

19EEE477 – ELECTRIC VEHICLE TECHNOLOGY

L	T	P	C
3	0	0	3

UNIT **Introduction** **8 hours**

Air pollution, global warming, petroleum resources, induced costs, and development strategies for future oil supply, Overview of Past, current and future of electric vehicles.

UNIT 2 **Vehicles' classification** **8 hours**

Classification of vehicles: Conventional IC engines, electric vehicles, hybrid electric vehicles, plug-in hybrid vehicles, and fuel cell vehicles. Basic principles and operation of electric vehicles.

UNIT 3 **Configuration and Architecture** **8 hours**

Configuration of electric vehicles, performance of electric vehicles: traction motor characteristics, requirement of tractive and transmission effort and energy consumption. Architecture of hybrid vehicles: series and parallel.

UNIT 4 **Basic electric propulsion systems** **8 hours**

(Elementary treatment only) Principle, operation and performance of DC motors, induction motors, brushless DC motors and switched reluctance motors

UNIT 5 **Overview of communication in EVs** **8 hours**

Vehicle to grid communication, vehicle to vehicle communications, and grid to vehicle communication

Textbooks:

1. Ehsani, M., Gao, Y., Longo, S., & Ebrahimi, K. M. (2018). Modern electric, hybrid electric, and fuel cell vehicles. CRC press.
2. Larminie, James, and John Lowry. Electric vehicle technology explained. John Wiley & Sons, 2012.

References:

1. Lu, J. and Hossain, J., 2015. Vehicle-to-grid: linking electric vehicles to the smart grid. Institution of Engineering and Technology.

19EHS475: ENTREPRENEURSHIP DEVELOPMENT

L T P C
3 0 0 3

This course aims to provide entrepreneurial abilities because business conditions have changed significantly since the advent of new technologies and business started demanding from both CEOs and managers entrepreneurial abilities which are in line with latest and contemporary business models in the era of globalization and disruption. This course includes a description of various concepts like process of entrepreneurship, opportunity identification, business plan preparation, registration process of business enterprise, funds requirement for business and evaluation of business enterprise.

Course Objectives:

• To identify the concept and process of Entrepreneurship and its role in the society.

• To recognize opportunity identification, different business model and business plan preparation.

• To explain the entrepreneurship development programmes (EDP) and Central government policy initiatives for entrepreneurship development

• To identify registration process of business enterprise.

• To assess funds requirement and evaluation of business enterprise.

Unit I: **8L**

Introduction: Entrepreneur and Entrepreneurship; Description of an Entrepreneur; Traits of an Entrepreneur; evolution of Entrepreneurship; functions of an entrepreneur; Entrepreneurial mindset; Entrepreneurial Motivation; entrepreneurial process; entrepreneurial competencies; types of entrepreneurship; role of entrepreneurship in the economic development.

Learning Outcomes:

At the end of this unit, the student will be able to

• identify the traits and functions of entrepreneur(L2).

• recognize entrepreneurial process and entrepreneurial competencies(L3).

• demonstrate the role of entrepreneurship in the economic development(L4).

Unit II: 8L

Business Idea Generation and Business Opportunity Identification: Scanning the environment; finding the gaps for new business and new ways of business, Start-up Culture and Incubation; Boot Camps; Mentoring the ideation process, validation of different ideas, Proto type Development; Business Model Development; need and importance of Business Plan preparation- process of Business Plan.

Learning Outcomes:

At the end of this unit, the student will be able to

• list the gaps for new business and new ways of business(L1).

• identify startup culture and incubation and boot Camps(L2).

• recognize mentoring the ideation process, validation of different ideas(L2).

• apply proto type development and business model development(L3).

• demonstrate the need for and importance of business plan preparation- process of Business Plan(L3).

Unit III: 8L

Entrepreneurship Development Programmes and Government Support to Entrepreneurs: Evolution of

Entrepreneurship Development Programmes (EDP)-Phases of EDPs-Course content and curriculum of EDPs– Educational Institutions and Entrepreneurship Development Programmes; Definition of Micro, Small and Medium Enterprises (MSME), growth and development of MSME's in India; Central Government Policy initiatives; District Industrial Centres and Industrial Estates.

Learning Outcomes:

At the end of this unit, the student will be able to

• identify the phases of EDPs and curriculum of EDPs(L2).

• recognize growth and development of MSME's in India(L2).

• to explain central government policy initiatives and district industrial centres(L2).

Unit IV: 8L

Registration of Business Enterprises: Business Name registration; Trademark registration; Patent registration and legal formalities; Sole Proprietorship, Partnership, Limited Liability Partnership (LLP), Private Limited Company and Public Limited Company Registration process; benefits of registration of enterprises; process of obtaining licenses and permissions including export and import license; Income Tax and Goods and Service Tax (GST) registration process.

Learning Outcomes:

At the end of this unit, the student will be able to

• interpret registration of business enterprises (L3).

• evaluate sole Proprietorship, Partnership, Limited Liability Partnership (LLP) (L6).

• Identify process of obtaining licenses and permissions including export and import license (L2).

Unit V: 8L

Funds Requirement and Evaluation of Business Enterprise: Own Capital v/s Loan Capital (equity and debt); Cost of the project; evaluation of different sources of funds - Projected Income and Turnover statements; Seed Capital, Angel Investment and Venture Capital; Institutional Financing to Entrepreneurs; Working Capital; Short term-medium term and Long term financing to entrepreneurs by financial institutions and commercial banks.

Learning Outcomes:

At the end of this unit, the student will be able to

• interpret the cost of the project, projected income and turn over statements (L3).

• evaluate different sources of funds (L6).

• recognize institutional Financing to Entrepreneurs financial institutions and commercial banks (L2). • Identify
process of obtaining licenses and permissions including export and import license (L2).

Case Analysis (not exceeding 200 words): Any Software Company Business Plan- Any Automobile Company
Business Plan- Any Ecommerce Business plan.

Course Outcomes:

At the end of the course, the student will be able to

• interpret the concept and process of Entrepreneurship and its role in the society (L3).

• differentiate different business model and analyse business plan preparation (L4).

• appraise entrepreneurship development programmes (EDP) and Central government policy initiatives for
entrepreneurship development (L4).

• conclude registration process of business enterprise (L6).

• estimate funds requirement and interpret short term, medium term and long term financing to entrepreneurs by financial institutions and commercial banks (L6).

Teaching and learning resources

1. Donald F. Kuratko, Entrepreneurship: Theory, Process, Practice, Cengage Learning, New Delhi, Latest Edition.

2. Robert Hisrich, M.J.Manimala, M.P.Peters and D. A.Shepherd “Entrepreneurship” MC Graw Hill Education, Latest Edition.

3. Bruce R Barringer, Preparing effective Business Plan-an Entrepreneurial Approach, New Delhi: Pearson Publication, Latest Edition.

4. Jeffrey A Timmons, New Venture Creation, New Delhi: Irwin publishers, Latest Edition.

5. Dr. S. S. Khanka “Entrepreneurship Development”, S. Chand and Company Limited, New Delhi, Latest Edition.

6.PoornimaM.Charantimath,"EntrepreneurshipDevelopment-SmallBusiness Enterprises", Pearson, New Delhi, Latest Edition.

7. Arya Kumar, & quot; Entrepreneurship: Creating and Leading an Entrepreneurial Organization" Pearson, New Delhi, Latest Edition.

8. Vasant Desai, Dynamics of Entrepreneurial Development and Management New Delhi: Himalaya Publishing House, Latest Edition.

Journals

1. Harvard Business Review
2. International Journal of Entrepreneurial Behaviour And Research
3. International Journal of Small Business Management
4. International Journal of Entrepreneurship And Innovation Management

Daily English News Papers

1. The Mint
2. The Economic Times
3. Business Standard
4. Business Line

Interdisciplinary Elective-II

S. No.	Course Code	Course Title	Category	L	T	P	C	Remarks Offered by
1	19EEI472	Micro Electromechanical Systems	ID	3	0	0	3	EECE
2	19ECS472	Introduction to cloud computing	ID	3	0	0	3	CSE
3	19EME435	Electric and Hybrid Vehicle Design	ID	3	0	0	3	EECE
4	19EHS403	Organizational Behavior	ID	3	0	0	3	Management

19EEI472: Micro Electromechanical Systems

L	T	P	C
3	0	0	3

This course introduces the fundamentals and applications of MEMS. The course emphasizes the working principles, fabrication technologies and packaging methods of MEMS and Microsystems. This course also deals with operating principles of Micro characterization techniques.

Course Objectives:

- To make clear the fundamentals and applications of MEMS and micro systems.
- To explain the working principles of micro sensors and actuators.
- To impart knowledge on various micro fabrication technologies.
- To outline the fundamentals of Micro characterization methods.
- To discuss different packaging methods used in MEMS and microsystems.

UNIT I **8L**

Introduction: Need for miniaturization, Microsystems versus MEMS, micro fabrication, smart materials, structures and systems, integrated microsystems: micromechanical structures, microsensors, microactuators, applications of smart materials and microsystems. Applications of MEMS in the automotive, health care, aerospace, industrial products, consumer products and telecommunications.

Learning outcomes:

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

- get an overview of MEMS and microsystems (L1).
- state the need for miniaturization (L1).
- describe the role of micro fabrication (L2).
- differentiate the micro sensors and actuators(L4).
- recognize the applications of MEMS in various fields(L1).

UNIT II **8L**

Microsensors and Actuators: Silicon capacitive accelerometer, piezo resistive pressure sensor, conductometric gas sensor, electrostatic comb drive, a magnetic micro relay, portable blood analyzer, piezoelectric inkjet print head, micromirror array for video projection, micro-PCR systems, smart materials and systems.

Learning outcomes:

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

- illustrate the working principles of various MEMS sensors (L1).
- discuss about the differences between micro sensors and actuators (L2).
- explain the operation of MEMS accelerometers, pressure sensors and gas sensors (L2).
- summarize the advantages and limitations of various MEMS sensors and actuators (L2).
- list the applications of various smart materials and systems (L1).

UNIT -III **8L**

Micro Fabrication Technologies: Silicon as a material for micromachining, thin-film deposition, lithography, doping, etching, silicon micromachining: bulk and surface, specialized materials for microsystems: polymers and ceramic materials, advanced processes for micro fabrication: wafer bonding techniques, dissolved wafer processes, LIGA process, HexSil process.

Learning outcomes:

After completion of this unit, the student will able to

- identify the importance of silicon as a substrate material (L1).

- get on overview on physical and chemical techniques for thin film deposition (L1).
- distinguish dry and wet chemical etching techniques (L4).
- compare bulk and surface micromachining processes (L2).
- describe polymeric and ceramic materials and their processing (L2).

UNIT -IV **8L**

Micro Characterization Techniques: Scanning electron microscopy, X-ray diffraction, X-ray photoelectron spectroscopy, atomic force microscopy, UV-visible spectroscopy, Fourier transform infrared spectroscopy, transmission electron spectroscopy.

Learning outcomes:

After completion of this unit, the student will able to

- understand the working principles of various characterization techniques (L1).
- explain the advantages and limitations of different characterization techniques (L2).
- recognize the techniques to characterize a material (L2).
- summarize the features of various characterization techniques (L4).
- differentiate the types of spectroscopy techniques(L4).

UNIT -V **8L**

MEMs Packaging: Overview of mechanical packaging of microelectronics, micro-system packaging, interfaces in micro-system Packaging, essential packaging technologies, three-dimensional packaging, assembly of MEMS, selection of packaging materials, signal mapping and transduction, design case: pressure sensor packaging.

Learning outcomes:

After completion of this unit, the student will able to

- differentiate microelectronic packaging and microsystem packaging (L4).
- describe different interfaces in microsystem packaging (L2).
- summarize the features of three dimensional packaging (L4).
- identify materials used for microsystem packaging (L1).
- describe the major steps involved in pressure sensor packaging (L2).

Text Books:

1. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre, Micro and Smart Systems, Wiley India, 2010.
2. Tai-Ran Hsu, MEMS and Microsystems: Design and Manufacture, Mc Graw Hill India, 1st edition, 2004.

References:

1. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, John Wiley, 2006.
2. Mohamed GadelHak, The MEMS Handbook, 2nd Edition, CRC Press, 2005
3. M.-H. Bao, Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes, Elsevier, New York, 2000.
4. M.J. Madou, Fundamentals of Microfabrication, 3rd Ed, CRC Press, 2011.
5. Vinod Kumar Khanna, Nano sensors: Physical, Chemical and Biological, Series in Sensors, CRC press, Taylor and Francis Group, 2012.

Course outcomes:

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

- understand the MEMS and microsystem working principles (L1).
- acquire knowledge on micro sensors and actuators (L2).
- describe various MEMS fabrication methods (L2).
- explain the working principles of various types of micro characterization methods (L2).
- understand different microsystems packaging techniques (L1).

19ECS472: Introduction to Cloud Computing

LTPC
3 0 0 3

Module I 8 Hrs

Understanding Cloud Computing: Cloud origins and influences, basic concepts and terminology. Fundamental Concepts and Models: Roles and boundaries, cloud characteristics, cloud delivery models, cloud deployment models.

Module II 8 Hrs

Cloud Enabling Technology: Data center technology, virtualization technology, web technology, multitenant technology, service technology.

Module III 8 Hrs

Cloud Infrastructure Mechanisms: Logical network perimeter, virtual server, cloud storage device, cloud usage monitor, resource replication.

Module IV 8 Hrs

Fundamental Cloud Architectures: Workload distribution architecture, resource pooling architecture, dynamic scalability architecture, elastic resource capacity architecture, service load balancing architecture, cloud bursting architecture, elastic disk provisioning architecture, redundant storage architecture.

Module V 8 Hrs

Cloud Delivery Model Considerations: The cloud provider perspective: Building IaaS environments, equipping PaaS environments, optimizing SaaS environments.

Text Book(s)

1. Thomas Erl, Ricardo Puttini, Zaigham Mahmood ,Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 2013.

References

1. John W. Rittinghouse, James F.Ransome, Cloud Computing: Implementation, Management and Security, CRC Press, 2012.

2. Anthony T.Velte, Toby J Velte Robert Elsenpeter, Cloud Computing a practical approach, , Mc Graw Hill,2010.
3. Michael Miller, Cloud Computing: Web,Based Applications That Change the Way You Work and Collaborate Online, Que Publishing, 2008.
4. Haley Beard, Cloud Computing Best Practices for Managing and Measuring Processes for On demand Computing, Applications and Data Centers in the Cloud with SLAs, Emereo Pty Limited, 2008.
5. Gautam Shroff, Enterprise Cloud Computing: Technology, Architecture, applications, Cambridge University Press, 2010.
6. Ronald L. Krutz,Russell Dean Vines A Comprehensive Guide to Secure Cloud Computing, 2010.

19EME435 – ELECTRIC AND HYBRID VEHICLE DESIGN

L T P C
2 1 0 3

Course Description:

This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. This course goes deeper into the various aspects of hybrid and electric drive train such as their configuration, types of electric machines that can be used, energy storage devices, etc. Each topic will be developed in logical progression with up-to-date information.

Course Educational Objectives:

The purpose of the course is to

- Study various basic concepts of hybrid and electric vehicles.
- Expose various basic conventional vehicle performance and various hybrid drive-train topologies.
- Familiarize various electric components used in hybrid and electric vehicles
- Expose various energy storage requirements in hybrid and electric Vehicles
- Interpret the energy management strategies used in hybrid and electric vehicles.

UNIT 1 Basic concepts of Hybrid Electric Vehicles 8 hours

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT 2 Conventional Vehicles 10 hours

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

Hybrid Electric Drive-Trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

UNIT 3 Electric Propulsion Unit 8 hours

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

UNIT 4 Energy Storage 8 hours

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

UNIT 5 Energy Management Strategies 8 hours

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Text Books:

1. Chrismi, M. AbulMasrur and David WenzhangGao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Wiley, 2011.

2. Yang Sheng Xu, HuihuanQian, Jingyu Yan and Tin Cun Lam, Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids, IET, 2014.

References:

1. Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003.
2. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2004..

Course Outcomes:

Upon completion of the course, the students would be able to

1. Compare the difference between hybrid and electric vehicles (L2)
2. Identify different hybrid drive-train topologies. (L3)
3. Estimate the various electric components used in hybrid and electric vehicles (L5)
4. Assess various problems in hybridization of different energy storage devices. (L5)
5. Predict various issues of energy management strategies. (L6)

19EHS403: Organizational Behaviour

L T P C
3 0 0 3

Module I:

Introduction; Definition of Organization Behavior and Historical development, Environmental Context (Information Technology and Globalization), Diversity and Ethics, Design and Cultural, Reward Systems. The Individual: Foundation of individual behavior, Ability

Module II:

Learning: Definition, Theories of Learning, Individual Decision Making, classical conditioning, operant conditioning, social Making, learning theory, continuous and intermittent reinforcement. Perception: Definition, Factors influencing perception, attribution theory, selective perception, projection, stereotyping, Halo effect.

Module III:

Motivation: Maslow's Hierarchy of Needs, Mc. Gregory's theory X and Y, Herzberg's motivation Hygiene theory, David Mc Cleland three needs theory, Victor vroom's expectancy theory of motivation.

Module IV:

Values and attitudes: Definitions – values, Attitudes: Types of values, job satisfaction, job involvement, professional Ethics, Organizational commitment, cognitive dissonance. Conflict Management: Definition of conflict, functional and dysfunctional conflict, stages of Conflict process.

Module V:

Leadership: Definition, Behavioral theories – Blake and Mouton managerial grid, Contingency theories – heresy - Blanchard's situational theory, Leadership styles – characteristics, Transactional, transformation leaders. The Organization: Mechanistic and Organic structures, Minitberg's basic elements of organization, Organizational Designs and Employee behavior, organization development – quality of work life (QWL)

Text Books(s)

1. Stephen P Robbins -Organizational Behaviour, Pearson Education Publications,ISBN– 81–7808–561-5, 9th Edn. 2012.

2. Fred Luthans -Organizational Behaviour, Mc Graw Hill International Edition,ISBN–0–07–20412–1, 11th Edn. 2006.

Reference Book(s)

1. Hellriegel, Srocum and woodman, Thompson Learning -Organization Behaviour, Prentice Hall India, 9th Edition -2001.

2. Aswathappa -Organizational Behavior, Himalaya Publishers. 2001.

3. VSP Rao and others -Organizational Behaviour, Konark Publishers 2002.

4. Organizational Behaviour- (Human behaviour at work) John Newstron / Keith Davis 9th Edition 2002.

5. Paul Henry and Kenneth H. Blanchard -Management of Organizational Behaviors, Prentice Hall of India, 1996

19EME456: OPTIMIZATION TECHNIQUES

L	T	P	C
3	0	0	3

This course exposes the evaluation of the best possible solution for various engineering planning and design problems. The aim of the course is to train the students to develop a mathematical model and to solve the model by applying an appropriate mathematical programming technique. This course also covers advanced optimization techniques to solve dynamic and integer programming problems.

Course Objectives:

- To illustrate the importance of optimization techniques in theory and practice.
- To formulate and solve engineering design problems in the industry for optimal results
- To test the analytical skills in solving real engineering problems by applying appropriate optimization technique.
- To demonstrate various advanced optimization techniques being developed in recent times.
- To develop and promote research interest in problems of Engineering and Technology

UNIT I **8 Hrs**

Introduction to optimization: Introduction, engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function, classification of optimization problems.
Classical Optimization techniques: Introduction, single variable optimization, multi variable optimization with no constraints, multi variable optimization with equality and inequality constraints.

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

- **describe** the need and origin of the optimization methods [**L1]**
- **classify** design points, constraints, and optimization problems **[L2]**
- **choose** the method needed to solve the optimization problem [**L3]**

UNIT II **10 Hrs**

One Dimensional Minimization Methods: Introduction, unimodal function, elimination methods-exhaustive search, interval halving method, Fibonacci method, golden section method, interpolation methods-quadratic & cubic interpolation methods, direct root methods-Newton method, secant method.

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

- **apply** elimination methods to find the narrowest region in which optimum point lies **[L3]**
- **solve** one dimensional minimization problems using interpolation and direct root methods **[L3]**

UNIT III **8 Hrs**

Unconstrained Minimization Methods: Introduction, Direct Methods- random search methods, univariate method, Powell’s method. Descent method - steepest descent method (Cauchy’s method)

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

- **apply** random search methods to solve unconstrained multi-variable optimization problems [**L3]**
- **employ** pattern directions to find the optimal solution [**L3]**

UNIT IV **8 Hrs**

Dynamic Programming: Introduction, Bellman's optimality principle, application of Dynamic Programming - **Shortest Path Problem, cargo-loading problem, optimal subdividing problem,** Linear programming problem.

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

- **formulate** the given linear/non-linear programming problem as a dynamic programming problem[**L6**]
- **evaluate** the optimal solution to dynamic programming problems using multi-stage decision process [**L4]**

UNIT V **8 Hrs**

Integer Programming: Introduction, All Integer and Mixed Integer Programming problems- Gomory's cutting plane method & Branch-and-bound method. Balas algorithm for zero-one programming.

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

- **formulate** the integer and/or binary programming problem [**L3**]
- evaluate the optimal solution to integer and/or binary programming problem [**L4**]

Course outcomes:

- ➢ **classify** optimization problems and **apply** classical optimization techniques to solve NLPPs having differentiable functions [**L2&L3]**
- ➢ **apply** the concept of uni-modal function to **solve** one dimensional minimization problems **[L3]**
- ➢ **solve** any multi variable optimization problems
- ➢ **solve** any complex optimization problem as a dynamic programming problem and **analyze** its solution [**L3&L4]**
- ➢ recognize the significance of integer and/or binary solutions and apply a suitable algorithm for better decision making [**L1&L3]**

Textbooks:

1. S.S.Rao, Engineering optimization theory and practice,3rd Edition, New age international,2007.

Reference

1. H.A.Taha, Operations Research, 9th Edition, Prentice Hall of India, 2010.
2. F.S.Hillier, and G.J.Lieberman, Introduction to Operations Research, 7th Edition, TMH, 2009.

19EME446: MODERN MANUFACTURING METHODS (Elective)

L	T	P	C
3	0	0	3

Modern manufacturing is at the heart of industrial production, from raw materials to semi-finished products and finished goods. Over the last decade, a number of innovative approaches have been developed that enable for more adaptable, energy-efficient, and environmentally friendly production processes. The students will learn about modern manufacturing procedures that are used in today's industry. Modern manufacturing methods concentrate on crucial factors of manufacturing, such as waste reduction, manpower, materials, capacity, and so on.

Course Objectives:

This subject provides students with

- An understanding of adaptive control to overcome the adverse effect of rapid changes in the system behavior.
- The Knowledge on manufacturing philosophies to achieve a competitive advantage through cost reduction and efficient service of customer demands.
- An understanding of form, fit and function of a part before expensive tooling is purchased.
- Comprehensive knowledge on material handling system to reduce unit cost of the part, reduced manufacturing cycle, reduced delays and damage.
- Analyze the existing production systems for the purpose of optimization, design verification of new systems, bottlenecks of the project, risks etc.

Course Outcomes:

Upon completion of the course the students will be able to

- Demonstrate a basic understanding of adaptive control machining; understand the various manufacturing philosophies, and role and material handling in manufacturing.
- Analyze the importance of Lean and Agile manufacturing strategies over mass production and can demonstrate the improvement in productivity and quality of the components.
- Improves the soft skills during development of customized software for manufacturing system simulation.
- It gives a clear insight in the area of prototype development and use of advanced materials for the product development.

Module I **8 hours**

Adaptive Control (AC): Definition of adaptive control, Importance of adaptive control system, comparison of conventional, CNC and AC systems; classification of adaptive control, adaptive control constraint, adaptive optimization, adaptive controlled optimization for machining process.

Module II **9 hours**

Lean, Agile and JIT Manufacturing: Introduction to Lean manufacturing, types of wastes in lean manufacturing, comparison lean and agile manufacturing, comparison of lean and agile. JIT Approach: Introduction, definition, elements of JIT, how JIT works, effects of JIT production, plant layout for JIT, product design for JIT, steps in implementation of JIT, benefits of JIT.

Module III **9 hours**

Rapid Prototyping: Definition, basic steps in rapid prototyping, various techniques in rapid prototyping - Stereolithography, Laminated Object Manufacturing, Selective Laser Sintering, Fused Deposition Modeling, Solid Ground Curing, 3D Printing; applications of rapid prototyping.

Module IV **8 hours**

Nano Manufacturing: Introduction, definition, Importance of nanomaterials, Classification of preparation methods, Nanomaterial - synthesis and processing - Mechanical grinding, wet chemical synthesis - Sol-gel process, Gas phase synthesis – Chemical vapour deposition (CVD), characteristics of Nano particles, applications of nanomaterials.

Module V **8 hours**

Micromachining processes: Definition, Need and applications of micromachining in engineering industries. Principle of mechanical, thermoelectric, electrochemical, and chemical micromachining processes - Size comparisons in micro manufacturing and micro products. Problems in micro machining.

Text Book(s)

1. Serope Kalpakjian, Steven Schmid, Manufacturing Engineering and Technology, 7/e, Pearson Education Publications, 2013.
2. David D Bedworth, M R Henderson, Philip M Wolfe, Computer Integrated Design and Manufacturing, McGraw Hill College, 1991.

References

1. Dr. Sadhu Singh, Computer Aided Design and Manufacturing, 5/e, Khanna Publishers, 2014.
2. P.N. Rao, CAD/CAM Principles and Applications, 6/e, Tata Mc Graw Hill, 2006.
3. Jain V. K., Introduction to Micromachining, 2nd edition, Narosa Publishers, New Delhi 2014.