Mahatma Education Society's

Pillai College of Engineering

(Autonomous)

Affiliated to University of Mumbai

Dr. K. M. Vasudevan Pillai's Campus , Sector 16, New Panvel – 410 206.

Department of Mechanical Engineering

Syllabus

of

B.Tech. in Mechanical Engineering

for

The Admission Batch of AY 2021-22

First Year - Effective from Academic Year **2021-22**

Second Year - Effective from Academic Year **2022-23**

Third Year - Effective from Academic Year **2023-24**

Fourth Year - Effective from Academic Year **2024-25**

as per

Choice Based Credit and Grading System

Mahatma Education Society's

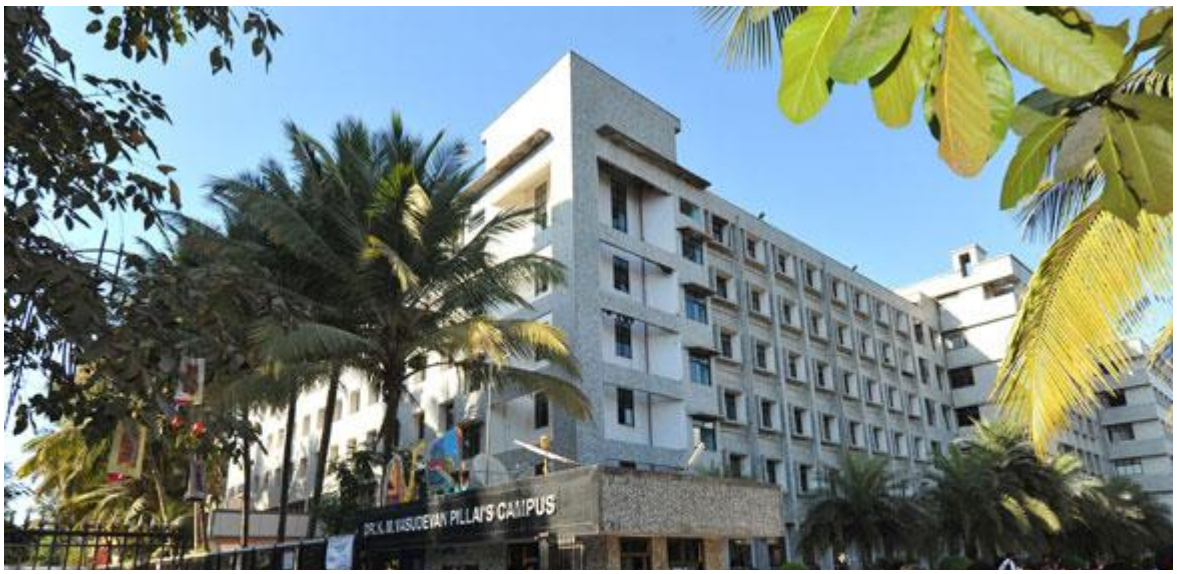
Pillai College of Engineering

Vision

Pillai College of Engineering (PCE) will admit, educate and train a diverse population of students who are academically prepared to benefit from the Institute's infrastructure and faculty experience, to become responsible professionals or entrepreneurs in a technical arena. It will further attract, develop and retain, dedicated, excellent teachers, scholars and professionals from diverse backgrounds whose work gives them knowledge beyond the classroom and who are committed to making a significant difference in the lives of their students and the community.

Mission

To develop professional engineers with respect for the environment and make them responsible citizens in technological development both from an Indian and global perspective. This objective is fulfilled through quality education, practical training and interaction with industries and social organizations.



Dr. K. M. Vasudevan Pillai's Campus , Sector - 16, New Panvel – 410 206

Department of Mechanical Engineering

Vision

To develop a world class programme with excellence in teaching, learning and research that would lead to growth, innovation and recognition.

Mission

The mission of the Mechanical Engineering Program is to benefit the society at large by providing technical education to interested and capable students. These technocrats should be able to apply basic and contemporary science, engineering and research skills to identify problems in the industry and academia and be able to develop practical solutions to them.

Program Educational Objectives (PEOs):

I. To prepare students for successful careers in industry to meet the needs of Indian and Global companies.
II. To provide students with a sound foundation in the mathematical, scientific and engineering fundamentals.
III. To develop the ability among students to synthesize data, interpret them appropriately and be able to apply concepts to mechanical system design or to a mechanical subsystem of an interdisciplinary system.
IV. To provide opportunity for students to work in their individual capacity as well as to function as teams on multidisciplinary projects.
V. To enable students for lifelong learning and introduce them to professional ethics and sustainable development.
VI. To develop among students an attitude towards self-employment through entrepreneurship

Program Outcomes:

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.T
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

1. Students should be able to design and develop mechanical systems(design, thermal and manufacturing) using core as well as interdisciplinary skills.
2. Students should be able to generate and develop ideas that can result in self employment (eg.Start-ups) and also result in creation of more jobs for the society.
3. Students should be able to apply technical and managerial skills to work as good team leader as well as players in diverse interdisciplinary projects.
4. Students should be able to model and develop solutions for problems relevant to industry.

The Autonomous status of the institute has given an opportunity to design and frame the curriculum in such a way that it incorporates all the needs and requirements of recent developments in all fields within the scope of the Technical education. This curriculum will help graduates to attain excellence in their respective field. The curriculum has a blend of basic and advanced courses along with provision of imparting practical knowledge to students through minor and major projects. The syllabus has been approved and passed by the Board of Studies.

Outcome based education is implemented in the academics and every necessary step is undertaken to attain the requirements. Every course has its objectives and outcomes defined in the syllabus which are met through continuous assessment and end semester examinations. Evaluation is done on the basis of Choice Based Credit and Grading System (CBCGS). Optional courses are offered at department and institute level. Selection of electives from the same specialization makes the student eligible to attain a B. Tech. degree with respective specialization.

Every learner/student will be assessed for each course through (i) an Internal/Continuous assessment during the semester in the form of either Practical Performance, Presentation, Demonstration or written examination and (ii) End Semester Examination (ESE), in the form of either theory or viva voce or practical, as prescribed by the respective Board Studies and mentioned in the assessment scheme of the course content/syllabus. This system involves the Continuous Evaluation of students' progress Semester wise. The number of credits assigned with a course is based on the number of contact hours of instruction per week for the course. The credit allocation is available in the syllabus scheme of each semester.

The performance of a learner in a semester is indicated by a number called Semester Grade Performance Index (SGPI). The SGPI is the weighted average of the grade points obtained in all the courses by the learner during the semester. For example, if a learner passes five courses (Theory/labs./Projects/ Seminar etc.) in a semester with credits C1, C2, C3, C4 and C5 and learners grade points in these courses are G1, G2, G3, G4 and G5 respectively, then learners SGPI is equal to:

$$SGPI = \frac{C_1G_1 + C_2G_2 + C_3G_3 + C_4G_4 + C_5G_5}{C_1 + C_2 + C_3 + C_4 + C_5}$$

The learner's up to date assessment of the overall performance from the time s/he entered for the programme is obtained by calculating a number called the Cumulative Grade Performance Index (CGPI), in a manner similar to the calculation of SGPI. The CGPI therefore considers all the courses mentioned in the scheme of instructions and examinations, towards the minimum requirement of the degree learners have enrolled for. The CGPI at the end of this semester is calculated as,

$$CGPI = \frac{C_1G_1 + C_2G_2 + C_3G_3 + \ldots + C_i * G_i + \ldots + C_nG_n}{C_1 + C_2 + C_3 + \cdots + C_i + \ldots + C_n}$$

The Department of Mechanical Engineering offers a B. Tech. programme in Mechanical Engineering. This is an eight semester course. The complete course is a 163 credit course which comprises core courses and elective courses. The elective courses are distributed over 7 specializations. The specializations are:

1. Thermal and Fluids Science
2. Design Engineering
3. Materials Science and Nanotechnology
4. Mechatronics & Robotics
5. Manufacturing Engineering
6. Energy Science and Engineering
7. Automotive System

The students also have a choice of opting for Institute level specializations. These are

1. Business and Entrepreneurship
2. Bio Engineering
3. Engineering Design
4. Art and Humanities
5. Applied Science
6. Life Skills, Repair, Maintenance and Safety

As minimum requirements for the credits to be earned during the B.Tech in Mechanical Engineering program, a student will have to complete a minimum of three specializations of which two are to be chosen from the department list and one has to be from the Institute level specialization list. In order to complete each specialization, a minimum of three courses under that specialization has to be completed. The credit requirement for the B.Tech. in Mechanical Engineering course is tabulated in Table 1.

Table 1. Credit Requirement for B.Tech in Mechanical Engineering

Category	Credits
Humanities and Social Sciences including Management courses	8
Basic Science courses	25
Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc	24
Professional core courses	60
Professional Elective courses relevant to chosen specialization/branch	20
Open subjects – Electives from other technical and /or emerging subjects	9
Project work, seminar and internship in industry or elsewhere	17
Mandatory Courses - Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge	Non credit
Total Credits	**163**

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester I

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract /Tut	Theory	Pract/ Tut	Total
ME 101	Engineering Mathematics I	TLP	3	2	3	1	4
ME 102	Engineering Physics I	TL	2	1	2	0.5	2.5
ME 103	Engineering Chemistry I	TL	2	1	2	0.5	2.5
ME 104	Engineering Mechanics	TL	3	2	3	1	4
ME 105	Basic Electrical and Electronics Engineering	TL	3	2	3	1	4
ME 106	Basic Engineering Workshop I	L	-	3	-	1.5	1.5
Total			**13**	**11**	**13**	**5.5**	**18.5**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ME 101	Engineering Mathematics I	40	40	40	60	2	25	-	125
ME 102	Engineering Physics I	30	30	30	45	2	25	-	100
ME 103	Engineering Chemistry I	30	30	30	45	2	25	-	100
ME 104	Engineering Mechanics	40	40	40	60	2	25	25	150
ME 105	Basic Electrical and Electronics Engineering	40	40	40	60	2	25	25	150
ME 106	Basic Engineering Workshop I	-	-	-	-	-	50	-	50
Total				**180**	**270**	**10**	**175**	**50**	**675**

T- Theory , L- Lab , P-Programming, C- Communication

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester II

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract/ Tut	Theory	Pract/ Tut	Total
ME 107	Engineering Mathematics II	TLP	3	2	3	1	4
ME 108	Engineering Physics II	TL	2	1	2	0.5	2.5
ME 109	Engineering Chemistry II	TL	2	1	2	0.5	2.5
ME 110	Engineering Drawing	TL	2	4	2	2	4
ME 111	Programming with Python	TLP	1	2	1	1	2
ME 112	Professional Communication and Ethics I	TLC	1	2	1	1	2
ME 113	Basic Engineering Workshop II	L	-	3	-	1.5	1.5
Total			**11**	**15**	**11**	**7.5**	**18.5**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ME 107	Engineering Mathematics II	40	40	40	60	2	25	-	125
ME 108	Engineering Physics II	30	30	30	45	2	25	-	100
ME 109	Engineering Chemistry II	30	30	30	45	2	25	-	100
ME 110	Engineering Drawing	40	40	40	60	3	25	25	150
ME 111	Programming with Python	-	-	-	-	-	50	25	75
ME 112	Professional Communication and Ethics I	20	20	20	30	1	25	-	75
ME 113	Basic Engineering Workshop II	-	-	-	-	-	50	-	50
Total				**160**	**240**	**10**	**225**	**50**	**675**

T- Theory , L- Lab , P-Programming, C- Communication

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester III

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract /Tut	Theory	Pract/ Tut	Total
ME 201	Manufacturing Processes	TL	3	2	3	1	4
ME 202	Engineering Mathematics III*	TL	3	1	3	1	4
ME 203	Strength of Materials*	TL	3	2	3	1	4
ME 204	Thermodynamics*	T	3	-	3	-	3
ME 205	Metallurgy and Materials	TL	3	2	3	1	4
ME 206	Computer Aided Drafting	L	-	2	-	1	1
ME 291	Minor Project I	LC	-	4	-	2	2
Total			**15**	**13**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ME 201	Manufacturing Processes	40	40	40	60	2	50	-	150
ME 202	Engineering Mathematics III*	40	40	40	60	2	25	-	125
ME 203	Strength of Materials*	40	40	40	60	2	25	25	150
ME 204	Thermodynamics*	40	40	40	60	2	-	-	100
ME 205	Metallurgy and Materials	40	40	40	60	2	25	-	125
ME 206	Computer Aided Drafting	-	-	-	-	-	25	50	75
ME 291	Minor Project I	25 (Mid Sem assessment)			-	-	25	25	75
Total				**225**	**300**	**10**	**175**	**100**	**800**

T- Theory , L- Lab , P-Programming, C- Communication
*** - Common with B.Tech in Automobile Engineering**

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester IV

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract/ Tut	Theory	Pract/ Tut	Total
ME 207	Advanced Manufacturing Technology	TL	3	2	3	1	4
ME 208	Theory of Machines & Mechanisms*	TL	3	2	3	1	4
ME 209	Fluid Mechanics and Machinery*	TL	3	2	3	1	4
ME 210	Human Values and Social Ethics*	T	2	-	2	-	2
ME 211	Data Science	TLP	-	1#+2	-	1.5	1.5
ME 212	Internet of Things	TL	-	1#+2	-	1.5	1.5
ME 292	Minor Project II	LC	-	4	-	2	2
Total			**11**	**16**	**11**	**8**	**19**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ME 207	Advanced Manufacturing Technology	40	40	40	60	2	50	-	150
ME 208	Theory of Machines & Mechanisms*	40	40	40	60	2	25	25	150
ME 209	Fluid Mechanics and Machinery*	40	40	40	60	2	25	25	150
ME 210	Human Values and Social Ethics*	-	-	-	-	-	50	-	50
ME 211	Data Science	-	-	-	-	-	25	50	75
ME 212	Internet of Things	-	-	-	-	-	50	25	75
ME 292	Minor Project II	25 (Mid Sem assessment)			-	-	25	25	75
Total				**145**	**180**	**6**	**250**	**150**	**725**

 # - Theory class to be conducted for full class

*** - Common with B.Tech in Automobile Engineering**

T- Theory , L- Lab , P-Programming, C- Communication

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester V

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract/ Tut	Theory	Pract /Tut	Total
ME 301	Finite Element Analysis*	TL	3	2	3	1	4
ME 302	Heat Transfer*	TL	3	2	3	1	4
ME 303	Measurements and Instrumentation	TL	3	2	3	1	4
ME 304	Machine Design I	TL	3	2	3	1	4
ME 305	Professional Communication and Ethics II	TLC	1	2	1	1	2
ME 30x	DLOC I	T/TL	3	-	3	-	3
ME 391	Minor Project III	LC	-	4	-	2	2
Total			**16**	**14**	**15**	**8**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ME 301	Finite Element Analysis*	40	40	40	60	2	25	25	150
ME 302	Heat Transfer*	40	40	40	60	2	25	25	150
ME 303	Measurements and Instrumentation	40	40	40	60	2	25	25	150
ME 304	Machine Design I	40	40	40	60	2	25	-	125
ME 305	Professional Communication and Ethics II	-	-	-	-	-	50	-	50
ME 30x	DLOC I	40	40	40	60	2	-	-	100
ME 391	Minor Project III	25 (Mid Sem assessment)			-	-	25	25	75
Total				**250**	**300**	**10**	**150**	**100**	**800**

T- Theory , L- Lab , P-Programming, C- Communication
*** - Common with B.Tech in Automobile Engineering**

Group	Department Specialization	Course Code	DLOC I
1	Thermal Engineering and Fluid Science	ME 306	Advanced Fluid Mechanics (T)
2	Design Engineering	ME 307	Design for Excellence (T)
3	Mechatronics & Robotics	ME 308	Signal Processing (T)

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester VI

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract/ Tut	Theory	Pract/ Tut	Total
ME 309	Mechatronics	TL	3	2	3	1	4
ME 310	Machine Design II	T	3	2	3	1	4
ME 311	Engineering Vibrations	T	3	2	3	1	4
ME 3xx	DLOC II	T/TL	3	-	3	-	3
ME 3xx	DLOC III	T/TL	3	-	3	-	3
IL 36x	ILOC I	T	3	-	3	-	3
ME 392	Minor Project IV	LC		4	-	2	2
Total			**18**	**10**	**18**	**5**	**23**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)	Term Work	Pract /Oral	Total
		1	2	Avg					
ME 309	Mechatronics	40	40	40	60	2	25	25	150
ME 310	Machine Design II	40	40	40	60	2	25	25	150
ME 311	Engineering Vibrations	40	40	40	60	2	25	25	150
ME 3xx	DLOC II	40	40	40	60	2	-	-	100
ME 3xx	DLOC III	40	40	40	60	2	-	-	100
IL 36x	ILOC I	40	40	40	60	2	-	-	100
ME 392	Minor Project IV	25 (Mid Sem assessment)			-	-	25	25	75
Total				**265**	**360**	**12**	**100**	**100**	**825**

T- Theory , L- Lab , P-Programming, C- Communication

Group	Department Specialization	Course Code	DLOC II (3)
1	Thermal Engineering and Fluid Science	ME 312	Advanced Heat Transfer (T)
		ME 313	Experimental Methods for Thermal and Fluid Systems (T)
2	Design Engineering	ME 314	Reliability Engineering (T)
		ME 315	Failure Analysis (T)
3	Mechatronics & Robotics	ME 316	Micro Electro Mechanical Systems (T)
		ME 317	Control Systems (T)

Group	Department Specialization	Course Code	DLOC III (3)
4	Materials Science and Nanotechnology	ME 318	Advanced Composites and Polymeric Materials (T)
		ME 319	Biomaterials & Tissue Engineering (T)
5	Manufacturing Engineering	ME 320	Manufacturing Analytics (T)
		ME 321	Optimization Techniques (T)
6	Energy Science and Engineering	ME 322	Wind Energy & Conversion Systems (T)
		ME 323	Thermal Energy Storage Systems and Applications (T)
7	Automotive System	ME 324	Vehicle Systems (T&L)
		ME 325	Automotive Chassis and Body Systems (T)

Group	Institute Specialization	Course Code	ILOC I
1	Business and Entrepreneurship	IL 360	Entrepreneurship (T)
		IL 361	IPR and Patenting (T)
2	Bio Engineering	IL 362	Introduction to Bioengineering (T)
3	Engineering Design	IL 363	Product Design (T)
4	Art and Humanities	IL 364	Visual Art (T)
		IL 365	Journalism, Media and Communication studies (T)
5	Applied Science	IL 366	Computational Physics (T)
		IL 367	Polymers and Polymeric Materials (T)
6	Life Skills, Repair, Maintenance and Safety	IL 368	Vehicle Safety (T)
		IL 369	Maintenance of Electronics Equipment (T)

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester VII

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract/ Tut	Theory	Pract/ Tut	Total
ME 401	Production Planning and Systems	T	3	-	3	-	3
ME 402	Power Engineering	TL	3	2	3	1	4
ME 4xx	DLOC IV	T/TL	3	-	3	-	3
ME 4xx	DLOC V	T/TL	3	2	3	1	4
IL 4xx	ILOC II	T	3	-	3	-	3
ME 491	Major Project I	LC	-	6	-	3	3
Total			**15**	**10**	**15**	**5**	**20**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)	Term Work	Pract /Oral	Total
		1	2	Avg					
ME 401	Production Planning and Systems	40	40	40	60	2	-	-	100
ME 402	Power Engineering	40	40	40	60	2	25	25	150
ME 4xx	DLOC IV	40	40	40	60	2	-	-	100
ME 4xx	DLOC V	40	40	40	60	2	25	25	150
IL 4xx	ILOC II	40	40	40	60	2	-	-	100
ME 491	Major Project I	-	-	-	-	-	50	-	50
Total				**200**	**300**	**10**	**100**	**50**	**650**

T- Theory , L- Lab , P-Programming, C- Communication

Group	Department Specialization	Course Code	DLOC IV (3)
1	Thermal Engineering and Fluid Science	ME 403	Thermal Design of Electronic Equipment (T)
		ME 404	Computational Methods in Thermal Engineering (T)
2	Design Engineering	ME 405	Design of Mechanical Systems (T)
		ME 406	Tribology (T)
3	Mechatronics & Robotics	ME 407	Robotics (T)
		ME 408	Modelling and Simulation (T&L)

Group	Department Specialization	Course Code	DLOC V (4)
4	Materials Science and Nanotechnology	ME 409	Nanotechnology, Nanostructures and Nanomaterials (T)
		ME 410	Electrical, Magnetic and Optoelectronic Materials (T)
5	Manufacturing Engineering	ME 411	Logistics and Supply Chain Management (T)
		ME 412	Quality Engineering (T)
6	Energy Science and Engineering	ME 413	Sustainable/Zero Energy Buildings (T)
		ME 414	Energy Systems Modelling & Analysis (T&L)
7	Automotive System	ME 415	Alternate Fuels and Emissions (T&L)
		ME 416	Automotive Electronics (T&L)

Group	Institute Specialization	Course Code	ILOC II
1	Business and Entrepreneurship	IL 470	E commerce and E business (T)
		IL 471	Business Analytics (T)
2	Bio Engineering	IL 472	Biomedical Instrumentation (T)
3	Engineering Design	IL 473	Design for Sustainability (T)
4	Art and Humanities	IL 474	Political Science (T)
5	Applied Science	IL 475	Research Methodology (T)
6	Life Skills, Repair, Maintenance and Safety	IL 476	Maintenance of Mechanical Equipment (T)
		IL 477	Cooking and Nutrition (T)

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester VIII

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract /Tut	Theory	Pract /Tut	Total
ME 417	Refrigeration and Air Conditioning	TL	3	2	3	1	4
ME 418	Personal Financial Management	T	2	-	2	-	2
ME 4xx	DLOC VI	T/TL	3	2	3	1	4
IL 4xx	ILOC III	T	3		3		3
ME 492	Major Project II	LC	-	12	-	6	6
Total			**11**	**16**	**11**	**8**	**19**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)	Term Work	Pract /Oral	Total
		1	2	Avg					
ME 417	Refrigeration and Air Conditioning	40	40	40	60	2	25	25	150
ME 418	Personal Financial Management	20	20	20	40	2	-	-	60
ME 4xx	DLOC VI	40	40	40	60	2	25	25	150
IL 4xx	ILOC III	40	40	40	60	2	-	-	100
ME 492	Major Project II	-	-	-	-	-	50	100	150
Total				**140**	**220**	**8**	**100**	**150**	**610**

T- Theory , L- Lab , P-Programming, C- Communication

Group	Department Specialization	Course Code	DLOC VI (4)
1	Thermal Engineering and Fluid Science	ME 419	Instrumentation in Thermal Systems (T&L)
2	Design Engineering	ME 420	Synthesis of Mechanisms (T&L)
3	Mechatronics & Robotics	ME 421	Microprocessor and Controllers (T&L)
4	Materials Science and Nanotechnology	ME 422	Characterization Techniques (T&L)
		ME 423	Processing and Testing of Materials (T&L)
5	Manufacturing Engineering	ME 424	Tool Engineering (T)
		ME 425	Additive Manufacturing (T)
6	Energy Science and Engineering	ME 426	Energy Audit and Management (T)
		ME 427	Solar Energy Engineering (T&L)
7	Automotive System	ME 428	Hybrid & Electric Vehicles (T&L)
		ME 429	Vehicle Dynamics and Control (T&L)

Group	Institute Specialization	Course Code	ILOC III
1	Business and Entrepreneurship	IL 480	Digital Business Management and Digital Marketing (T)
2	Bio Engineering	IL 481	Medical Image Processing (T)
3	Engineering Design	IL 482	Technologies for Rural Development (T)
4	Art and Humanities	IL 483	Economics (T)
5	Applied Science	IL 484	GIS and Remote Sensing (T)
6	Life Skills, Repair, Maintenance and Safety	IL 485	Physical Education (T)
		IL 486	Environmental Management (T)

Department Specialization:

Minimum **Two Specialization** to be completed (Minimum **Three** subjects from each.)

Department Specializations						
1	**2**	**3**	**4**	**5**	**6**	**7**
Thermal and Fluids Science	***Design Engineering***	***Mechatronics & Robotics***	***Materials Science & Nanotechnology***	**Manufacturing Engineering**	***Energy Science and Engineering***	***Automotive System***
Advanced Fluid Mechanics (T)	Design for Excellence (T)	Signal Processing (T)	Advanced Composites and Polymeric Materials (T)	Manufacturing Analytics (T)	Wind Energy & Conversion Systems (T)	Vehicle Systems (T&L)
Advanced Heat Transfer (T)	Reliability Engineering (T)	Micro Electro Mechanical Systems (T)	Biomaterials & Tissue Engg (T)	Optimization Techniques (T)	Thermal Energy Storage Systems and Applications (T)	Automotive Chassis and Body Systems (T)
Experimental Methods for Thermal/Fluid Systems (T)	Failure Analysis (T)	Control Systems (T)	Nanotechnology, Nanostructures and Nanomaterials (T)	World Class Manufacturing (T)	Sustainable/Zero Energy Buildings (T)	Alternate Fuels and Emissions (T&L)
Thermal Design of Electronic Equipment (T)	Design of Mechanical Systems (T)	Robotics (T)	Electrical, Magnetic and Optoelectronic Materials (T)	Quality Engineering (T)	Energy Systems Modelling & Analysis (T&L)	Automotive Electronics (T&L)
Computational methods in Thermal Engg (T)	Tribology (T)	Modelling and Simulation (T&L)	Characterization Techniques (T&L)	Tool Engg (T)	Energy Audit and Management (T)	Hybrid & Electric Vehicles (T & L)
Instrumentation in Thermal Systems (T&L)	Synthesis of Mechanisms (T&L)	Microprocessor and Controllers (T&L)	Processing and Testing of Materials (T&L)	Additive Manufacturing (T)	Solar Energy Engineering (T&L)	Vehicle Dynamics and Control (T&L)

Institute Specialization:
Minimum **One Specialization** to be completed (Minimum **Three** subjects from each.)

Institute Specializations					
1	**2**	**3**	**4**	**5**	**6**
Business and Entrepreneurship	***Bio Engineering***	***Engineering Design***	***Art and Humanities***	***Applied Science***	***Life Skills, Repair, Maintenance and Safety***
Entrepreneurship	Introduction to Bioengineering	Product Design	Visual Art	Computational Physics	Vehicle Safety
IPR and Patenting	Biomedical Instrumentation	Design for Sustainability	Journalism, Media and Communication studies	Polymers and Polymeric Materials	Maintenance of Electronics Equipment
E- Commerce and E-Business	Medical Image Processing	Technologies for Rural Development	Political Science	Research Methodology	Maintenance of Mechanical Equipment
Business Analytics			Economics	GIS and Remote Sensing	Cooking and Nutrition
Digital Business Management and Digital Marketing					Physical Education
					Environmental Management

Course Code	Course Name	Credits
ME 101	**Engineering Mathematics I**	**3+1**

Course Objectives:

1. To develop the basic Mathematical skills of engineering students that are imperative for effective understanding of complex numbers and acquaint students with the hyperbolic, logarithmic functions in engineering subjects.
2. To understand the regression analysis and interpolation methods.
3. To understand differentiation and expansions of functions. which will serve as basic tools for specialized studies in many fields of engineering and technology.
4. To learn the partial differentiation techniques and its applications used in engineering problems.
5. To learn the applications of Matrices and eigenvalues and eigenvectors useful in engineering.
6. To provide hands on experience using SCILAB software to handle Mathematical modelling.

Course Outcomes:

Upon successful completion of course learner/student will be able to

1. Apply the basic concept of complex numbers, Hyperbolic and logarithmic functions used to solve problems in engineering.
2. Apply the concept of regression and interpolation in engineering problems.
3. Apply the concept of expansion of functions and successive differentiation.
4. Use the basic concepts of partial differentiation in finding the Maxima and Minima required in engineering problems.
5. Use the concept of matrices in solving the system of equations and eigen values in many areas of research.
6. Apply the concept of numerical Methods for solving the engineering problems with the help of SCILAB software.

Module	Detail Content	Hrs.
1	**Complex Numbers** **Pre-requisite:** Review of Complex Numbers - Algebra of Complex Number, Cartesian, polar and exponential form of complex number. De Moivre's Theorem. 1.1. Applications of De Moivre's Theorem. 1.2. Powers and Roots of complex number. 1.3 Introduction to Hyperbolic and Inverse Hyperbolic functions and simple examples. 1.4 Logarithmic functions, Separation of real and Imaginary parts of Logarithmic Functions	6

2	**Regression Analysis and Correlation** 3.1 Interpolation: - Lagrange's Linear and Quadratic 3.2 Linear Regression, Lines of regression 3.3 Fitting a Regression Line: Method of least squares. 3.4 Karl Pearson's Coefficient of correlation (r) and related concepts, Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems).	6
3	**Successive Differentiation, Expansion of Function** 3.1 Successive differentiation: nth derivative of standard functions 3.2 Taylor's Theorem (Statement only) and Taylor's series, Maclaurin's series (Statement only). Expansion of$e^{\wedge}$ (x), sin(x), cos(x), tan(x), sinh(x), cosh(x), tanh(x), log(1+x), sin−1(x), cos−1 (x), tan−1 (x).	6
4	**Partial Differentiation and Applications of Partial Differentiation.** 4.1 Partial Differentiation: Function of several variables, Partial derivatives of first and higher order. Differentiation of composite function. 4.2.Euler's Theorem on Homogeneous functions with two independent variables (without proof). Deductions from Euler's Theorem. 4.3 Maxima and Minima of a function of two independent variables, Lagrange's method of undetermined multipliers with one constraint. Jacobian of two independent variables.	9
5	**Matrices :-** **Pre-requisite:** Inverse of a matrix, addition, multiplication and transpose of a matrix ,Elementary row and column transformation 5.1.Symmetric, Skew‐ Symmetric, Hermitian, Skew Hermitian,Unitary, Orthogonal Matrices and properties of Matrices (Without Proof). 5.2 Rank of a Matrix using Echelon forms, reduction to normal form and PAQ form. 5.3.System of homogeneous and non –homogeneous equations, their consistency and solutions. 5.4 Eigen values and Eigen vectors of Matrices.	9
6	**Numerical Methods** 6.1 Solution of system of linear algebraic equations, (1) Gauss Elimination,(2) Gauss Jacobi Iteration Method (3) Gauss Seidel Iteration Method, 6.2 Solutions of Transcendental equations (1) Bisection method (2) Secant Method (3) Newton Raphson	6

Theory Assessment:

Internal Assessment (40 marks)

Assessment consists of two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed.

End Semester Examination (60 marks)

1. Question paper will comprise of total 05 questions, each carrying 20 marks.
2. Total 03 questions need to be solved.
3. Question No: 01 will be compulsory and based on the entire syllabus wherein 4 sub-questions of 5 marks each will be asked.

Term Work:

General Instructions:

1. Batch wise practicals are to be conducted. The number of students per batch should be as per norms.
2. Students must be encouraged to write SCILAB Programs in the laboratory. Each Student has to perform at least 4 SCILAB practicals and at least 6 assignments on the entire syllabus.
3. SCILAB Practicals will be based on (i) Gauss Elimination(ii) Gauss Seidel Iteration method (iii) Gauss Jacobi Iteration Method (iv) Bisection method (v) Secant Method (vi) Newton Raphson (vii) Matrices (viii) Maxima and Minima.(At least four).

The distribution of Term Work marks will be as follows –

1. Attendance (Theory, Practicals) : 05 marks
2. Assignments on entire syllabus : 10 marks
3. SCILAB Practicals : 10 marks
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture mentioned in the syllabus.

Text/ References Books:

1. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited, 9thEd.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Matrices, Shanti Narayan, S. Chand publication.
5. Applied Numerical Methods with MATLAB for Engineers and Scientists by Steven Chapra, McGraw Hill .

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Course Code	Course Name	Credits
ME 102	**Engineering Physics I**	**2+0.5**

Course Objectives:

1. To impart knowledge of basic concepts in applied physics and founding principles of technology..
2. To provide the knowledge and methodology necessary for solving problems in the field of engineering.
3. To develop scientific temperament for scientific observations, recording, and inference drawing essential for technology studies.
4. To improve ability to analyze experimental results and write laboratory reports.

Course Outcomes:

Upon successful completion of this course, the learner will be able to

1. Explain the functioning of lasers and their various applications.
2. Able to explain the working principle of optical fibres and their applications especially in the field of communication.
3. Explain the limits of Classical Physics and apply the fundamentals of quantum mechanics to study the one dimensional motion of microscopic particles.
4. Apply the knowledge of superconductivity to SQUID and Magnetic levitation.
5. Apply the reasons for Acoustic defects and use this in the proper design of a Hall/Auditorium and use the knowledge of Piezoelectric and Magnetostriction effect for production of ultrasonic waves and its application in various fields.
6. Apply the knowledge of coordinate systems and vector calculus to various situations. Also the learner will be able to study further as the base is set in this topic.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	**Lasers:** Laser: spontaneous emission and stimulated emission; metastable state, population inversion, types of pumping, resonant cavity, Einstein's equations; Helium Neon laser; Nd:YAG laser; Semiconductor laser, Applications of laser- Holography (construction and reconstruction of holograms) and industrial applications(cutting, welding etc), Applications in the medical field; LIDAR (Light Detection and Ranging)	4
2.	**Optical Fibres:** Working Principle and structure , Numerical Aperture for step index fibre; critical angle; angle of acceptance; V number; number of modes of propagation; types of optical fibres; Applications : Fibre optic communication system; sensors (Pressure, temperature, smoke, water level), applications in the medical field.	4

3.	**Quantum Mechanics:** De Broglie hypothesis of matter waves; properties of matter waves; wave packet, phase velocity and group velocity; Wave function; Physical interpretation of wave function; Heisenberg uncertainty principle; non existence of electron in nucleus; Schrodinger's time dependent wave equation; time independent wave equation; Free electron, Particle trapped in one dimensional infinite potential well, Quantum Computing.	6
4.	**Superconductivity:** Critical temperature, critical magnetic field, Meissner'seffect, Type I and Type II and high Tc superconductors; BCS Theory (concept of Cooper pair); Josephson effect Applications of superconductors- SQUID, MAGLEV	3
5.	**Ultrasonics and Acoustics:** Ultrasonic Wave generation; Magnetostriction Oscillator; Piezoelectric Oscillator; Applications of ultrasonic: Echo sounding; NDT; ultrasonic cleaning(cavitation); ultrasonic sensors; Industrial applications of ultrasonic(soldering, welding, cutting, drilling) Conditions of good acoustics; Reflection of sound(reverberation and echo); absorption of sound; absorption coefficient; Sabine's formula; Acoustic Design of a hall; Common Acoustical defects and acoustic materials	4
6.	**Vector Calculus:** Scalar and vector fields, Cartesian, polar, Cylindrical and Spherical Coordinate system, gradient, curl and divergence in Cartesian coordinate system, Central force, line integral, work energy theorem, surface integral, volume integral, divergence theorem, Continuity Equation, Stoke's theorem, Maxwell's Equations.	4

Laboratory Syllabus:

Sr. No.	List of Experiments (Any Five)	Hrs.
1	Determination of number of lines on the grating surface using LASER Source.	1
2	Determination of Numerical Aperture of an optical fibre.	1
3	Determination of wavelength using Diffraction grating. (Laser source)	1
4	Study of Ultrasonic Distance Meter.	1
5	Determination of angular divergence of laser beam.	1
6	Determination of absorption coefficient of sound of given material.	1
7	To measure the thickness of fine wire and grating element of the given grating with help of Laser source	1

Theory Assessment :

Internal Assessment Test

Assessment consists of two class tests of 30 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed.

End Semester Examination

In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

Laboratory Assessment:

Term work:

Term Work shall consist of a minimum five experiments.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments and Journal) **:** 10 marks
- Project Groupwise or Topic Presentation : 10 marks
- Attendance (Theory and Practical) : 05 marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Books/References:-

1. A text book of Engineering Physics-Avadhanulu & Kshirsagar, S. Chand
2. A textbook of Optics - N. Subramanyam and Brijlal, S.Chand
3. Fundamentals of optics by Jenkins and White, McGrawHill
4. Modern Engineering Physics – Vasudeva, S.Chand
5. Concepts of Modern Physics- ArtherBeiser, Tata McGraw Hill
6. A TextBook of Engineering Physics, S. O. Pillai, New Age International Publishers.
7. Optics - Ajay Ghatak, Tata McGraw Hill8. Introduction to Electrodynamics- D. J. Griffiths, Pearson publication
8. Physics for Engineers, M.R. Srinivasan, New Age International Publishers.

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Course Code	Course Name	Credits
ME 103	**Engineering Chemistry I**	**2+0.5**

Course Objectives:

1. To impart a scientific approach and to familiarize the applications of chemistry in the field of engineering.
2. The student with the knowledge of the basic chemistry, will understand and explain scientifically the various problems related to chemistry in the industry/engineering field.
3. To develop abilities and skills that are relevant to the study and practice of chemistry.

Course Outcomes:

Upon successful completion of course learner/student will be able to:

1. To understand and analyse the combustion mechanisms of various fuels and be able to characterize the fuels for practical purposes.
2. To determine the quality of the lubricants and be able to suggest lubricants for different industrial applications.
3. To become familiarized with corrosion types and the environmental factors affecting corrosion and to suggest the method of corrosion protection.
4. To analyse the quality of water and will be able to suggest methods to improve water quality
5. To apply phase rule to one and two component systems and understand the importance of phase diagrams in material science and engineering..
6. To acquire knowledge about the alloys and the determination of composition of the alloys.

Theory Syllabus:

Module	Detail Content	Hrs.
1	**Fuels and Combustion** **Pre-requisite:** What are fuels, Types of fuels, Characteristics of fuels. Calorific value of a fuel - HCV and LCV, Theoretical determination of calorific value of fuel by Dulong's formula, Numerical problems Solid fuels : Coal, Analysis of coal - Proximate and Ultimate analysis, Numerical problems Liquid fuels: Composition and refining, Knocking, Octane number, Cetane number, Biodiesel Gaseous Fuels: LPG and CNG Combustion of fuels – Numerical problems for calculating the amount of air needed for the complete combustion of solid and gaseous fuels. Limitations of fossil fuels. Alternate and non conventional energy sources- solar, wind, hydropower and biomass	6

2	**Lubricants** **Pre - requisites** : Definition of Lubricants and Lubrication, functions of lubricants Mechanisms of lubrication – Thick film, Thin film and Extreme pressure Classification of lubricants - Solid (MoS_2, graphite), Semi solid (greases), Liquid (animal/vegetable oils, mineral oils, synthetic oils) Properties of lubricants and their significance - Viscosity and Viscosity Index, Flash and Fire Points, Cloud and Pour Points, Acid Number, Saponification Number, Steam Emulsification Number and related numerical problems.	3
3	**Corrosion and its Control** **Pre-requisite:-** corrosion , corrosion product, electrochemical series, corrosive and non corrosive metals. Mechanism of corrosion - Chemical and Electrochemical corrosion. Types of corrosion : Galvanic corrosion, Differential aeration corrosion, Pitting corrosion, Intergranular corrosion, Waterline corrosion, Stress corrosion. Factors Affecting Corrosion Rate : - (i) Nature of metal, (ii) Nature of environment. Methods of mitigating corrosion : Material selection, Design, Cathodic protection, Anodic protection Protective Coatings: Metallic coatings anodic coating (galvanizing) and cathodic coating (Tinning), Different Methods of Applying Metallic Coatings, Organic coatings	6
4	**Water and its Treatment** **Pre-requisite** : Knowledge of sources of water, Possible impurities in water, Characteristics imparted by impurities in water. Hardness in water – types & its units, Determination of hardness by EDTA method, and numerical problems. Effects of Hard water in boilers - Priming and Foaming, Scales and Sludges, Boiler corrosion, caustic embrittlement, Softening of water- Ion exchange process. Desalination of brackish water- Reverse Osmosis, Electrodialysis, Ultrafiltration	4
5	**Phase Rule** Gibbs Phase Rule - Introduction, definition of terms with examples, One component system (Water system), Reduced Phase rule, Two component system (Pb-Ag system) , Limitations of phase rule.	3
6	**Alloys** Introduction to Alloys, Plain Carbon Steel and Alloy Steels Alloys of Cu, Al and Pb	2

List of Experiments:

Experiment	Detail Content	Hrs.
1	Determination of Hardness in water	1
2	Determination of Viscosity of oil by Redwood Viscometer	1
3	Determination of Flash point of a lubricant using Abel's apparatus	1
4	Determination of Acid Value and Saponification Value of an oil.	1
5	Determination of Chloride content of water by Mohr's Method	1
6	Determination of moisture content and volatile matter in coal sample.	1
7	Study of the effect of different environments (Acid, Base) on corrosion rate.	1
8	Determination of COD Value of water.	1
9	Removal of hardness using ion exchange column.	1
10	Determination of Iron in Plain Carbon Steel.	1

Theory Assessment

Internal Assessment Test (30 marks)

Assessment consists of two class tests of 30 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed.

End Semester Examination (45 marks)

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprises of 3 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

Term work:

Term Work shall consist of minimum five experiments.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments and Journal) : 10 marks
- Assignments and Viva on modules : 10 marks
- Attendance (Theory and Tutorial) : 05 marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Text books/Reference Books:

1. Engineering Chemistry – P.C.Jain and Monika Jain, Dhanpat Rai Publications
2. A Textbook of Engineering Chemistry, - Shashi Chawla (DhanpatRai publications)
3. A textbook of Engineering Chemistry - S.S. Dara, S. Chand Publishing House
4. Engineering Chemistry – Wiley India (ISBN-9788126519880)
5. Essentials of Physical Chemistry - Arun Bahl, B.S. Bahl and G.D. Tuli ,
6. Textbook on Experimental and calculations in Engineering Chemistry – S.S. Dara S. Chand Publishing House
7. Experiments in Engineering Chemistry – I.K International Publishing House

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Course Code	Course Name	Credits
ME 104	**Engineering Mechanics**	**3+1**

Course Objectives:

1. To develop the capacity to predict the effects of force and motion and to acquaint the concept of static and dynamic equilibrium.
2. Ability to visualize physical configurations in terms of actual systems and it's constraints, and able to formulate the mathematical function of the system.
3. To study, analyse and formulate the motion of moving particles/bodies.

Course Outcomes:

On successful completion of course learner/student will be able to:

1. Illustrate the concept of force, moment and apply the same along with the concept of equilibrium in two and three dimensional systems with the help of FBD.
2. Determine the centroid and MI of plane lamina.
3. Makes the students able to apply equilibrium equations in statics.
4. Evaluate co-efficient of friction between the different surfaces in contact.
5. Establish relation between velocity and acceleration of a particle and analyze the motion by plotting the relation.
6. The ability to understand Newton's law in motion, and recognize different kinds of particle motions.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	**Coplanar Force System and Resultant:** 1.1.System of Coplanar Forces: Classification of force systems, Principle of transmissibility, composition and resolution of forces. 1.2.Resultant: Resultant of coplanar force system (Concurrent forces, parallel forces and non-concurrent Non-parallel system of forces). Moment of force about a point, Couples, Varignon's Theorem. Force couple system. Distributed Forces in plane. 1.3.Equilibrium of System of Coplanar Forces and Beams: Conditions of equilibrium for concurrent forces, parallel forces and non-concurrent non- parallel general forces and Couples. Equilibrium of rigid bodies free body diagrams. Types of beams, simple and compound beams, type of supports and reaction. Determination of reactions at supports for various types of loads on beams. (Including problems on internal hinges)	08
2.	**Centroid and MI:** 2.1 First moment of Area, Centroid of composite plane Laminas 2.2 Second moment of Area, MI of composite plane Laminas	05
3.	**Forces in Space:** 3.1 System of Non-Coplanar Force System 3.2 Resultant of Non-Coplanar Force System	05
4.	**Friction:** 4.1 Static and Dynamic Friction: Systems of Statics and Dynamic/ Kinetic Friction, Coefficient of Friction, Angle of Friction, Laws of friction. Concept of Cone of friction.	06

	4.2 Wedge Friction: Equilibrium of bodies on inclined plane. Application to problems involving wedges and ladders. 4.3 Rope and Belt Friction: Block Friction including Rope and Belt Friction.	
5.	**Kinematics of Particle and Rigid Body:** 5.1 Kinematics of Particle and Rigid Body: Motion of particle with variable acceleration. General curvilinear motion. Tangential& Normal component of acceleration, Motion curves (a-t, v-t, s-t curves). Application of concepts of projectile motion and related numerical. 5.2 Kinematics of Rigid Body: Translation, Rotation and General Plane motion of Rigid body. The concept of Instantaneous center of rotation (ICR) for the velocity. Location of ICR of mechanism. Velocity analysis of rigid body using ICR	06
6	**Kinetics of a Particle:** 6.1 Kinetics of a Particle: Force and Acceleration: -Introduction to basic concepts, D'Alemberts Principle, concept of Inertia force, Equations of dynamic equilibrium, Newton's second law of motion. (Analysis limited to simple systems only.) 6.2 Kinetics of a Particle: Work and Energy: Work Energy principle for a particle in motion. Application of Work – Energy principle to a system consists of connected masses and Springs. 6.3 Kinetics of a Particle: Impulse and Momentum: Principle of linear impulse and momentum. Impact and collision: Law of conservation of momentum, Coefficient of Restitution. Direct Central Impact and Oblique Central Impact. Loss of Kinetic Energy in collision of inelastic bodies.	06

Laboratory Syllabus:

Practical	Details	Hours
1	Verification of Polygon law of coplanar forces	2
2	Verification of Principle of Moments (Bell crank lever.)	2
3	Determination of support reactions of a Simply Supported Beam.	2
4	Determination of coefficient of friction) using inclined plane	2
5	Collision of elastic bodies (Law of conservation of momentum).	2
6	Kinematics of particles. (Uniform motion of a particle, Projectile motion, motion under gravity)	2
7	Kinetics of particles. (collision of bodies)	2

Theory Assessment:

Internal Assessment for 40 marks:

Assessment consists of two class tests of 40 marks each.

The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed.

End Semester Examination: 60 Marks

1. Question paper will comprise of total 06 questions, each carrying 15 marks.
2. 10 percent of marks will be asked from the self-study topics.
3. Total 04 questions need to be solved.
4. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.

6. Remaining questions will be mixed in nature. (e.g. Suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
7. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

Laboratory Assessment:
Internal Assessment for 25 marks:
Term Work:
It comprises Laboratory Experiments and Assignments.
The distribution of marks for term work shall be as follows:

Practical Work and Journal	: 10 marks.
Assignments	: 10 marks.
Attendance	: 05 Marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.
End Semester Practical/Oral Examination: 25 Marks
Pair of Internal and External Examiner should conduct practical/viva based on entire syllabus.

Books/References:

1. Engineering Mechanics by Beer &Johnston, Tata McGrawHill
2. Engineering Mechanics (Statics) by Meriam and Kraige, WileyBools
3. Engineering Mechanics (Dynamics) by Meriam and Kraige, WileyBools
4. Engineering Mechanics by F. L. Singer, Harper& RawPublication
5. Engineering Mechanics by ShaumSeries

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Course Code	Course Name	Credits
ME 105	**Basic Electrical and Electronics Engineering**	**3+1**

Course Objectives:
The course is aimed

1. To provide knowledge on fundamentals of D.C. circuits and its applications
2. To impart knowledge on fundamentals of 1-Φ A.C. circuits and its applications.
3. To impart knowledge on fundamentals of 3-Φ A.C. circuits and its applications.
4. To provide knowledge on fundamentals of DC machines.
5. To impart knowledge of Basic Electronics circuits

Course Outcomes:
On successful completion of course learner/student will be able to

1. To evaluate D.C. circuits using network theorems.
2. Apply the concept of ac circuit and its resonance phenomena for a given RL, RC and RLC circuit.
3. To evaluate 3-Φ AC circuits.
4. To illustrate the working principle of DC machines.
5. To apply the concept of rectification.

Theory Syllabus:

Module	Detail Content	Hrs.
1	**DC Circuits** Kirchhoff 's laws, Ideal and practical voltage and current source, Mesh and Nodal analysis (super node and super mesh excluded), Source transformation, Star-delta transformation, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, (Source transformation not allowed for Superposition theorem, Mesh and Nodal analysis)	12
2	**AC Circuits** Generation of alternating voltage and currents, RMS and Average value, form factor , crest factor, AC through resistance, inductance and capacitance, R-L , R-C and R-L-C series and parallel circuits, phasor diagrams, power and power factor, series and parallel resonance, Q-factor	12
3	**Three Phase AC Circuits** Three phase voltage and current generation, star and delta connections (balanced load only), relationship between phase and line currents and voltages, Phasor diagrams, Basic principle of wattmeter, measurement of power by two wattmeter method .	6
4	**Electrical Machines (No Numericals)** Principle of operation of DC motors and DC generators, construction and classification of DC machines, emf equation.	3
5	**Basic Electronics** Semiconductor diode, Diode rectifier with R load: Half wave, full wave-center tapped and bridge configuration, RMS value and average value of output voltage, ripple factor, rectification efficiency,	3

	introduction to C and L filter (no derivation).CE, CB, CC transistor configuration, CE input-output characteristics	

Laboratory Syllabus:

Experiment	Details	Hours
1	Mesh and Nodal analysis	2
2	Verification of Superposition Theorem.	2
3	Verification Thevenin's Theorem.	2
4	Study of R-L series and R-C series circuit.	2
5	R-L-C series resonance circuit	2
6	R-L-C parallel resonance circuit	2
7	Relationship between phase and line currents and voltages in three phase system (star & delta)	2
8	Power and phase measurement in a three phase system by one wattmeter method	2
9	Power and phase measurement in a three phase system by two wattmeter methods.	2
10	Speed Control of DC motors.	2
11	Speed Control of Induction motors.	2
12	Half wave and Full wave rectifier .	2

Theory Assessment:
Internal Assessment : 40 marks
Assessment consists of two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed.
End Semester Examination: 60 marks

1. Question paper will comprise of total 05 questions, each carrying 20 marks.
2. Total 03 questions need to be solved.
3. Question No: 01 will be compulsory and based on the entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture mentioned in the syllabus.

Lab Assessment:
Term Work:
General Instructions:
Term work consists of performing minimum 06 practicals . Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.
The distribution of Term Work marks will be as follows –

1. Attendance (Theory, Practicals) : 05 marks
2. Assignments on entire syllabus : 10 marks
3. Practicals : 10 marks

End Semester Oral Examination:
Pair of Examiners should conduct Viva based on contents of the entire syllabus.
Oral Examination will be for 25 Marks

Books/References:

1. B.L.Theraja “Electrical Technology” Vol-I and II, S. Chand Publications, 23 rd ed. 2003.
2. Joseph A Edminister, “Schaum‟s outline of theory and problems of electric circuits” Tata McGraw Hill, 2 nd edition
3. Electronics Devices & Circuit Theory" by Boylestad, Pearson Education India
4. D P Kothari and I J Nagrath “Theory and Problems of Basic Electrical Engineering”, PHI 13 th edition 2011.

Back To Scheme

Course Code	Course Name	Credits
ME 106	**Basic Engineering Workshop I**	**1.5**

Course Objectives:

1. To impart training to help the students develop engineering skill sets.
2. To inculcate respect for physical work and hard labor.
3. To get exposure to interdisciplinary engineering domain.

Course Outcomes:

Learners will be able to

1. Develop the necessary skill required to handle/use different fitting tools.
2. Develop skill required for hardware maintenance.
3. Able to install an operating system and system drives.
4. Able to identify the network components and perform basic networking and crimping.
5. Able to prepare the edges of jobs and do simple arc welding.
6. Develop the necessary skill required to handle/use different plumping tools.
7. Demonstrate the turning operation with the help of a simple job.

Trade Nos.	**Detailed Content**	**Hrs.**
Note: Trade 1 and 2 are compulsory. Select any ONE trade topics out of the topic at trade 3 to 5. Demonstrations and hands on experience to be provided during the periods allotted for the same. Report on the demonstration including suitable sketches is also to be included in the term work. CO-1 is related to Trade-1, CO-2 to CO-4 is related to Trade-2 CO-5 is related to Trade-3, CO-6 is related to Trade-4 CO-7 is related to Trade-5 CO evaluation is to be done according to the opted Trades in addition to **Compulsory Trades.**		
Trade-1	**Fitting (Compulsory):** • Use and setting of fitting tools for chipping, cutting, filing, marking, center punching, drilling, tapping. • Term work to include one job involving following operations : filing to size, one simple male- female joint, drilling and tapping	10
Trade-2	**Hardware and Networking: (Compulsory)** • Dismantling of a Personal Computer (PC), Identification of Components of a PC such as power supply, motherboard, processor, hard disk, memory (RAM, ROM), CMOS battery, CD drive, monitor, keyboard, mouse, printer, scanner, pen drives, disk drives etc. • Assembling of PC, Installation of Operating System (Any one) and Device drivers, Boot-up sequence. Installation of application software (at least one) • Basic troubleshooting and maintenance • Identification of network components: LAN card, wireless card, switch, hub, router, different types of network cables (straight cables, crossover cables, rollover cables) Basic networking and crimping. NOTE: Hands on experience to be given in a group of not more than four students	08

Trade-3	**Welding:*** • Edge preparation for welding jobs. Arc welding for different job like, Lap welding of two plates, butt welding of plates with simple cover, arc welding to join plates at right angles.	06
Trade 4	**Plumbing*:** • Use of plumbing tools, spanners, wrenches, threading dies, demonstration of preparation of a domestic line involving fixing of a water tap and use of coupling, elbow, tee, and union etc.	06
Trade-5	**Machine Shop*:** • At least one turning job is to be demonstrated and simple job to be made for Term Work in a group of 4 students.	06

* Optional trade can choose one trade out of 3,4 and 5

Laboratory Assessment
Internal Assessment: 50 marks
Term Work:

1. All the jobs mentioned above
2. Complete Work-Shop Book giving details of drawing of the job and time sheet

The distribution of marks for Term work shall be as follows:

Job Work : 30 marks
Workshop book : 10 marks
Attendance : 10 marks

Books/References:

1. Workshop Technology by H K Hajara Choudhary
2. Manufacturing Technology by R C Jain
3. Workshop Technology by R S Khurmi and J S Gupta
4. Workshop Technology by Chapman.

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Course Code	Course Name	Credits
ME 107	**Engineering Mathematics II**	**3+1**

Course Objectives:

1. To develop the basic mathematical skills of differential equations of engineering students
2. To understand the linear differential equation with constant coefficients used in mathematical modelling.
3. To acquaint the students with the Beta, Gamma functions and DUIS.
4. To learn different techniques to solve double and triple integrations.
5. To learn the concept of vector differentiation and Integration.
6. To provide knowledge of numerical techniques using SCILAB software to handle Mathematical modelling.

Course Outcomes:

Upon successful completion of course learner/student will be able to

1. Apply the basic concept of linear differential equations to solve problems in engineering.
2. Apply the basic concept of applications of higher order differential equations in mathematical modelling to solve real life problems.
3. Apply the basic concepts of beta, gamma and DUIS to solve engineering problems.
4. Apply the concept of double and triple integration in solving problems of engineering and technology.
5. Apply the concept of vector differentiation and Integration in optimization.
6. Apply the concept of differentiation and integration numerically for solving the engineering problems with the help of SCILAB software.

Module	Detail Content	Hrs.
1	**Differential Equations of First Order and First Degree** 1.1 Exact differential Equations, Equations reducible to exact form by using integrating factors. 1.2 Linear differential equations, equation reducible to linear form. 1.3 Application of differential equation of first order and first degree in engineering.	6
2	**Linear Differential Equations With Constant Coefficients and Variable coefficients of higher order.:-** 2.1 Linear Differential Equation with constant coefficient- complementary function, particular integrals of differential equation of the type f(D)y = X where X is *e ^ax* , sin(*ax + b*) , cos (*ax + b*), *x*^n, *e ^ax V*, *x V*. 2.2 Cauchy Differential equation, Method of variation of parameters two variables	7
3	**Beta and Gamma Function, Differentiation under Integral sign** 3.1 Beta and Gamma functions and its properties. 3.2 Differentiation under integral sign with constant limits of integration(One parameter).	6
4	**Double Integration:-** Prerequisite:Tracing of curves 4.1 Double integration- Evaluation of Double Integrals. (Cartesian & Polar),Change of order of Integration and evaluation	8

	4.2 Evaluation of double integrals by changing to polar coordinates. 4.3. Triple integration**:** Evaluation (Cartesian, cylindrical and spherical polar coordinates)	
5	**Vector Differentiation and Integration** 3.1 Vector function of scalar quantities, Vector operator del, Gradient, Divergence, Curl and their physical interpretation and Laplacian 3.2 Directional derivatives , Solenoidal and irrotational (conservative) vector fields. 3.3 Line integrals – definition and problems, circulation, work done, Engineering applications of Line integral.	6
6	**Numerical Techniques:-** 6.1 Numerical solution of ordinary differential equation (a) Euler's method (b) Modified Euler method, (c)Runge‑Kutta fourth order method 6.2 Numerical integration (a) Trapezoidal (b) Simpson's 1/3rd (c) Simpson's 3/8th rule	6

Theory Assessment:

Internal Assessment (40 marks)

Assessment consists of two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed.

End Semester Examination: (60 marks)

1. Question paper will comprise of a total 05 questions, each carrying 20 marks.
2. Total 03 questions need to be solved.
3. Question No: 01 will be compulsory and based on the entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture mentioned in the syllabus.

Term Work:

General Instructions:

1. Batch wise practicals are to be conducted. The number of students per batch should be as per norms.
2. Students must be encouraged to write SCILAB Programs in the laboratory. Each Student has to perform at least 4 SCILAB practicals and at least 6 assignments on the entire syllabus.
3. SCILAB Practicals will be based on (i) Euler's method (ii) Modified Euler method, (iii)Runge‑Kutta fourth order method (iv) Trapezoidal (v) Simpson's 1/3rd (vi) Simpson's 3/8th rule(vii) Differential equations (viii) Integratio.(At least four)

The distribution of Term Work marks will be as follows –

1. Attendance (Theory,Tutorial and Practicals) : 05 marks
2. Class assignments on entire syllabus : 10 marks
3. SCILAB Practicals : 10 marks

Books/References:

1. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited, 9thEd.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Applied Numerical Methods with MATLAB for Engineers and Scientists by Steven Chapra, McGraw Hill .

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Course Code	Course Name	Credits
ME 108	**Engineering Physics II**	**2+0.5**

Course Objectives:

1. To impart knowledge of basic concepts in applied physics and founding principles of technology.
2. To provide the knowledge and methodology necessary for solving problems in the field of engineering.
3. To develop scientific temperament for scientific observations, recording, and inference drawing essential for technology studies.
4. To improve ability to analyze experimental results and write laboratory reports.

Course Outcomes:

Upon successful completion of this course, the learner will be able to

1. Able to understand fundamental concepts of classical optics and applications of interference in science and technology.
2. Able to understand fundamental concept of diffraction of light and its applications
3. To comprehend the basic concepts of semiconductor physics and apply the same to electronic devices.
4. Apply the concepts of crystallography and to use XRD techniques for analysis of crystal structure .
5. Comprehend the properties of Supercapacitors to apply them in novel applications.
6. Comprehend the significance of nanoscience and nanotechnology and its current and futuristic frontier applications.

Theory syllabus:

Module	Detail Content	Hrs.
1.	**Thin Film Interference :** Interference by division of amplitude and by division of wave front; Interference in thin film of constant thickness due to reflected and transmitted light; origin of colours in thin film; Wedge shaped film(angle of wedge and thickness measurement); Newton's rings Applications of interference - Determination of thickness of very thin wire or foil; determination of refractive index of liquid; wavelength of incident light; radius of curvature of lens; testing of surface flatness; Anti-reflecting films and Highly reflecting film.	5
2.	**Diffraction of light:** Fraunhoffer diffraction at single slit, Fraunhoffer diffraction at double slit, Diffraction Grating, Resolving power of a grating, dispersive power of a grating Application of Diffraction - Determination of wavelength of light with a plane transmission grating.	4
3.	**Physics of semiconductor Devices:** Splitting of energy levels for band formation; Classification of semiconductors(direct & indirect band gap, elemental and compound); Conductivity, mobility, current density (drift & diffusion) in semiconductors(n type and p type); p-n junction Diode (unbiased, forward bias, reverse bias); Breakdown mechanism (zener & avalanche), Hall Effect.	5

	Applications of semiconductors: Rectifier diode, LED, Zener diode, Photo diode, Photovoltaic cell, BJT, FET, SCR., MOSFET	
4.	**Crystallography and X-Ray Diffraction Techniques:** Introduction to crystallography, Miller indices of crystallographic planes & directions; interplanar spacing; X-ray diffraction and Bragg's law; Determination of Crystal structure using Bragg's diffractometer; Frenkel and Schotkey crystal defects. EDAX technique for determination of elemental composition	4
5.	**Supercapacitors, Fuel cells and Hydrogen storage:** Principle, construction, materials and applications, comparison with capacitor and batteries : Energy density, Power density. Concept of Hydrogen adsorption/ desorption, techniques for determination of BET (Brunauer-Emmett-Teller) pore surface area, Adsorption/desorption isotherms	4
6.	**Nanoscience and Nanotechnology:** Introduction to nano-science and nanotechnology, Surface to volume ratio, Two main approaches in nanotechnology -Bottom up technique and top down technique; Important tools in nanotechnology such as Scanning Electron Microscope,Transmission Electron Microscope, Atomic Force Microscope. Nano materials: Methods to synthesize nanomaterials (Ball milling, Sputtering, Physical Vapour deposition, sol gel), properties and applications of nanomaterials.	3

Laboratory Syllabus:

Sr. No.	Title of the Experiment (Any Five)	Hrs.
1	Determination of radius of curvature of a lens using Newton's ring set up	1
2	Determination of diameter of wire/hair or thickness of paper using Wedge shape film method and estimation of Young's modulus of the material.	1
3	Determination of width of a slit using single slit diffraction experiment (laser source)	1
4	Study of Miller Indices, Plane and direction.	1
5	Study of Hall Effect.	1
6	Determination of energy band gap of semiconductor.	1
7	Study of I-V characteristics of light emitting diodes(LED).	1
8	Determination of 'h' using Photocell.	1
9	Study of I-V characteristics of semiconductor photodiode and determination of its spectral response.	1
10	Study of I-V characteristics of a photovoltaic solar cell and finding the efficiency.	1
11	Zener diode as a voltage regulator.	1

Theory Assessment:

Internal Assessment Test

Assessment consists of two class tests of 30 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed.

End Semester Examination

In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

Laboratory Assessment

Term work:

Term Work shall consist of a minimum five experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments and Journal) **:** 10 marks
Project Groupwise or Topic Presentation : 10 marks
Attendance (Theory and Practical) : 05 marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Textbook/Reference Books:

1. A text book of Engineering Physics-Avadhanulu & Kshirsagar, S. Chand
2. A textbook of Optics - N. Subramanyam and Brijlal, S.Chand
3. Fundamentals of optics by Jenkins and White, McGrawHill
4. Modern Engineering Physics – Vasudeva, S.Chand
5. Concepts of Modern Physics- ArtherBeiser, Tata McGraw Hill
6. A TextBook of Engineering Physics, S. O. Pillai, New Age International Publishers.
7. Optics - Ajay Ghatak, Tata McGraw Hill
8. Introduction to Nanotechnology- Charles P. Poole, Jr., Frank J. Owens, Wiley India edition
9. Solid State Electronic Devices- B. G. Streetman, Prentice Hall Publisher
10. Introduction to Solid State Physics- C. Kittel, John Wiley& Sons publisher
11. Ultracapacitors: The future of energy storage- R.P Deshpande, McGraw Hill
12. Nanotechnology: Principles and Practices, Dr. S.K. Kulkarni, Capital Publishing Company.
13. Physics for Engineers, M.R. Srinivasan, New Age International Publishers.

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Course Code	Course Name	Credits
ME 109	**Engineering Chemistry II**	**2+0.5**

Course objectives:

1. With the knowledge of the basic chemistry, the student will be able to understand and explain scientifically the various chemistry related problems in the industry/engineering field.
2. The student will be able to understand the new developments and breakthroughs efficiently in engineering and technology.

Course outcomes: Upon successful completion students will be able to

1. To recognize the electrochemical processes and determine the cell potentials in various electrochemical systems.
2. To develop knowledge on electrochemical energy storage systems and familiarization with the characterization methods of batteries.
3. To identify various polymeric materials and to determine polymer molecular weights from different types of experiments.
4. To acquire theoretical background of different classes of materials used in engineering applications and would be able to choose the right materials for specific applications
5. To describe the theoretical background of spectroscopic techniques such as NMR, IR, UV spectroscopy.
6. To assess the environmental impact and understand discuss some mitigation strategies.

Theory Syllabus:

Module	Detail Content	Hrs.
1	**Engineering Electrochemistry** Pre-requisite: redox reaction, cell reaction, electrode and its type, salt bridge, Electrode potential, electrode reaction, derivation of Nernst equation for single electrode potential, numerical problems. Types of Electrochemical cells Reference electrodes - Introduction, Construction, working of SHE, Calomel electrode.	3
2	**Battery Technology** Pre- requisite : Electrochemical Reactions, Cell potential, Electrochemical series Introduction, classification – primary, secondary and reserve batteries. Characteristics – Capacity, Electricity storage density, energy efficiency, cycle life and shelf life. Construction, working and applications of Lead – Acid Storage cell Lithium batteries - Introduction, construction, working and applications of Li-MnO2 Fuel Cells: Introduction, classification of fuel cells, limitations & advantages of fuel cells, Construction of Hydrogen oxygen alkaline fuel cells.	4
3	**Polymeric Materials** Pre - requisite : Polymer, Monomer, Polymerization, Degree of polymerisation, Classification of polymers, Mechanism of polymerisation.	6

	Molecular weight of polymers: number average and weight average, numerical problems. , Polydispersity Index, Polymer crystallinity - glass transition temperature and its significance Compounding and Processing of Polymers Preparation , properties and uses of PMMA, Kevlar, Urea- Formaldehyde Elastomers: Natural rubber and vulcanized rubber, mechanism of vulcanization.	
4	**Advanced Engineering Materials** **4.1 Nanomaterials** Pre-requisite: Concept of nano scale, definition of nanoparticles Importance of nano size, Properties of nanomaterials – Size, optical properties, magnetic properties, electrical properties Nanoscale materials- carbon nanotubes, nano wires, fullerenes. Synthesis of Nanoparticles by Chemical vapor deposition (CVD) method and Laser Ablation Method Applications of nano materials **4.2 Composite Materials** Pre requisite : Definition and basic understanding of composite materials. Constitution of composite materials- Matrix and Dispersed phase Particle reinforced composites, Fibre reinforced composites, structural composites - properties and applications. Factors affecting the dispersion of nanoparticles in the matrix **4.3 Smart Materials** Shape Memory Alloys and Applications	6
5	**Spectroscopic Techniques** Pre-requisites **:** Electromagnetic radiation, characteristics of electromagnetic radiation, electromagnetic spectrum. Spectroscopy - Principle, Interaction of radiation with matter, Selection rules. Types of spectroscopy,: IR, UV, NMR, Emission Spectroscopy, (Flame Photometry), Fluorescence and Phosphorescence, Jablonski diagram	3
6	**Environmental And Green Chemistry** Pre- requisites: Definition of Environment and Primary concept of environmental pollution**.** Concept and Scope of Environmental Chemistry. Environmental Pollution and Control - Industrial Waste pollution Water Pollution - BOD and COD, determination and numerical problems. Concept of 12 principles of Green chemistry, discussion with examples, numericals on atom economy.	2

List of Experiments

Experiment	Details	Hrs.
1	Determination of Cell potential of Zn- Cu system	1
2	Molecular weight determination of polymers by Oswald Viscometer	1
3	Preparation of Urea Formaldehyde	1
4	Preparation of biodegradable polymer using corn starch or potato starch.	1
5	Preparation of Magnetic Nanoparticles.	1
6	Synthesis of Biodiesel	1

7	Determination of electrical conductivity of unknown solution.	1
8	Preparation of Hand Sanitizer using ethyl alcohol	1
9	Determination of Caffeine in Tea	1
10	Determination of pH using glass electrode.	1

Theory Assessment

Internal Assessment: 30 marks

Assessment consists of two class tests of 30 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed.

End Semester Examination: 45 marks

In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

Term work:

Term Work shall consist of a minimum five experiments.

The distribution of marks for term work shall be as follows:

· Laboratory work (Experiments and Journal) : 10 marks
· Assignments and Viva on modules : 10 marks
· Attendance (Theory and Tutorial) : 05 marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Text books/Reference Books:

1. Engineering Chemistry – P.C.Jain and Monika Jain, Dhanpat Rai Publications
2. A Textbook of Engineering Chemistry, - Shashi Chawla (DhanpatRai publications)
3. A textbook of Engineering Chemistry - S.S. Dara, S. Chand Publishing House
4. Engineering Chemistry – O.G. Palanna , Tata Mc Graw Hill
5. Environmental Chemistry – A.K.De, New Age International
6. Fundamentals of Molecular Spectroscopy – C.N . Banwell, Tata Mc Graw Hill
7. Instrumental methods of chemical analysis – B.K.Sharma, Goel Publishing House
8. Textbook on Experimental and calculations in Engineering Chemistry – S.S. Dara S. Chand Publishing House
9. Experiments in Engineering Chemistry – I.K International Publishing House

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Course Code	Course Name	Credits
ME 110	**Engineering Drawing**	**2+2**

Course Objectives:

1. To develop graphic skills for communication of concepts, ideas and design of engineering products.
2. To impart and inculcate proper understanding of the theory of projection.
3. To impart the knowledge of reading a drawing
4. To improve the visualization skill.
5. To teach basic utility of Computer Aided drafting (CAD) tool

Course Outcomes:

Upon successful completion of this course, learner will be able to

1. Apply the basic principles of projections in Projection of Lines and Planes
2. Apply the basic principles of projections in Projection of Solids.
3. Apply the basic principles of sectional views in Section of solids and development of surfaces.
4. Apply the basic principles of projections in converting 3D view to 2D drawing.
5. Read a given drawing and visualize an object from the given two views.
6. Apply basic AutoCAD skills to draw different views of a 3D object.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	**Introduction to Engineering Graphics** Principles of Engineering Graphics and their significance, usage of Drawing instruments, Types of Lines, Dimensioning Systems as per IS conventions. Introduction to plain and diagonal scales. **Engineering Curves** Basic construction of Cycloid, Involutes and Helix (of cylinder) only.	1 3
2.	**Projection of Points and Lines** Lines inclined to both the Reference Planes (Excluding Traces of lines) and simple application based problems on Projection of lines. **Projection of Planes** Triangular, Square, Rectangular, Pentagonal, Hexagonal and Circular planes inclined to either HP or VP only. (Exclude composite planes).	3 2
3.	**Projection of Solids** (Prism, Pyramid, Cylinder, Cone only) Solid projection with the axis inclined to HP and VP. (Exclude Spheres, Composite, Hollow solids and frustum of solids). Use change of position or Auxiliary plane method	6
4.	**Section of Solids** Section of Prism, Pyramid, Cylinder, & Cone cut by plane perpendicular to at least one reference plane (Exclude Curved Section Plane). Use change of position or Auxiliary plane method. **Development of Lateral Surfaces** Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.	4 2
5.	**Orthographic and Sectional Orthographic Projections: -** Fundamentals of orthographic projections. Different views of a simple	4

	machine part as per the first angle projection method recommended by I.S. Full or Half Sectional views of the Simple Machine parts. **Missing Views:** The identification of missing views from the given views. Create the third view from the two available views so that all the details of the object are obtained.	2
6	**Isometric Views:-** Principles of Isometric projection – Isometric Scale, Isometric Views, Conversion of Orthographic Views to Isometric Views (Excluding Sphere).	3

Laboratory Syllabus:

Component-1: (Use half Imperial Drawing Sheet)

Sr. No.	Activities to be completed in the Drawing Laboratory.	Hrs.
1	One Practice sheet on projection of solids(minimum 2 problems)	4
2	Sheet 1: Projection of Solids (3 Problems).	4
3	One Practice sheet on Section of Solids. (minimum 2 problems) # Term Sheet 2: Section of solids. (3 problems).	6
4	One practice sheet on Orthographic projection. (minimum 1 problem) # Term Sheet 3: Orthographic Projection (With section 1 problem, without section 1 problem).	6
5	One practice sheet on Isometric drawing. (minimum 2 problems) # Term Sheet 4: Isometric Projection. (3 problems).	4

Component-2 : Self-study problems/ Assignment: (In A3 size Sketch book, to be submitted as part of Term Work)

1. Engineering Curves. (2 problems)
2. Projection of Lines (2 problems)
3. Projection of planes (2 problems)
4. Projection of solids. (2 problems)
5. Section of solids (2 problems)
6. Orthographic Projection. (With section 1 problem, without section 1 problem).
7. Missing views. (1 problem)
8. Isometric Drawing. (2 problems)

Component-3 : Computer Graphics: Engineering Graphics Software - Orthographic Projections, Isometric Projections, Co-ordinate Systems, Multi-view Projection.

Part	To be Taught in laboratory	Hrs.
Part - A	**Overview of Computer Graphics Covering:** Listing the computer technologies that impact on graphical communication, demonstrating knowledge of the theory of CAD software such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.	3
	Customization & CAD Drawing: Consisting of set up of the drawing page and the printer including scale settings, Setting up of units and drawing limits, ISO and ANSI standards for coordinate dimensioning.	3

	Annotations, layering & other Functions Covering: Applying dimensions to objects, applying annotations to drawings, Setting up and use of layers, layers to create drawings, Create, edit and use customized layers, Changing line lengths through modifying existing lines (extend/lengthen), Printing documents to paper using the print command, orthographic projection techniques, Drawing sectional views of objects (simple machine parts).	
Part -B	**Activities to be completed in the CAD Laboratory.** (All printouts to be part of Term Work. Preferably, Use A3 size sheets for print out.)	
	1. Orthographic Projections (without section)- 1 problem	4
	2. Orthographic Projection (with section)- 1 problem	4
	3. Orthographic Reading – 1 problem	2
	4. Isometric Drawing – 3 problems.	4

Theory Assessment:
Internal Assessment: 40 Marks
Assessment consists of two class tests of 40 marks each.
Among the two tests one is Conventional (manual drawing) and Second using CAD Software
End Semester Examination: 60 Marks

1. Question paper will comprise of a total 06 questions, each carrying 15 marks.
2. Any 4 questions need to be solved. There won't be any compulsory Question
3. Questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

Laboratory Assessment:
Internal Assessment for 25 marks:
Term Work:

Component-1	:	7 Marks
Component-2	:	6 Marks
Component-3	:	7 Marks
Attendance	:	5 Marks
Total Marks	**:**	**25 Marks**

End Semester Practical/Oral Examination:
Pair of Internal and External Examiners should conduct practical examination based on contents.

1. Isometric drawing. (1 problem) (10 Marks)
2. Orthographic Projection (With Section) (1 problem). (15 Marks)

Books/References:

1. N.D. Bhatt, "Engineering Drawing (Plane and solid geometry)", Charotar Publishing House Pvt. Ltd.
2. N.D. Bhatt & V.M. Panchal, "Machine Drawing", Charotar Publishing House Pvt. Ltd.David V Hutton; Fundamentals of Finite element analysis; 7th Edition Tata McGraw Hill.
3. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publisher.
4. Prof. Sham Tickoo (Purdue University) & Gaurav Verma, "(CAD Soft Technologies) : Auto CAD 2012 (For engineers and Designers)", Dreamtech Press NewDelhi.
5. Dhananjay A Jolhe, "Engineering Drawing" Tata McGraw Hill.

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Course Code	Course Name	Credits
ME 111	**Programming with Python**	**1+1**

Course Objectives:

1. To introduce basic concepts of Python programming language as well as common packages and libraries.
2. To generate an ability to design, analyze and perform experiments on real life problems in mechanical engineering using python.

Course Outcomes: Learners will be able to

1. Demonstrate understand of basic concepts of python programming.
2. Identify, install and utilize python packages
3. Develop and execute python programs for specific applications.
4. Develop and build python program to solve real-world engineering problems
5. Prepare a report on case studies selected.

Module	Detail Content	Hrs.
1.	Introduction to python and its applications. Installation of Python and setting up a programming environment such as Anaconda and Spyder Python Basics: Variable and variable types, Booleans, Numbers (integers, floats, fractions, complex numbers), strings, lists, tuples, sets, dictionaries. bytes and byte arrays, Manipulating variables, indexing, slicing, basic operators (arithmetic, relational, logical, membership, identity). String methods, list methods, list slicing, set methods, in built python functions, input and output functions.	04
2.	Basic Coding in Python: If, else, elif statements, for loops, range function, while loops, List comprehensions, functions in python. Introduction to OOP, Classes, Objects, Reading and writing files.	02
3.	Python libraries: Installing of different libraries, packages or modules. Basic concepts of the following libraries: NumPy, Matplotlib, Pandas, SciPy Optional libraries based on case studies in Module 4: Pillow, Scikit, OpenCV, Python in Raspberry Pi	04
4.	Case Studies using Python (Select any 3): 1. Solving a linear differential equation using SciKit and plotting the result in matplotlib. Students can use differential equations from any previous topic studied in the programme such as mechanics, materials science, fluid mechanics, kinematics of machines, thermodynamics, production etc. 2. Image processing and manipulation and auto detection of any object. Applications in self-driving cars may be discussed. 3. Python programming of a Raspberry PI: Students can sense using a sensor, process the reading and then control some physical output (like motor or LED) 4. Project involving basic machine learning (Students should understand the basic concepts of machine learning and apply to specific situation) 5. Any other case study that uses Python to solve Mechanical Engineering problems. 6. Customizing applications by writing API programs using python like to create joints, get physical properties, get circle and arc data from	06

	edge.	

Lab Assessment:

Termwork : 50 marks (Continuous evaluation)
Practical/Oral : 25 marks

Books/References:-

1. Core Python Programming, Dr. R. NageswaraRao, Dreamtech Press
2. Programming through Python, M.T.Savaliya and R.K.Maurya, StarEdu Solutions
3. Beginning Python: Using Python 2.6 and Python 3.1. James Payne,Wrox publication2.
4. Any digital resources and online guides for python or its packages. Such as "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/

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Course Code	Course Name	Credits
ME 112	**Professional Communication and Ethics I**	**1+1**

Course Objectives:

1. To understand, compare and demonstrate the importance and relevance of communication with specific emphasis on listening skill.
2. To promote practice in speaking skill and encourage learners to compose on the spot speeches for the purpose of developing and generating ideas.
3. To train learners in reading strategies that will enhance their global understanding of the text and help them to comprehend academic and business correspondence.
4. To illustrate effective writing skills in business, academic and technical areas.
5. To inculcate confident personality traits with grooming and social etiquette
6. To train learners in producing words on the basis of contextual cues and reflect on errors in sentences.

Course Outcomes:

Upon successful completion of course learner/student will be able to

1. Listen, comprehend and identify potential barriers in spoken discourse with ease and accuracy.
2. Develop confidence and fluency in speaking at social,academic and business situations as well as make effective professional presentations.
3. Implement reading strategies for systematic, logical understanding, that will enhance the skill of comprehension, summarisation and evaluation of texts.
4. Understand and demonstrate effective writing skills in drafting academic, business and technical documents.
5. Communicate effectively in academic as well as business settings, displaying refined grooming and social skills.
6. Anticipate the meaning of unfamiliar words with the help of contextual cues and construct grammatically correct sentences.

Theory Syllabus:

Module	Detail Content	Hrs.
1	**The Importance and Strategies of Effective Listening** Prerequisite: Able to listen, read, speak, write and comprehend the target language Introduction to communication 1.1 Importance and relevance of communication 1.2 Listening skill - Ability to discriminate stress and intonation - Comprehend meaning of audio text-graded on the basis of vocabulary, sentence construction and theme. - Potential barriers	4
2	**Developing Speaking Skills** 2.1 Intensive Speaking- on the spot topics 2.2 Responsive speaking-answering a question 2.3 Interactive speaking-conversations 2.4 Extensive speaking-speech, oral presentations-specific emphasis on plagiarism check and generating the report	4

3	**Strategies and Techniques to build Reading Skill** 3.1 Global understanding of the text- inference, anticipation and deduction 3.2 Detailed understanding of text-scanning for specific information (special emphasis on reading comprehension exercises and summarisation)	2
4	**Developing Professional Writing Skills** 4.1 Effective introduction with emphasis on general statement, opposing statement and thesis statement 4.2 Critical response to a text with special reference to purpose, evaluation of the content, theme and style of a text 4.3 Organization of ideas, sentence construction and word choice, grammar and usage 4.4 Explanation and support of ideas (special reference to writing paragraphs and business letters- Sales and complain letters)	4
5	**Etiquette and Grooming for Personality Development** 5.1 Social Etiquette 5.2 Corporate etiquette 5.3 Confidence building and Personality development	1
6	**Vocabulary and Grammar** 6.1 Contextual vocabulary Development- Word Maps 6.2 Identifying errors in a sentence.	1

Laboratory Syllabus

Prerequisite: Basic language skills

Sr. No.	Assignment	Detailed Lab/Tutorial Description
1	Assignment 1	Written record of listening activities-Listening practice tasks of 3 types (through audio recordings of 1) Monologues 2) Dialogues 3) Formal/Expert Talk or Lecture)
2	Assignment 2	Transcription of the public speech along with a plagiarism report-Practice public speech
3	Assignment 3	Summarization through graphic organisers (1. Text to graphic organizer 2. Graphic organizer to text)
4	Assignment 4	1. Case studies on critical thinking 2. 2 business letters in complete block format
5	Assignment 5	Documentation of case studies/Role play based on Module 5
6	Assignment 6	1.Contextual Vocabulary Development 2. Aptitude Test

Theory Assessment:

Internal Assessment : 20 marks

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed.

(Note: Summarization should be a compulsory question in Test II and not in the End Semester Theory Examination.)

End Semester Examination: 30 marks

1. Question paper will consist of 5 questions, each carrying 10 marks.
2. Total 3 questions need to be solved.

3. Q.1 will be compulsory, based on the entire syllabus.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of marks should be proportional to number of hours assigned to each module.

Term work:

Term Work shall consist of 8 Assignments .

The distribution of marks for term work shall be as follows:

1. Assignments : 10 marks
2. Oral Exam/ Public Speaking : 10 marks
3. Attendance (Theory and Tutorial) : 05 marks

Text Books/Reference Books:

1. Raman Meenakshi & Sharma Sangeeta, Communication Skills, Oxford University Press
2. Kumar Sanjay & Lata Pushp, Communication Skills, Oxford University Press
3. Locker, Kitty O. Kaczmarek, Stephen Kyo. (2019). Business Communication:
4. Building Critical Skills. Place of publication not identified: Mcgraw-hill.
5. Murphy, H. (1999). Effective Business Communication. Place of publication not identified: Mcgraw-Hill.
6. Lewis, N. (2014). Word power made easy. Random House USA.

Back To Scheme

Course Code	Course Name	Credits
ME 113	**Basic Engineering Workshop II**	**1.5**

Course Objectives:

1. To impart training to help the students develop engineering skill sets.
2. To inculcate respect for physical work and hard labor.
3. To get exposure to interdisciplinary engineering domain.

Course Outcomes:

Learner will be able to

1. Develop the necessary skill required to handle/use different carpentry tools.
2. Identify and understand the safe practices to adopt in electrical environment.
3. Demonstrate the wiring practices for the connection of simple electrical load/ equipment.
4. Design, fabricate and assemble PCB.
5. Develop the necessary skill required to handle/use different measuring tools.
6. Develop the necessary skill required to use different sheet metal tools.
7. Able to demonstrate the operation, forging with the help of a simple job.

Trade	Detailed Content	Hrs.
Note: Trade 1 and 2 are compulsory. Select any ONE trade topics out of the topic trade 3 to 5. Demonstrations and hands on experience to be provided during the periods allotted for the same. Report on the demonstration including suitable sketches is also to be included in the term work Trade evaluation is to be done according to the opted Trades in addition to Compulsory Trades.		
Trade-1	**Carpentry(Compulsory)** 6. Use and setting of hand tools like hacksaws, jack planes, chisels and gauges for construction of various joints, wood tuning and modern wood turning methods. 7. Term work to include one carpentry job involving a joint and report on demonstration of a job involving wood turning	**10**
Trade-2	**Basic Electrical work shop:(Compulsory):** 8. Single phase and three phase wiring. Familiarization. of protection switch-gears and their ratings (fuse, MCB, ELCB). Wiring standards, Electrical safety in the work place safe work practices. Protective equipment, measures and tools. 9.Layout drawing, layout transfer to PCB, etching and drilling and soldering technique	**08**
Trade-3	**Measurement*** 10. Vernier Height gauge, wire gauge, Dial gauge. Use of the listed gauges and precaution.	**06**
Trade 4	**Sheet metal working *** 11. Use of sheet metal, working hand tools, cutting , bending , spot welding operation	**06**
Trade-5	**Forging (Smithy):*** 12. At least one forging job to be demonstrated and a simple job to be made for Term Work in a group of 4 students.	**06**

* Students can choose one trade out of Measurement, Sheet metal work and Forging.

Internal Assessment: 50 marks
Term Work:

1. All the jobs mentioned above
2. Complete Work-Shop Book giving details of drawing of the job and time sheet

The distribution of marks for Term work shall be as follows:

Job Work : 30 marks
Workshop book : 10 marks
Attendance : 10 marks

Books/References:

1. Workshop Technology by H K Hajara Choudhary
2. Manufacturing Technology by R C Jain
3. Workshop Technology by R S Khurmi and J S Gupta
4. Workshop Technology by Chapman.

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Course Code	Course Name	Credits
ME 201	**Manufacturing Processes**	**3+1**

Course Objectives:

1. To familiarize with the various production processes used on shop floors
2. To study appropriate production processes for a specific application.
3. To introduce to the learner various machine tools used for manufacturing
4. To introduce to the learner various production toolings used for manufacturing

Course Outcomes:

Learner will be able to

1. Demonstrate an understanding of casting and forming process
2. Demonstrate applications of various types of welding processes.
3. Operate machine tools for various machining processes and Select proper machine tools and cutting tools for economic production.
4. Develop competency for selecting appropriate machining parameters to optimize output characteristics such as MRR, surface finish.
5. Design jigs and fixtures for simple jobs and Select dies for sheet metal processing
6. Illustrate the concept of producing polymer components and ceramic components.

Theory Syllabus:

Module	Detail Content	Hrs.
1	**Introduction to Production Processes and Metal Casting** 1.1. Classification of Production Processes and applications areas 1.2. Pattern making materials, Types of pattern and allowances. 1.3. Sand moulding and Machine moulding 1.4. Gating system :Types of riser, types of gates, solidification 1.5. Special casting processes : CO2 and shell moulding, Investment casting, Die casting, Vacuum casting, Inspection & casting defects and remedies	06
2	**Joining Processes** 2.1. Classification of various joining processes; Applicability, advantages and limitations of Adhesive bonding, Mechanical Fastening; Welding and allied processes, Hybrid joining processes. 2.2. Classification and Working of various welding methods: Gas, Arc, Chemical, Radiant, Solid State etc. 2.3. Welding Joints, Welding Positions, Welding defects and their remedies.	08
3	**Forming processes** 3.1 Introduction and classification of metalworking processes, hot and cold working processes 3.2 Introduction, classification and analysis of forging and rolling operations, Defects in rolled and forged components, 3.3 Extrusion process, Classification and analysis of wire and tube drawing processes.	06
4	**Machine Tools and Machining Processes** Lathe Machines, Milling Machines, Drilling Machines, and Grinding Machines and selection of grinding wheel (Dressing and Truing), Broaching machines, Lapping/Honing machines (Super Finishing Operations) and	08

	shaping/slotting/planning Machines. **Gear Manufacturing** Gear milling, standard cutters and limitations, Gear Hobbing, Gear Shaping, Gear Shaving and Gear Grinding processes	
5	**Machining science** Theory of metal cutting Mechanics of chip formation, Concept of chip formation and types of chips, Geometry and nomenclature of single point cutting tool, Speed, feed, depth of cut, Taylor's tool life equation, factors affecting tool life, MRR, Computation of tool life. **Sheet metal working processes** Classification of Sheet metal operations, types of Presses used in sheet metal operations, types of dies, metal cutting in a punch and die set up, die details and accessories, clearance, angular clearance, economic strip layout, centre of pressure, cutting forces, methods of reducing cutting forces. Force calculations. **Work holding devices** Introduction to Jigs and Fixtures and types, P3-2-1 principle of location and principles of clamping and guiding. Design of jig for simple component, design of milling fixture for simple component.	08
6	**Polymer Processing:** Polymer Molding Techniques for thermoplastic and thermosetting plastics. Applications of Plastics in engineering field, compression moulding, transfer moulding, injection moulding, film and sheet forming, thermoforming and their applications. **Powder Metallurgy** Introduction to PM, Powder making processes, Steps in PM. Compaction and Sintering processes. Secondary and finishing operations in PM.	04

Laboratory Syllabus:

S. No.	Details	Hrs.
1	Introduction to Lathe Machine, demonstration of various machining processes performed on lathe machine. One Job on Plain and Precision Turning, Taper Turning and; Screw Cutting by setting gear train; for desired thread cutting on lathe as per chart	10
2	Introduction to Shaping Machine and various machining processes performed on Shaping Machine One job on shaping machine to make horizontal and inclined surface	04
3	One composite job including welding, grinding, milling,	10
4	Lathe Machine maintenance activity, like apron overhauling, tailstock overhaul etc.	02

Theory Assessment:
Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests - 40 Marks
2. Continuous evaluation- Test/Assignments /Quiz/Case studies/Seminar presentation - 40 Marks

End Semester Examination: 60 Marks
Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Laboratory Assessment:
Internal Assessment for 50 marks.
Term Work:

1. All the jobs mentioned above
2. Complete Work-Shop Book giving details of drawing of the job and time sheet

The distribution of marks for Term work shall be as follows:

Job Work with complete workshop book : 40 marks
Attendance : 10 marks

Books/References:

1. Welding technology by O P Khanna
2. Foundry technology by O P Khanna
3. Elements of workshop technology. Vol. 1 & II by S K Hajra Choudhury
4. Tool Design by Cyril Donaldson, George H. LeCain, and V. C. Goold
5. Jigs and Fixtures by P H Joshi, Tata McGraw Hill
6. Manufacturing Science by Ghosh and Malik
7. Rapid Manufacturing –An Industrial revolution for the digital age by N.Hopkinson, R.J.M.Hauge, P M, Dickens, Wiley
8. Rapid Manufacturing by Pham D T and Dimov, Springer Verlag
9. Production Technology by WAJ Chapman Vol I, II, III
10. Production Technology by P C Sharma.
11. Production Technology by Raghuvanshi.
12. Industry 4.0: The Industrial Internet of Things by Alasdair Gilchrist, 2016, Apress.
13. Cyber-Physical Systems: From Theory to Practice by Danda B. Rawat, Joel Rodrigues, Ivan Stojmenovic, 2015, C.R.C. Press.
14. Optimization of Manufacturing Systems using Internet of Things by Yingfeng Zhang, Fei Tao, 2017, Academic Press (AP), Elsevier.

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Course Code	Course Name	Credits
ME 202	**Engineering Mathematics III**	**3+1**

Course Objectives:

1. To learn the Laplace Transform, Inverse Laplace Transform of various functions, and its applications.
2. To understand the concept of Fourier Series and enhance the problem-solving skills.
3. To learn complex form of Fourier series and Fourier Transform.
4. To acquaint with the concepts of probability, random variables, and expectations.
5. To acquaint with the concepts of probability distributions and sampling theory.
6. To learn the partial differential equations and numerical methods to solve it which are used in engineering problems

Course Outcomes:

On successful completion of course learner/student will be able to:

1. Understand the concept of Laplace transform and its application to solve the real integrals, understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
2. Apply the knowledge of Fourier series in engineering problems.
3. Apply the knowledge of complex form of Fourier series and Fourier Transform in problem solving.
4. Illustrate understanding of the concepts of probability and expectation for decision making.
5. Use the concept of probability and sampling theory in data science.
6. To apply the numerical methods to find the solution of Mathematical Models of real-life problems.

Theory Syllabus:

Module	Detailed	Hrs.
1	**Laplace Transform and Inverse Laplace Transform** Definition, Condition of Existence, Laplace Transforms of Standard Functions. Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by t, Division by t, Laplace Transform of derivatives and integrals. Inverse Laplace Transform: use of standard formulae, using derivative, Partial fractions method, first shift property and second shifting property to find inverse Laplace transform, Convolution theorem (without proof) **Optional Topics:** Applications of Laplace Transform to solve initial and boundary value problems involving linear ordinary differential equations of first and second order, Bilateral Laplace Transform	6

2	**Fourier Series** Orthogonal and orthonormal set of functions, Dirichlet's conditions, Fourier series of periodic function with period 2π and 2l, Fourier series of functions with point of discontinuity, and of even and odd functions, Half range Sine and Cosine Series. Parseval's Identity (without proof)	6
3	**Fourier Integral and Fourier Transform** Complex form of Fourier Series, Fourier Integrals Fourier cosine and sine transform. Applications of Fourier Transform, Comparison of Fourier and Laplace transforms.	6
4	**Probability Theory** Conditional probability, Total Probability and Baye's Theorem. Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expectation, Variance, Co-variance. **Optional Topics:** Moments, Moment generating functions, (Four moments about the origin & about the mean).	6
5	**Probability Distribution and Sampling Theory-I** Probability Distribution: Binomial, Poisson and Normal distribution, Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. Students't-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t-test) **Optional Topics:** Test of significance of large samples, Proportion test	6
6	**Partial Differential Equations** Introduction of Partial Differential equations Classification Method of separation of variables to solve the problem of Vibrations of string, One dimensional heat and wave equations. Numerical methods to solve PDE: Bender Schmidt scheme and Simplified Crank Nicholson scheme. **Optional Topics**: Approximation of derivatives by difference schemes, Solution of Laplace equation and applications.	6

Theory Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 40 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed.

End Semester Theory Examination:

1. Question paper will comprise of a total 05 questions, each carrying 20 marks.
2. Total 03 questions need to be solved.
3. Question No: 01 will be compulsory and based on the entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture mentioned in the syllabus.

Lab Assessment:

Term Work:

General Instructions:

1. Batch wise practicals are to be conducted. The number of students per batch should be as per norms.
2. At Least 6 tutorials/assignments need to be submitted based on the entire syllabus.

Term Work assessment must be based on the overall performance of the student with every tutorial/assignment graded from time to time.

The distribution of Term Work marks will be as follows –

1. Attendance (Theory,Tutorial) : 05 marks
2. Assignments/Tutorials on entire syllabus : 20 marks

Books/References:

1. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited, 9thEd.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education
5. Advanced Engineering Mathematics H.K. Das, S. Chand, Publications

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Course Code	Course Name	Credits
ME 203	**Strength of Materials**	**3+1**

Prerequisites:

1. Fundamentals of engineering mechanics
2. Concept of centroid, Analysis of forces and moments
3. Algebra and trigonometry, Elementary Calculus

Course Objectives:

1. To understand mechanical behavior of the body by determining the stresses, strains and deflections produced by the loads up to the elastic limit.
2. To understand the fundamental concepts related to shear force and bending moments, torsional moments, strain energy.
3. To understand the fundamental concepts related to deflection of beams, columns and struts, thin cylindrical and spherical shells

Course Outcomes: Upon successful completion of this course, learner will be able to:

1. Apply principles of statics to determine reactions & internal forces in statically determinate beams
2. Understand the different types of stresses and strains developed in the member subjected to axial, bending, shear & torsional loads.
3. Compute slope and deflection at various points of a beam.
4. Identify, formulate, and solve static engineering problems.
5. Comprehend the behaviour & properties of engineering materials.

Theory Syllabus:

Module	Detail Content	Hrs.
1	**Simple stresses and strains:** Stress, strain, Stress-strain diagram for ductile and brittle materials, factor of safety. Hooke's law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus. Interrelation between elastic constants. Thermal stresses and strains. Principal stresses and Principal planes, Mohr's circle. Moment of Inertia and Polar moment of Inertia.	06
2	**Shear Force and Bending Moment in Beams:** Definition of bending moment and shear force, Sign conventions, Relationship between load intensity, bending moment and shear force. Shear force and bending moment diagrams for statically determinate beam due to concentrated load, uniformly distributed load, uniformly varying load and couple, Point of Contraflexure. Beams with Internal Hinges/Moment Release (limited to two per beam).	07
3	**Stresses in Beams:** **Flexural stresses –** Theory of simple bending, Assumptions, derivation of equation of bending, neutral axis, determination of bending stresses, section modulus. **Shear stresses –** Derivation of formula, shear stress distribution across various beam sections like rectangular, circular, I, T sections **Direct and Bending stresses-** Introduction, eccentric loading, columns with eccentric loading, Limit of eccentricity,	07

4	**Torsion of Shafts:** Introduction to Torsion, Torsion formula – stresses and deformations in circular and hollow shafts, Stepped shafts, Design of shafts according to theories of failure. **Strain Energy:** Strain energy due to axial load (gradual, sudden and impact), Strain energy due to bending and torsion.	06
5	**Deflection of Beams:** Double integration method, Maxwell's reciprocal theorems for computation of slopes and deflection in beams for point and distributed loads, derivation of formula for slope and deflection for standard cases, Area moment theorems for computation of slopes and deflections in beams – Conjugate beam method	07
6	**Columns and Struts:** Concept of buckling of columns, derivation of Euler's formula for buckling load for columns with various end conditions, concept of equivalent length, limitations of Euler's formula, Rankine's formula, safe load on columns. **Thin Cylinders and Spheres:** Cylinders and Spheres due to internal pressure, Cylindrical shell with hemispherical ends.	07

Laboratory Syllabus:

Module	Details	Hrs.
1	Tension Test on Mild Steel Bar and other ductile materials using UTM (Universal Testing Machine), for specimens having diameter between 6 - 12 mm.	2
2	Compression Test on Concrete or Wooden Block using UTM.	2
3	Flexure (Bending) Test on Simply Supported Beam (3 Point Bending) using UTM.	2
4	Shear Test on rods of various materials using Shear Attachment on UTM.	2
5	Hardness Tests using Hardness Testing Machine: (a). Rockwell Hardness Test (b). Brinell Hardness Test	2
6	Impact Tests on Impact Testing Machine: (a). Izod Impact Test (b). Charpy Impact Test	2
7	Torsion Test on Tor-steel rod using Torsion Testing Machine.	2
8	Tensile Test on thin cross-section (rectangular/circular) specimens using Tensile Testing Machine.	2

Theory Assessment:

Internal Assessment: 40 marks.

1. Consisting of One Compulsory Class Tests - 40 Marks
2. Continuous evaluation- Test/Assignments /Quiz/Case studies/Seminar presentation - 40 Marks

End-Semester (Theory) Examination: 60 marks.

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Laboratory Assessment:
Term Work: 25 marks.
Term Work consists of an ample number of assignments and experiments as decided by the Instructor. Mini-project based on this subject may be undertaken for which the number of assignments may be suitably reduced. Students can also avail NPTEL Certification for this course, which shall be considered in place of the assignment work.
Viva-você / Practical: 25 marks.
Viva-você (on the entire syllabus) or Practical exam (on at least one experiment) shall be conducted at the end of the course. In case both viva-voce and practical exams are conducted, 15 marks shall be allotted to viva-voce and 10 marks to the practical exam.

Books/References:

1. S. S. Rattan, Strength of Materials, TMH Publications
2. R.K. Bansal, Strength of Materials, Laxmi Publications, India
3. Beer and Johnston - Strength of materials - CBS Publication
4. Ramamrutham - Strength of material - Dhanpat Rai Publication
5. W. A. Nash and M. C. Potter, Strength of Materials, Schaum's Outline Series, McGraw-Hill
6. Singer and Pytel - Strength of materials - Harper and Row Publication
7. Strength of Materials - Lab Manual, by Anand Jayakumar Arumugham, Notion Press.
8. Experiments in Strength of Materials and Cement Laboratory, by Earl B. Smith, Leopold Classic Library.
9. Laboratory Strength of Materials, by Murad, Hassan, Abdulrahman

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Course Code	Course Name	Credits
ME 204	**Thermodynamics**	**3**

Course Objectives:

1. To explore ideas about energy into forms suitable for engineering analysis.
2. To introduce entropy and show its use for thermodynamic analysis.
3. To study power systems utilizing working fluids like vapour and gas.
4. To study the overview of fuels & combustion.
5. To demonstrate the procedures for determining thermodynamic properties of pure substances from tables of property data.
6. To introduce the first law of thermodynamics, energy balances, and mechanisms of energy transfer to or from a system.

Course Outcomes:

Upon successful completion of this course, the learner will be able to

1. Able to solve energy balance problems for closed (fixed mass) systems that involve heat and work interactions
2. Able to apply the second law of thermodynamics to cycles and cyclic devices.
3. Able to evaluate internal energy, enthalpy, entropy of simple compressible systems from properties that are more readily measured.
4. Able to calculate the enthalpy of reaction, enthalpy of combustion, and the heating values of fuels.
5. Able to investigate the performance of vapour & gas power cycles.
6. Able to do the availability analysis for the design and analysis of thermal systems.

Module	Detail Content	Hrs.
1	**1.1 Introduction** Importance of Thermodynamics, concept of equation of state, energy, internal energy, specific properties, heat & work transfer, pdV work or displacement work. **1.2 First Law of thermodynamics** First law applied to the closed system undergoing a cycle and change of state, ideal gas processes, PMM1. Flow process and flow energy, First law applied to steady flow processes, − vdp work, relation between non flow work and flow work, Limitations of the 1st law.	6
2	**2.1 Second Law of Thermodynamics:** Thermal reservoir, Concept of heat engine, Heat pump and Refrigerator, Statement of the second law of thermodynamics, equivalence between Kelvin-Planck and Clausius statement, Reversible and irreversible Process, Causes of irreversibility, PMM2, Carnot cycle, Carnot theorem, Corollary of Carnot theorem, Thermodynamic temperature scale. **2.2 Entropy:** Clausius Inequality theorem, Entropy - a property of the system, Temperature-Entropy diagram, increase of entropy principle, entropy transfer and entropy generation, Entropy balance, Entropy change during a process.	7
3	**3.1 Availability:** Quality energy, available and unavailable energy, useful work and dead state, availability of closed systems and steady flow process. **3.2 Thermodynamic Relations**	6

	Helmholtz and Gibbs functions, Maxwell equation (without derivation), TdS relations, Volumetric expansivity, Isothermal & isentropic compressibility, Clausius-Clapeyron equation, Joule Thomson coefficient – porous plug experiment, definition of third law of thermodynamics.	
4	**4.1 Properties of Pure Substance:** Pure substance, phase change phenomenon of pure substance, saturation pressure and saturation temperature, terminology of pure substance, P-V-T surfaces, p-v, p-T, T-s & h-s (Mollier diagram) diagrams, Steam diagram, critical point and triple point, Quality of steam, Calculation of various properties of steam, advantages & applications of use of steam, **4.2 Vapour Power Cycle:** Carnot cycle, Limitations of Carnot vapour cycle, Rankine cycle, mean temperature of heat addition, Rankine cycle with superheat, reheat.	7
5	**5.1 Gas Power Cycle:** Nomenclature of a reciprocating engine, Mean effective pressure, Assumptions of air Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Comparison of Otto and Diesel cycle for same compression ratio. Working principle of Brayton Cycle, Stirling Cycle, Ericsson Cycle, Lenoir cycle and Atkinson cycle. (No Numerical for Brayton, Stirling, Ericsson, Lenoir & Atkinson Cycle).	6
6	**6.1 Combustion Thermodynamics:** Complete and incomplete combustion, air fuel ratio, theoretical and excess air for combustion, enthalpy of formation, analysis for a non flow process involving combustion at constant volume, analysis of steady flow or constant pressure combustion, heating values, adiabatic flame temperature, combustion efficiency enthalpy and internal energy of combustion.	6

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. Fundamentals of engineering thermodynamics by Michael J. Moran &Howard N. Shapiro, John wiley and Sons, Fifth edition,
2. Applied thermodynamics by B K Ventanna, PHI publications.
3. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A. Boles, 9th edition, TMH
4. Basic Engineering Thermodynamics by Rayner Joel, 5thedition, Longman Publishers
5. Engineering Thermodynamics by P Chattopadhyay, 2ndedition, Oxford University Press India
6. Thermodynamics by P K Nag, 6thEdition,TMH
7. Thermodynamics by Onkar Singh, 4th Edition New AgeInternational
8. Thermodynamics by C P Arora,1st EditionTMH
9. Thermal Engineering By Ajoy Kumar, G. N. Sah, 2nd Edition, Narosa Publishing house

10. Engineering Thermodynamics Through Examples by Y V C Rao, Universities Press (India) PvtLtd
11. Fundamentals of Thermodynamics by Moran &Shapiro, Eighth Edition, Wiley
12. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., 9th Edition John Wiley & Sons
13. Thermodynamics by W.C. Reynolds, McGraw-Hill &Co
14. Thermodynamics by J P Holman, 4th Edition McGraw-Hill & Co.

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Course Code	Course Name	Credits
ME 205	**Metallurgy and Materials**	**3+1**

Prerequisites:

1. 12th std Chemistry
2. 12th std Physics

Course Objectives:

1. To help students know about the different types of materials
2. To enable students to make a good selection of materials
3. To be able to understand the significance of structure property relationship

Course Outcomes:

Upon successful completion of this course, learner will be able to:

1. Identify the different classes of materials
2. Suggest ways to improve the strength of materials
3. Differentiate between steels and cast irons wrt composition and property development
4. Analyse the phase transformations in steels
5. Apply heat treatment to different components based on the property requirement
6. Evaluate the reasons of failure in components and take corrective actions

Theory Syllabus:

Module	Detail Content	Hrs.
1.	Classification of Materials, Crystal Structures,Miller's indices for planes and directions. Crystal Defects,	6
2.	Deformability and Strengthening mechanisms-Hot and Cold working, Recrystallisation-its effects and factors affecting it	6
3.	Concepts of solidification, Phases,Phase diagrams, Alloying - Fe-Fe3C diagram and cooling of steels and cast irons,	10
4.	Austenite transformation-equilibrium and non equilibrium, Hardenability and its importance, Alloy Steels-stainless steels, tool steels,	6
5.	Heat treatments-Thorough and Surface. Isothermal treatments - Patenting, Austempering and martempering, Ausforming and Maraging	5
6.	Failure by fracture-micromechanisms-fatigue and creep. Non destructive evaluation to prevent failures	6

Laboratory Syllabus:

Module	Details	Hrs.
1	Study of Characterization techniques and Metallographic sample preparation and etching	2
2	Comparison of Microstructures and hardness before and after Annealing, Normalizing and Hardening in medium carbon steel	2
3	Study of tempering characteristics of hardened steel	2
4	Determination of hardenability of steel using Jominy end Quench Test (Using different hardness testers to measure the Hardness)	2
5	Fatigue test – to determine number of cycles to failure of a given material at a given stress	2

6	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity)	2
7	Torsion test on mild steel bar / cast iron bar	2
8	Impact test on metal specimen (Izod/Charpy Impact test)	2
9	Hardness test on metals – (Brinell/ Rockwell Hardness Number	2

Theory Assessment:
Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

End Semester Examination: 60 Marks
Weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Laboratory Assessment:
Term Work Marks: 25 Marks

1) Laboratory Work (Journal Completion): 20 Marks
2) Attendance: 5 Marks

Books/References:

1. Materials Science and Engineering: An Introduction: Willaim Callister Jr. and David G. Rethwisch, Wiley Publication
2. Introduction to Physical Metallurgy, Sidney H. Avner, Tata Mcgraw Hill
3. Introduction to Engineering Materials,BK Agrawal, TataMcgraw Hill
4. Materials Science and Engineering: A First Course,Raghavan V, Prentice Hall India
5. Materials Science and Engineering: An Introduction: Willaim Callister Jr. and David G. Rethwisch, Wiley Publication
6. Introduction to Physical Metallurgy, Sidney H. Avner, Tata Mcgraw Hill
7. Introduction to Engineering Materials,BK Agrawal, TataMcgraw Hill
8. Materials Science and Engineering: A First Course, Raghavan V, Prentice Hall India
9. Automotive Materials, Brian Cantor

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Course Code	Course Name	Credits
ME 206	**Computer Aided Drafting**	**1**

Prerequisites:

1. Engineering Drawing

Course Objectives:

1. To impart the 3D modeling skills for development of 3D models of basic engineering components.
2. To introduce Product data exchange among CAD systems.
3. To familiarize with production drawings with important features like GD&T, surface finish.

Course Outcomes: Upon successful completion of this course, learner will be able to

1. Visualize and prepare 2D modeling of a given object using modelling software.
2. Build a solid model of a given object using 3D modeling software.
3. Visualize and develop the surface model of a given object using modelling software.
4. Generate assembly models of given objects using assembly tools of a modelling software

Module	Detail Content	Hrs.
1	**CAD Introduction** CAD models Creation, Types and uses of models from different perspectives. Parametric modelling and Non - Parametric Modelling. **GD & T** Limits, Fits and Tolerance	4
2	**2D Sketching** Geometric modeling of an Engineering component, sketching commands of creation, modification commands and viewing the sketch.	4
3	**Solid Modeling** 3D Geometric modeling of an Engineering component, modeling features. Using 3D components from software library (Eg. Nut, Bolt, Screw etc.)	6
4	**Surface Modeling** Extrude, Sweep, Trim etc and Mesh of curves, free form surfaces etc. Feature manipulation using Copy, Edit, Pattern, Suppress, History operations etc.	6
5	**Assembly** Constraints, Exploded views, interference check. Drafting (Layouts, Standard & Sectional Views, Detailing & Plotting), Bill of materials, Giving machining symbols using software in drafting.	4
6	**Data Exchange** CAD data exchange formats Like IGES, PDES, PARASOLID, DXF and STL along with their comparison and applicability. **Case Study**	2

Assessment:

Term work:

1. Printouts/Plots: 20 marks
2. Attendance : 05 marks

Using the above knowledge and skills acquired through six modules students should complete minimum six assignments/experiments from the given sets of assignments **(two from each set)** using standard CAD modeler like PTC Creo/CATIA/ Solid work/UG /any other suitable software.

Set 1: Beginner Level:

3D modeling of basic Engineering components likes Nuts, Bolts, Keys, cotter, Screws, Springs etc.

Set 2: Intermediate Level:

3D modeling of basic Machine components like Clapper block, Single tool post, Lathe and Milling tail stock, Shaper tool head slide, jigs and fixtures Cotter, Knuckle joint, Couplings: simple, muff, flanged Protected flange coupling, Oldham's coupling, Universal coupling, element of engine system and Miscellaneous parts.

Set 3: Advance Level:

1. Generation of any Assembly model (minimum five child parts) along with Production drawing for any of the system by creating 3D modeling with assembly constraints, Interference check, Exploded view, GD&T, Bill of material.
2. Reverse Engineering of a physical model: disassembling of any physical model having not less than five parts, measure the required dimensions of each component, sketch the minimum views required for each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions.

End Semester Practical/Oral examination:

To be conducted by pair of Internal and External Examiners

1. Practical examination duration is two hours, based on Advance level of the Term work. Oral examination should also be conducted to check the knowledge of CAD Modelling Tools.
2. The distribution of marks shall be as follows:
   Practical Exam : 30 marks
   Oral Exam : 20 marks
3. Evaluation of practical examinations to be done based on the printout of students' work.
4. Students work along with evaluation reports to be preserved till the next examination.

Books/References:

1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing by Laxminarayan and M.L.Mathur, Jain brothers Delhi
3. Machine Drawing by Kamat and Rao
4. Machine Drawing by M.B.Shah
5. A text book of Machine Drawing by R.B.Gupta, Satyaprakashan, Tech. Publication
6. Machine Drawing by K.I. Narayana, P. Kannaiah, K.Venkata Reddy
7. Machine Drawing by Sidheshwar and Kannaiah

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Course Code	Course Name	Credits
ME 291	**Minor Project I**	**2**

Course Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Minor Project:

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do surveys and identify needs, which shall be converted into a problem statement for minor-project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Student groups shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of the minor project.
- A log book has to be prepared by each group, wherein the group can record weekly work progress, and the guide/supervisor can verify and record notes/comments.
- Faculty supervisors may give inputs to students during minor project activity; however, focus shall be on self-learning.
- Students in a group shall understand the problem effectively, propose multiple solutions and select the best possible solution in consultation with the guide/supervisor.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
- The solution has to be validated with proper justification and the report has to be compiled in the standard format.
- With the focus on self-learning and innovation, addressing societal problems and entrepreneurship quality development within the students through the Minor Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Minor Project 1 in semester III and IV. Similarly, Minor Project 2 in semesters V and VI may be considered. In other words, based on the individual students' or group's capability, with the mentor's recommendations, if the proposed Minor Project adhering to the

qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Minor Project, in even semester with suitable improvements/modifications.

- Alternatively, student groups can work completely on a new project idea in the even semester, bearing no resemblance with the topic of odd semester. This policy can be adopted on a case to case basis.

Assessment:
Term Work - 25 marks
Mid Semester Evaluation - 25 marks
Practical/Oral Examination - 25 marks

Guidelines for Assessment of Minor Project - Term Work:

- The review/ progress monitoring committee shall be constituted by heads of department. The progress of the minor project to be evaluated on a continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In the first semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the student group.
  - If the problem is based on development of a mechanism or a simple device for attaining a desired objective, the first presentation shall be reviewed based on generation of multiple feasible solutions to the given problem and identification of the best possible solution based on various parameters which may include one of more of the following viz., the total weight, volume, power consumption, mechanical advantage, efficiency, cost (including labour) per piece once manufactured, and so on. This may include creation of unique free-hand sketches by each and every member of the group to contribute to the solution of the given problem. The best possible solution has to be finalized during one or more brainstorming sessions by the members of the student group. In case the problem is of a programming/coding type, then the first presentation may be dedicated to the understanding of the theory behind the problem related to a particular domain subject, including the drafting of an algorithm and/or flowchart, and may also include the introductory part of the programming.
  - Second review shall be based on the computerization (3D CAD model of parts and assembly), and possibly the animation, depicting the working characteristics of the proposed solution to the given problem, allocating material properties to each part, identifying mass properties of the assembled parts, and so on. Checking interference is one of the important criteria that can be used when assembling the parts. For software based projects, this may include the presentation based on the extension of the programming work so as to cover the major portion of the remaining part of the topic.

- In the second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed

in an earlier semester. For those selecting software based projects, this may include completing the other half of the programming related work, identifying the errors, optimizing the software code, customization, creating a graphical user interface of input and output (GUI), displaying output data in the form of graphs/tables/figures/diagrams, creation of the code in executable (.exe) format or in the form of a mobile App, etc.
    - First review shall be conducted based on the readiness of the working prototype, or programming of the remaining code for software based projects.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester. This may also include the testing and validation of tests with the literature/available data/theory. For software based projects, the presentation includes the remaining work other than the programming, as described above.

- Apart from the hardware type (development of device) and software (program/coding) type of projects, the topics may also include computer based work, viz., generation of virtual laboratory (for one or more experiments) for any subject/domain of choice, or CAD modeling, analysis, optimization, and/or product design, without any relevance to developing any physical product.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including:
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solutions.

Assessment criteria of Minor Project:

1. Quality of survey/need identification
2. Clarity of problem definition based on need
3. Innovativeness/uniqueness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness/uniqueness
8. Cost effectiveness and societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual as member or leader
13. Clarity in written and oral communication

- In a **one year project**, the first semester evaluation may be based on the first six criteria as highlighted above and the remaining criteria may be used for second semester evaluation of performance of students in the minor project.
- In the case of a **half year project,** all criteria in general may be considered for evaluation of performance of students in the minor project.

Guidelines for Assessment of Minor Project - Practical/Oral Examination:

- Report should be prepared as per the guidelines issued.
- Minor project shall be assessed through a presentation and demonstration of working model or the execution of programme code by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by the Head of Institution.
- Students shall be motivated to publish a paper based on the work in conferences or student competitions.

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Course Code	Course Name	Credits
ME 207	**Advanced Manufacturing Technology**	**3+1**

Course Objectives:

1. To familiarize with subtractive manufacturing processes in particular CNC systems.
2. To familiarize with various additive manufacturing processes
3. To familiarize with principle and working of non-traditional manufacturing
4. To introduce to them the Intelligent manufacturing in the context of Industry 4.0
5. To acquaint with basic process of developing 3D model using biomedical data.

Course Outcomes:
Learner will be able to

1. Develop and execute CNC part program for various machining operations.
2. Understand the generation of tool paths through different approaches.
3. Identify the additive manufacturing process for development of a component.
4. Illustrate principles and working of non-traditional manufacturing and select the proper process for the purpose of manufacturing.
5. Understand the manufacturing technologies enabling Industry 4.0
6. Develop a 3D model using available 2D images.

Theory Syllabus:

Module	Detail Content	Hrs.
1	**Computer aided Manufacturing:** Introduction, NC/CNC/DNC machines, Machining Centers, Coordinate system. CNC machining practices and programming: Manual part programming method, Canned Cycles for milling, turning.	08
2	**CAPP:** APT, Loops, Macros and Subroutines	06
3	**Additive Manufacturing:** Product development cycle and importance of prototyping, types of prototypes-principles and advantages, different types of generative manufacturing process viz. Vat Photopolymerisation, Material extrusion, Material Jetting, Binder Jetting, Powder bed Fusion, Direct energy deposition, Sheet Lamination.	06
4	**Nano Manufacturing techniques and micro-machining:** High speed machining and hot machining. Introduction to microfabrication for MEMS, bulk micromachining of silicon, surface micromachining of MEMS, wafer bonding for MEMS, LIGA process, micromachining of polymeric MEMS devices, 3D microfabrication	08
5	**Non-traditional Manufacturing processes** – Introduction, Construction, Working principle, Types, Process parameters, problems, merits, demerits and applications of : Chemical Machining, Ultrasonic Machining, Electro-Chemical Machining, Electric Discharge Machining, Electron Beam Machining, Plasma Arc Machining, Laser beam Machining and Ion Beam Machining.	06
6	**Intelligent manufacturing in the context of Industry 4.0:** Collaborative Manufacturing: Definition and Concept, Aims of Collaborative Manufacturing, Business Process Change Considerations for Collaborative Manufacturing, Enabling Technologies for	04

	Collaborative Manufacturing, Benefits and Limitations of Collaborative Manufacturing, Cloud Manufacturing ● Cyber-physical systems (CPS) ● Internet of Things (IoT) enabled manufacturing	

Laboratory Syllabus:

Module	Details	Hrs.
	Part A	
1.	Part programming and part fabrication on CNC Turning trainer (Involving processes like Step turning, facing, Taper turning, threading, etc.)	2
2.	Part programming and part fabrication on CNC Milling trainer (Involving processes like contouring, drilling, facing, pocketing etc.)	2
3.	Part Programming Simulation for any Unconventional Machining Process (Electric Discharge Machining, laser cutting Machining, Plasma Cutting Machining etc.)	2
4.	Tool-path generation by translation of part geometry from computer aided design (CAD) to computer aided manufacturing (CAM) systems.	4
	Part B	
5.	Development of physical 3D mechanical structure using any one of additive manufacturing processes.	4
6.	Study of the effect of variation in various parameters involved in additive manufacturing	2
7.	Creation of 3D model from 2D images using any image processing software and printing it. (3D Slicer open source) (Application: Any body organ like Heart, Gallbladder etc. as per available Dicom files)	2
8.	Manufacturing Simulation and Integration	2
	Part C	
9.	Case Study: Report on a visit conducted to any Commercial CNC Machining Centre explaining the Design features, pre processing in CAM software and its capabilities.	4

Theory Assessment:

Internal Assessment for 40 marks:

1. Consisting of One Compulsory Class Tests **-** 40 Marks
2. Continuous evaluation- Class Test/Assignments /Quiz/Case studies/Seminar presentation - 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Laboratory Assessment:
Internal Assessment: 50 marks
Term Work:

A. Minimum 3 exercises from 1-4 of the above list need to be undertaken.
B. Minimum 3 exercises from 2-8 of the above list need to be undertaken.
C. Exercise 9 is compulsory. Presentation/Seminar of the study done is required.

The distribution of marks for Term work shall be as follows:

Part A …….20 marks
Part B …….20 marks
Part C …….10 marks

Books/References:

1. CNC Programming for Machining, Kaushik Kumar, Chikesh Ranjan, J. Paulo Davim, Springer Publication.
2. Manufacturing Science by Ghosh and Malik
3. CAD/CAM Computer Aided and Manufacturing, Mikell P. Groover and Emory W. Zimmers, Jr., Eastern Economy Edition
4. CNC Technology and Programming, Krar, S., and Gill, A., McGraw Hill Publishers.
5. CAD/CAM Principles and Applications, P. N. Rao, Tata McGraw Hill Publications
6. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, I. Gibson l D. W. Rosen l B. Stucker, Springer Publication.
7. Rapid Manufacturing –An Industrial revolution for the digital age by N.Hopkinson, R.J.M.Hauge, P M, Dickens, Wiley.
8. Rapid Manufacturing by Pham D T and Dimov, Springer Verlag
9. Rapid Prototyping and Manufacturing, P. F. Jacobs, Society of Manufacturing Engineers
10. Production Technology by P C Sharma.
11. Industry 4.0: The Industrial Internet of Things by Alasdair Gilchrist, 2016, Apress.
12. Cyber-Physical Systems: From Theory to Practice by Danda B. Rawat, Joel Rodrigues, Ivan Stojmenovic, 2015, C.R.C. Press.
13. Optimization of Manufacturing Systems using Internet of Things by Yingfeng Zhang, Fei Tao, 2017, Academic Press (AP), Elsevier.
14. Medical Modelling The Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead Publishing Series in Biomaterials: Number 91, Elsevier Ltd.
15. Biomaterials, artificial organs and tissue engineering, Edited by Larry L. Hench and Julian R. Jones, Woodhead Publishing and Maney Publishing, CRC Press 2005

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Course Code	Course Name	Credits
ME 208	**Theory of Machines & Mechanisms**	**3+1**

Prerequisites:

1. Engineering Mathematics
2. Engineering Mechanics
3. Engineering Physics

Course Objectives:

1. To provide students with the knowledge on mechanisms and inversions.
2. To impart students with knowledge about forces acting on machine parts.
3. To enable students to understand the fundamental concepts of machines.
4. To study functioning of motion and power transmission machine elements.
5. To facilitate students to understand the functions of cams, gears, belt drives, chain drives and brakes.

Course Outcomes:

Upon successful completion of this course, learner will be able to

1. Identify mechanisms and their inversions.
2. Compute velocity and acceleration of various plane mechanisms by different methods.
3. Apply the principles for analyzing cams, gears and gear trains.
4. Synthesize mechanisms for following useful paths.
5. Draw cam profile for specific follower motion.
6. Develop and design mechanisms.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	**Fundamentals of Kinematics and Mechanisms** Concepts of Kinematics and Dynamics, Mechanisms and Machines, Planar and Spatial Mechanisms, Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion. Four bar chain and Slider Crank Mechanisms and their Inversions, Degrees of Freedom, Mobility and range of movement - Kutzbach and Grubler's criterion, Number Synthesis, Grashof's criterion.	06
2.	**Mechanisms with Lower Pairs:** Straight line mechanisms - Exact and Straight, Steering gear mechanisms: Condition for correct steering, Davis steering gear mechanism, Ackermann steering gear mechanism. Hooke's joint- Single and Double.	06
3.	**Velocity and Acceleration Analysis:** **Relative velocity method:** Relative velocity of a point on a link, Angular velocity of a link, Sliding velocity, Velocity polygons for simple mechanisms. **Relative acceleration method:** Relative acceleration of a point on a link, Angular acceleration of a link, Acceleration polygons for simple mechanisms. (limit to only 4 link mechanisms) **Instantaneous center of rotation (ICR) method:** Definition of ICR, Types of ICRs, Methods of locating ICRs (limit to only 6 link mechanisms), Kennedy's Theorem, Coriolis component of acceleration.	08

4.	**Flexible Power Transmission Systems:** **Belts:** Introduction, Types and all other fundamentals of belting, Dynamic analysis—belt tensions, condition of maximum power transmission. **Chains:** Types of chains, chordal action, variation in velocity ratio, length of chain. **Brakes:** Introduction, types and working principles, Introduction to braking of vehicles.	06
5.	**Kinematics of Cams:** Types of cams and followers, Cam and follower terminology, displacement, velocity and acceleration diagrams of follower motions viz Uniform velocity, Simple harmonic motion, Uniform acceleration and retardation motion and cycloidal motion.	06
6.	**Gears and Gear Trains:** **Gears:** Terminology, Law of Gearing, Characteristics of involute and cycloidal action, Interference and undercutting, centre distance variation, minimum number of teeth, contact ratio, spur, helical, spiral bevel and worm gears, problems. **Gear Trains:** Synthesis of Simple, compound & reverted gear trains, Analysis of epicyclic gear trains.	07

Laboratory Syllabus:

Module	Details	Hrs.
1.	3 to 5 problems on velocity analysis using the ICR method.	04
2.	3 to 5 problems on velocity and acceleration analysis using relative velocity and acceleration methods.	04
3.	3 to 5 problems on velocity and acceleration analysis using relative velocity and acceleration methods involving Coriolis component.	04
4.	Plotting of displacement–time, velocity-time and acceleration-time, jerk-time, and layout of cam profiles - 3 to 5 problems	06
5.	Project based learning on design and fabrication of any one mechanism for a group of maximum 4 students.	08

Theory Assessment:
Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests - 40 Marks
2. Continuous evaluation- Class Test/Assignments /Quiz/Case studies/Seminar presentation - 40 Marks

End-Semester Examination: 60 marks
Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Laboratory Assessment:
Term Work: 25 marks
Students have to submit signed and completed assignments based on the modules listed in the table, as a part of the term work. They can also avail NPTEL Certification for this course, for which the assignment work may be suitably reduced, at the discretion of the Instructor.
Viva-você: 25 marks
Viva-você exam shall be conducted at the end of the course.

Books/References:

1. S. S. Rattan, “Theory of Machines”, Tata McGraw Hill
2. R L Norton, Kinematics and Dynamics of Machinery, McGraw-Hill Education
3. Ashok G. Ambekar, “Mechanism and Machine Theory”, Prentice Hall, India
4. Theory of Machines, Singh Sadhu, Pearson Education.
5. Shigley J. E., and Uicker J.J., “Theory of Machines and Mechanism”, McGraw Hill Inc.
6. Wilson C.E., Sandler J. P. Kinematics and Dynamics of Machinery”, Pearson Education.

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Course Code	Course Name	Credits
ME 209	**Fluid Mechanics and Machinery**	**3+1**

Course Objectives:

1. To study fluid statics and fluid dynamics
2. To study application of mass, momentum and energy equations in fluid flow.
3. To learn various flow measurement techniques.
4. To study utilization of hydraulic energy

Course Outcomes:

Upon successful completion of this course, the learner will be able to

1. Calculate the forces exerted by fluid at rest on plane or curved submerged surfaces.
2. Apply Bernoulli equation to solve a variety of fluid flow problems.
3. Categorize the type of flow (whether laminar or turbulent) using Reynolds equation.
4. Estimate the loss of energy of the incompressible fluid associated with pipe flow.
5. Compare the performance of the impulse and reaction Turbine and plot their characteristics.
6. Estimate performance parameters of Centrifugal and positive displacement pumps.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	1.1 **Introduction :** Newtonian and Non Newtonian Fluids. 1.2 **Fluid Statics**: Forces on fluid elements, Hydrostatic thrust on Submerged surfaces (plane and curved). 1.3 **Fluid Kinematics:** Eulerian and Lagrangian approach to solutions; Velocity and acceleration in a Eulerian flow field; Definition of streamlines, path lines and streak lines; types of fluid flow, Definition and equations for stream function, velocity potential function (no numerical).	6
2.	2.1 **Fluid Dynamics:** Definition of control volume and control surface, Integral equations for the control volume: Reynolds Transport theorem (no numerical), Differential equations for conservation of mass, energy and momentum, Euler's equations in 1&3 dimensions and subsequent derivation of Bernoulli's equation and its application in flow measurement, pitot tube, venture, orifice	8
3.	3.1 **Laminar Viscous flow**: Introduction to Reynolds number, Navier-Stokes equation of motion (Without proof), Laminar flow between parallel plates (Plane Poiseuille & Couette flow), Laminar flow in circular pipe (Hagen-Poiseuille flow).	6
4.	4.1 **Hydrodynamic Boundary Layer Theory:** Concept of formation of boundary layer, boundary layer parameters, boundary layer along a long thin plate, 4.2 **Flow around submerged objects:** Concept of drag and lift, Types of drag, Streamlined and bluff bodies, Drag and lift on an aerofoil. 4.3 **Flow through pipes**: Head loss in pipes due to friction (Darcy-Weisbach equation (Without proof)), Loss of energy in pipe (major and minor), Hydraulic gradient and Energy gradient line, Pipes in series and parallel.	6

5.	5.1 **Types of hydro turbines** - impulse and reaction, definition of various turbine parameters like gross head, discharge, work done, input power, output power, efficiencies etc., Eulers' equation applied to a turbine, turbine velocities and velocity triangles, expression for work done. Pelton Turbine: Components of Pelton turbine, definition of design parameters like speed ratio, jet ratio, and estimation of various parameters like head, discharge, and efficiency etc., determination of number of buckets. Reaction Turbines: Types of reaction turbines - inward and outward flow, radial mixed and axial; elements of the turbine, estimation of various parameters 5.2 **Performance Characteristics:** Cavitations in turbines - causes, effects and remedies, Characteristics of turbines	7
6.	6.1 **Pumps:** Classification of pumps - positive displacement and non - positive displacement. Positive Displacement pumps: Types and applications, definition of head, discharge, work done and efficiency, types of reciprocating pumps, indicator diagram, use of air vessel. (No Numerical) 6.2 **Centrifugal Pumps:** Types - radial flow, mixed flow and axial flow, Priming of pumps, components of the pump, Euler's equation and velocity triangles 6.3 **Performance Characteristics**: Design constant e.g., head constant, flow constant etc., Concept of system and system characteristics, Series and parallel operation of pumps. Determination of operating point. Determination of available and required NPSH	6

Laboratory Syllabus:

Sr. No.	Details	Hrs.
1	Calibration of pressure gauge	2
2	Calibration of venture meter / orifice meter / nozzle meter / pitot tube	2
3	Determination of friction factor for pipes	2
4	Determination of minor losses in pipe fittings	2
5	Verification of Bernoulli's equation	2
6	Trial on Impulse / reaction turbine	2
7	Trial on positive displacement pump (Gear pump/ Vane pump/screw pump)	2
8	Trial on single stage / multistage centrifugal pump	2

Theory Assessment:
Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Class Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum

Laboratory Assessment:
Internal Assessment
Term Work Marks: 25 Marks

Laboratory Work (Journal Completion) : 20 Marks
Attendance : 5 Marks

End Semester Practical/Oral Examination:
Pair of Internal and External Examiners should conduct practical/viva based on contents.
Distribution of marks for practical/viva examination shall be as follows:

Practical Examination : 15 Marks
Oral Examination : 10 Marks

Books/References:

1. Fluid Mechanics by Yunus A Cengel and John M Cimbala, Tata McGraw Hill Education, 3rd Edition, 2014.
2. Fluid Mechanics and Machinery by C S P Ojha, Chandramouli and R Berndtsson, Oxford University Press, 1st Edition, 2010.
3. Fox and McDonald's Introduction to Fluid Mechanics by Philip J. Pritchard and John W. Mitchell, Wiley Publishers, 9th Edition,2016.
4. A textbook of Fluid Mechanics & Hydraulic machines by R K Bansal, Laxmi Publication, 9th Edition, 2005
5. A textbook of Fluid Mechanics & Hydraulic machines by R K Rajput, S. Chand & company ltd Laxmi Publication, 4th Edition, 2010
6. Fluid Mechanics by Frank M. White, McGraw Hill Education, 7th Edition, 2011.
7. Fluid Mechanics by Victor Streeter, Benjamin Wylie and K W Bedford, McGraw Hill Education, 9thEdition, 2010.
8. Engineering Fluid Mechanics by K. L. Kumar, Eurasia Publishing House (P) Ltd, 1 st Edition and Reprint 2016.
9. Fluid Mechanics and Hydraulic Machinery, Modi and Seth, Standard Book House
10. Introduction to Fluid Mechanics by James A. Fay, MIT Press, Campbridge, 1st Edition, 1996.
11. Fluid Mechanics and Hydraulics by Suresh Ukarande, Ane Books Pvt.Ltd, Revised & Updated 1st Edition, 2016

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Course Code	Course Name	Credits
ME 210	**Human Values and Social Ethics**	**2**

Prerequisite: Should have respect for justice and be able to reflect on one's personal beliefs and values

Course Objectives:

1. To enable learners to understand the core values that shape the ethical behaviour of a professional.
2. To develop an awareness on the different ethical dilemmas at the workplace and society.
3. To inculcate the ethical code of conduct in writing technical articles and technology development.
4. To internalize ethical principles and code of conduct of a good human being at home, society and at work place.

Course Outcomes: After successful completion of the course students will be able to

1. Learners will be able to recognize the relation between ethics and values pertinent for an engineering professional.
2. Learners will be able to exercise the responsibility for establishing fair and just processes for participation and group decision making
3. Learners will be able to demonstrate an awareness of self-held beliefs and values and how they are altered in interactions with others.
4. Learners will be able to acquire the writing skills necessary to analyse data from research and attribute the source with proper citation.
5. Learners will be competent to incorporate values and ethical principles in social and professional situations.

Module	Details	Hours
1	**Ethics and Values** : Meaning & Concept of Ethics Difference between Ethics and Values Ethical code of conduct	03
2	**Professional Ethics** : Professional Ethics vs Personal ethics Components of professional ethics Professional values and its importance	05
3	**Ethics and Society** : Relevance of values and ethics in social work Ethical dilemmas Values and ethical principles of social work · Service · Dignity and worth of a person · Importance of Human relationships · Integrity · Competence · Social Justice	04
4	**Ethics in Technical writing** : Documenting sources	07

	Presentation of Information Ethics & Plagiarism	
5	**Ethics and Technology Development** : Risk management and Individual rights Moral issues in development and application of technology Privacy/confidentiality of information Managing Technology to ensure fair practices	07

Assessment:

Termwork : 50 marks (Continuous evaluation)

Reference Books:

1. Martin Cohen, *101 Ethical Dilemmas* Routledge, 2nd edition, 2007.
2. M. Govindarajan, S. Natarajan & V.S. Senthilkumar, *Professional Ethics and Human Values,* Prentice Hall India Learning Private Limited, 2013.
3. Mike W. Martin, *Ethics in Engineering*, McGraw Hill Education; Fourth edition, 2017.

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Course Code	Course Name	Credits
ME 211	**Data Science**	**1.5**

Course Objectives:

1. To introduce concepts of Data Science using R programming language.
2. To introduce basic concepts of R programming language as well as common packages and libraries.
3. To generate an ability to utilize Data Science concepts with R programming to solve mechanical engineering related problems.

Course Outcomes: Upon successful completion of this course, the learner will be able to

1. To understand concepts of data science with R programming language.
2. To understand fundamentals of R programming and data frame.
3. To be able to visualise the data using R programming package.
4. To be able to prepare the data for analysis.
5. Understanding hypothesis testing and being able to make decisions.

Module	Detail Content	Hrs.
1.	**Introduction to business analytics** What is analytics & why is it so important? - Applications of analytics - Different kinds of analytics - Various analytics tools - Analytics project methodology	02
2.	**Fundamentals of R** Installation of R & R Studio - Getting started with R - Basic & advanced data types in R - Variable operators in R - Working with R data frames - Reading and writing data files to R - R functions and loops - Special utility functions - Merging and sorting data	08
3.	**Data visualization in R** Need for data visualization - Components of data visualization - Utility and limitations - Introduction to grammar of graphics - Using the ggplot2 package in R to create visualizations	06
4.	**Data preparation and cleaning using R** Needs & methods of data preparation - Handling missing values - Outlier treatment - Transforming variables - Derived variables - Binning data - Modifying data with Base R - Data processing with dplyr package	06
5.	**Understanding the data using univariate statistics in R** Summarizing data, measures of central tendency - Measures of variability, distributions - Using R to summarize data **Hypothesis testing and ANOVA in R to guide decision making** Introducing statistical inference - Estimators and confidence intervals - Central Limit theorem - Parametric and non-parametric statistical tests - Analysis of variance (ANOVA) - Conducting statistical tests	08
6.	**Correlation and Linear regression** Correlation - Simple linear regression - Multiple linear regression - Model diagnostics and validation - Case study **Logistic regression** Moving from linear to logistic - Model assumptions and Odds ratio - Model assessment and gains table - ROC curve and KS statistic - Case Study	08

Lab Assessment:

Termwork : 25 marks (Continuous evaluation)
Practical/Oral : 50 marks

Books/ References:

1. R for Data Science, Hadley Wickham, Garrett Grolemund, O'Reilly Media.
2. Hands-On Programming with R, Garrett Grolemund, O'Reilly Media.
3. Any digital resources and online guides for R or its packages.

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Course Code	Course Name	Credits
ME 212	**Internet of Things**	**1.5**

Course Objectives:

1. To understand the need and justification of IOT
2. To familiarize with robotic systems in automated
3. To provide a IoT system for the collection of information from the environment and its transfer to a server, as well as the skills necessary for the development of control logics, processing and display of data.
4. To create an environment for research, design, development and testing of IoT solutions, in the field of energy management, communication systems, distributed sensor devices and advanced user interfaces
5. Provide students unique interdisciplinary learning and innovation experiences with IoT technologies

Course Outcomes:

Upon successful completion of this course, the learner will be able to

1. Able to understand the application areas of IOT
2. Physical Design of IOT, Home Automation IOT, Environment, Agriculture, Industry, Health & LifeStyle.
3. Installing various necessary softwares, drivers and operating systems with knowledge of lots of hardwares like various microcontrollers and microprocessors.
4. Able to use different programming languages like C++, python, logical coding, blockly.
5. Control systems remotely over the internet.

List of Experiments

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation using C++ /python.
2. To interface LED/Bluzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. To interface DHT11 sensor with Arduino/Rasberry Pi and write a program to print temperature and humidity readings.
5. To interface OLED with Arduino/Rasberry Pi and write a program to print temperature and humidity readings on it.
6. Real time interfacing of sensors (temperature and humidity) and actuators (Servo motors) using Arduino. Controlling actuators & monitoring sensors output remotely using internet and wifi module.
7. To interface motor/Led bulb using relay with arduino/Raspberrypi and write a program to turn On motor from smartphone using blynk and Bluetooth module.
8. IOT Paralysis Patient Health Care Project using accelerometer, wifi module and microcontroller based notification system over smartphone for need of help.

Laboratory Assessment:

Internal Assessment

Term Work Marks: 50 Marks

Course Project	: 30 Marks
Laboratory Work (Journal Completion)	: 15 Marks

Attendance : 5 Marks

End Semester Practical/Oral Examination:

Pair of Internal and External Examiners should conduct practical/viva based on contents. Distribution of marks for practical/viva examination shall be as follows:

Practical Examination : 15 Marks
Oral Examination : 10 Marks

Books/References:

1. Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud by Cuno Pfister.
2. Internet of Things Programming Projects: Build Modern IoT Solutions with the Raspberry Pi 3 and Python Book by Colin Dow.
3. Beginning C for Arduino, Second Edition: Learn C Programming for the Arduino Book by Jack J Purdum.
4. Learning Python with Raspberry Pi, Book by Alex Bradbury and Ben Everard.

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Course Code	Course Name	Credits
ME 292	**Minor Project II**	**2**

Course Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcomes:

Learner will be able to

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as a member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
9. Demonstrate project management principles during project work.

Guidelines for Minor Project:

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do surveys and identify needs, which shall be converted into a problem statement for minor-project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Student groups shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of the minor project.
- A log book has to be prepared by each group, wherein the group can record weekly work progress, and the guide/supervisor can verify and record notes/comments.
- Faculty supervisors may give inputs to students during minor project activity; however, focus shall be on self-learning.
- Students in a group shall understand the problem effectively, propose multiple solutions and select the best possible solution in consultation with the guide/supervisor.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
- The solution has to be validated with proper justification and the report has to be compiled in the standard format.
- With the focus on self-learning and innovation, addressing societal problems and entrepreneurship quality development within the students through the Minor Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Minor Project 1 in semester III and IV. Similarly, Minor Project 2 in semesters V and VI may be considered. In other words, based on the individual students' or group's capability, with the mentor's

recommendations, if the proposed Minor Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Minor Project, in even semester with suitable improvements/modifications.

- Alternatively, student groups can work completely on a new project idea in the even semester, bearing no resemblance with the topic of odd semester. This policy can be adopted on a case to case basis.

Assessment:
Term Work - 25 marks
Mid Semester Evaluation - 25 marks
Practical/Oral Examination - 25 marks

Guidelines for Assessment of Minor Project:
Term Work

- The review/ progress monitoring committee shall be constituted by heads of departments of each institute. The progress of the minor project to be evaluated on a continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In the first semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the student group.
    - If the problem is based on development of a mechanism or a simple device for attaining a desired objective, the first presentation shall be reviewed based on generation of multiple feasible solutions to the given problem and identification of the best possible solution based on various parameters which may include one of more of the following viz., the total weight, volume, power consumption, mechanical advantage, efficiency, cost (including labour) per piece once manufactured, and so on. This may include creation of unique free-hand sketches by each and every member of the group to contribute to the solution of the given problem. The best possible solution has to be finalized during one or more brainstorming sessions by the members of the student group. In case the problem is of a programming/coding type, then the first presentation may be dedicated to the understanding of the theory behind the problem related to a particular domain subject, including the drafting of an algorithm and/or flowchart, and may also include the introductory part of the programming.
    - Second review shall be based on the computerization (3D CAD model of parts and assembly), and possibly the animation, depicting the working characteristics of the proposed solution to the given problem, allocating material properties to each part, identifying mass properties of the assembled parts, and so on. Checking interference is one of the important criteria that can be used when assembling the parts. For software based projects, this may include the presentation based on the extension of the programming work so as to cover the major portion of the remaining part of the topic.

- In the second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. For those selecting software based projects, this may include completing the other half of the programming related work, identifying the errors, optimizing the software code, customization, creating a graphical user interface of input and output (GUI), displaying output data in the form of graphs/tables/figures/diagrams, creation of the code in executable (.exe) format or in the form of a mobile App, etc.
  - First review shall be conducted based on the readiness of the working prototype, or programming of the remaining code for software based projects.
  - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester. This may also include the testing and validation of tests with the literature/available data/theory. For software based projects, the presentation includes the remaining work other than the programming, as described above.

- Apart from the hardware type (development of device) and software (program/coding) type of projects, the topics may also include computer based work, viz., generation of virtual laboratory (for one or more experiments) for any subject/domain of choice, or CAD modeling, analysis, optimization, and/or product design, without any relevance to developing any physical product.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including:
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solutions.

Assessment criteria of Minor Project:

1. Quality of survey/need identification
2. Clarity of problem definition based on need
3. Innovativeness/uniqueness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness/uniqueness
8. Cost effectiveness and societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual as member or leader
13. Clarity in written and oral communication

- In a **one year project**, the first semester evaluation may be based on the first six criteria as highlighted above and the remaining criteria may be used for second semester evaluation of performance of students in the minor project.
- In the case of a **half year project,** all criteria in general may be considered for evaluation of performance of students in the minor project.

Guidelines for Assessment of Minor Project Practical/Oral Examination:

- Report should be prepared as per the guidelines.
- Minor project shall be assessed through a presentation and demonstration of working model or the execution of programme code by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by the Head of Institution.
- Students shall be motivated to publish a paper based on the work in conferences or student competitions.

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Course Code	Course Name	Credits
ME 301	**Finite Element Analysis**	**3+1**

Prerequisites:

1. Understanding of Differential equations including degree, order, boundary conditions. Solution of Ordinary Differential equations.
2. Understanding of Basic Algebra and Matrices.
3. Understanding of Solid Mechanics, thermal, fluid systems along with their governing equations and variables.
4. Modelling of parts in any software

Course Objectives:

1. To equip with the Finite Element Analysis fundamentals.
2. To apply finite element formulation for the solution of mechanical engineering problems.
3. To make the students use simulation techniques to get results for complex problems.

Course Outcomes:

Upon successful completion of this course, learner will be able to

1. Apply weighted residual methods to solve governing differential equations of the problem domain.
2. Discretize the problem domain using appropriate elements and apply boundary conditions.
3. Apply the finite element formulation to solve one-dimensional mechanical engineering problems.
4. Apply the finite element formulation to solve two-dimensional mechanical engineering problems.
5. Apply the finite element method to solve one-dimensional dynamic problems.
6. Use professional-level finite element analysis software to solve real life problems.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	**Introduction:** Introduction to Finite Element Method, Weighted Residual Methods, Variational formulation of boundary value problems, Principal of Minimum Potential Energy, Ritz Method.	4
2.	**Basic concept of Finite Element Method:** Mathematical modeling of field problems in engineering with One dimensional second order equation, discretization , Element types, 1D linear and higher order elements, derivation of shape functions in local and natural coordinate systems, Stiffness matrix and force vectors, assembly of elemental matrices.	8
3.	**1D Analysis:** Application of element stiffness matrix to find Solution of problems from solid mechanics (Step bar, trusses, beams, torsion etc.), heat transfer, fluid flow etc.	8
4.	**Dynamic Analysis:** Dynamic equations of motion, consistent and lumped mass matrices, free vibration analysis.	6
5.	**2D Analysis:** Two dimensional equations, variational formulation, finite element formulation, Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements, triangular elements -	8

	shape functions, elemental matrices, stress analysis and RHS vectors, quadrilateral and higher order elements, isoparametric elements and its shape functions, Convergence and compatibility condition.	
6.	**Application of FEA:** Discussion of various case studies in different fields and its simulation in FEA software (may include special cases like composites, nonlinear analysis, multi domain analysis etc.).	5

Laboratory Syllabus:

Exercise	Detail Content	Hrs.
1	Introduction to ANSYS (APDL and Workbench)	2
2	Analysis of Rod subjected to axial Load (Step bar, taper rod)	2
3	Truss Analysis	2
4	Beam Analysis	2
5	Thermal Analysis	2
6	Modal analysis	2
7	Axis-symmetry Analysis	2
8	Convergence Study	2
9	Comparison of results while solving the same problem in 1D, 2D or 3D.	2
10	Writing a program using any programming language (Python, R, Matlab, Scilab, C++, etc.) for a finite element solution to any 1D/2D problem.	2
11	Course Project: Simulation of any assembly / Multi domain Analysis / Nonlinear analysis / Analysis of Composites etc.	4

Theory Assessment:
Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests - 40 Marks
2. Continuous evaluation- Class Test/ Assignments /Quiz/Case studies/Seminar presentation- 40 Marks

End Semester Examination: 60 Marks
Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Laboratory Assessment:
Internal Assessment: 25 marks
Term Work:

A. Minimum 6 exercises from 2-9 of the above list need to be undertaken.
B. Validation of the simulation results obtained through software with calculation.
C. Exercise 10 is compulsory. Presentation/Seminar of the study done is required.

The distribution of marks for Term work shall be as follows:

Part A : 10 marks
Part B : 5 marks
Part C : 10 marks

End Semester Practical/Oral Examination: 25 marks
A pair of Internal and External Examiners should conduct practical/viva based on contents.
Distribution of marks for practical/viva examination shall be as follows:

Practical Examination : 15 Marks
Oral Examination : 10 Marks

Books/References:

1. J. N. Reddy; An Introduction to Finite Element Method; 3rd Edition, McGraw Hill.
2. R. D. Cook, Davis S. Malkus, Michael E. Plesha and Robert J. Witt; Concepts and Applications of Finite Element Analysis; 4th Edition, Wiley.
3. S. S. Rao; The Finite Element Method in Engineering; 5th Edition, Elsevier, Butter Worth Heinemann.
4. O. C. Zienkiewicz and R. L. Taylor; The Finite Element Method, Vol. I and II, 6th Edition, Elsevier, Butter Worth Heinemann.
5. K.L. Bathe and E.L. Wilson; Finite Element Methods; Prentice Hall.
6. David V Hutton; Fundamentals of Finite element analysis; 7th Edition Tata McGraw Hill.
7. T. R. Chandrupatla and A. D. Belegundu; Introduction to Finite Elements in Engineering; 4th Edition, Pearson.
8. D. L. Logan; A first course in Finite Element Method; 5th Edition, Cengage Learning.
9. P. Seshu; Text book of Finite Element Analysis; 10th Edition, Prentice Hall of India.
10. N. S. Gokhale, S. S. Deshpande, S. V. Bedekar and A. N. Thite; Practical Finite Element Analysis; 1st Edition, Finite to Infinite.

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Course Code	Course Name	Credits
ME 302	**Heat Transfer**	**3+1**

Course Objectives:

1. To understand the fundamentals of heat transfer in fluids and solids during steady state and unsteady state.
2. To Study mathematical modeling and designing concepts of heat exchangers

Course Outcomes:

Learner will be able to

1. Understand the basic laws of heat transfer
2. Identify, formulate, and solve heat transfer problems in thermal analyses of engineering systems.
3. Analyze problems and develop solution for steady state and unsteady state heat conduction problem in simple geometries
4. Understand the fundamentals of convective heat transfer process Evaluate heat transfer coefficients for natural convection and forced convection.
5. Calculate radiation heat transfer between black body and grey body surfaces.
6. Analyze heat exchanger performance and estimate an effectiveness of heat exchanger.

Theory Syllabus:

Module	Detail Content	Hrs.
1	**Basic concepts of heat transfer:** Difference between heat transfer and Thermodynamics, Physical mechanism of different modes of heat transfer, Steady and unsteady heat transfer, one dimensional, two dimensional and three dimensional heat transfer, Fourier law of heat conduction, Thermal conductivity, Thermal resistance concept in heat transfer, Thermal diffusivity, Governing law of convection, Free and forced convection.	6
2	**Conduction:** Generalized heat conduction equation in rectangular, cylindrical and spherical coordinates (only equation for cylindrical and spherical coordinates, no derivation), Steady state heat conduction through plane wall, Composite wall, cylinder, composite cylinder wall, sphere, and composite sphere wall, Critical radius of insulation in cylinder and sphere, Thermal contact resistance, Internal Heat generation concept.	7
3	**Heat transfer from Extended Surface:** Types of extended surface and its significance Governing differential equation for fin and its solution, Fin performance: Fin effectiveness and Fin efficiency, Thermowell **Unsteady state heat transfer:** Applications of unsteady state heat transfer, Lumped system Analysis, characteristic length, Biot Number, Thermal time constant and Response of a thermocouple, Heisler Charts	6
4	**Convection:** Determination of heat transfer coefficient, Dimensional Analysis, Dimensionless numbers in free and forced convection and their significance.	7

	External Flow: Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent, flow over a flat plate, Flow across cylinder and sphere, Flow across bank of tubes **Internal Flow:** Velocity Boundary layer and Thermal Boundary layer, Laminar and Turbulent, flow in tubes, General thermal analysis: Constant heat flux and constant surface temperature **Heat Pipe:** Introduction and application	
5	**Radiation:** Emissivity, transmissivity, reflectivity, absorptivity, black body, Grey body, Opaque body, Radiation intensity, Basic laws of radiation, Radiation heat exchange between black bodies, Reciprocity theorem, Shape factor algebra, Radiation heat exchange between nonblack bodies, Electrical network approach for radiation heat exchange: Radiosity and irradiation, Radiation shield	6
6	**Boiling and Condensation:** Boiling heat transfer, Pool boiling: different regimes and pool boiling curve, Flow boiling: Different Regimes and Boiling curve, Condensation heat transfer, Film condensation, Dropwise Condensation. **Heat Exchangers:** Types of heat exchangers, Overall heat transfer coefficient, Fouling factor Analysis of heat exchangers, LMTD, Effectiveness –NTU method, Correction factor Effectiveness of heat exchangers.	7

Laboratory Syllabus:

S. No.	Details	Hrs.
1	Measurement of thermal conductivity of insulating powder	2
2	Measurement of thermal conductivity of metal rod	2
3	Performance analysis of extended surfaces under free and force convection	2
4	Unsteady state heat transfer in cylinder/rod/wall	2
5	Measurement of Emissivity of Grey surface	2
6	Estimation of overall heat transfer coefficient and effectiveness of double pipe heat exchanger (parallel flow and Counter flow arrangement)	2
7	Simulation to estimate effect of various parameters on heat transfer	2
8	Heat Transfer analysis/estimation using numerical methods/computational techniques	2

Theory Assessment:
Internal Assessment for 40 marks:
Internal Assessment: 40 marks.

1. Consisting of One Compulsory Class Tests - 40 Marks
2. Continuous evaluation- Class Test/Assignments /Quiz/Case studies/Seminar presentation - 40 Marks

End Semester Examination: 60 Marks
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum

Laboratory Assessment:
Term Work Marks: 25 Marks

Laboratory Work (Journal Completion) : 20 Marks
Attendance : 05 Marks

End Semester Practical/Oral Examination:
Pair of Internal and External Examiners should conduct practical/viva based on contents.

Distribution of marks for practical/viva examination shall be as follows:

Practical Examination	: 15 Marks
Oral Examination	: 10 Marks
Total	: 25 Marks

Books/References:

1. Fundamentals of Heat and Mass Transfer by F.P. Incropera and D P deWitt, Wiley India, 3rd Edition.
2. Introduction to thermodynamics and Heat transfer by Yunus A Cengel 2nd Edition, McGrawHill.
3. Fundamentals of Heat and Mass Transfer, M. Thirumaleshwar, Pearson Education India,2009.
4. Introduction to Heat Transfer, Som S. K ,PHI Publication.
5. Heat Transfer by P S Ghoshdastidar, 2nd Edition, Oxford University Press.
6. Heat and Mass Transfer, by R Rudramoorthy and L Malaysamy, 2nd Edition, PEARSON.
7. Heat Transfer by J P Holman, Mcgraw Hill.
8. Heat Transfer by S P Sukhatme, University Press.
9. Heat and Mass Transfer by PK Nag, TMH.

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Course Code	Course Name	Credits
ME 303	**Mechanical Measurements & Instrumentation**	**3+1**

Course Objectives:

1. To study the principles of precision measuring instruments & their significance.
2. To familiarize with the handling & use of precision measuring instruments/ equipment.
3. To Impart knowledge of architecture of the measurement system.
4. To deliver working principle of mechanical measurement system.

Course Outcomes:

Upon successful completion of this course, the learner will be able to

1. Handle, operate and apply the precision measuring instruments / equipment.
2. Analyze simple machined components for dimensional stability & functionality.
3. Classify various types of static characteristics and types of errors occurring in the system.
4. Understand the calibration process.
5. Classify and select proper measuring instruments for displacement, strain and acceleration measurements.
6. Classify and select proper measuring instruments for pressure, flow and temperature measurements.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	**Metrology** 1.1 Introduction to Metrology, Need for inspection, Fundamental principles and definition, Standards of measurement, Errors in measurements, International standardization. 1.2 Limits, fits and tolerances of interchangeable manufacture, Elements of interchangeable system, Hole based and shaft based systems, Tolerance grades, Types of fits, General requirements of Go & No go gauging, Taylor's principle, Design of Go & No go gauges.	5
2.	2.1 Principles of interference, Concept of flatness, Flatness testing, Optical flats, Optical Interferometer and Laser interferometer. 2.2 Surface texture measurement: importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters - Ra, Ry, Rz, RMS value etc., Surface roughness measuring instruments. 2.3 Screw Thread measurement: Two wire and three wire methods, Floating carriage micrometer. 2.4 Gear measurement: Gear tooth comparator, Master gears, Measurement using rollers and Parkinson's Tester.	8
3.	**Mechanical Measurements & instrumentation -** 3.1 Definition, Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying inputs.	5

	3.2 Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc.	
4.	4.1 Calibration of Measuring Sensors and Instruments Principles of Calibration, Calibration process, Control of Calibration Environment 4.2 Data Acquisition & Signal conditioning: Amplifier, Conversion, Filtering, Impedance Buffering, Modulation / Demodulation, Linearization, Grounding and Isolation 4.3 Signal Processing - Introduction, Analog filters - Active & Passive filters, Digital Filters. Convertors ADC DAC.	7
5.	5.1 Displacement Measurement: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance. Types, Digital Transducers (optical encoder), Nozzle Flapper Transducer 5.2 Strain Measurement: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors 5.3 Measurement of Angular Velocity: Tachometers, Tachogenerators, Digital tachometers and Stroboscopic Methods. 5.4 Acceleration Measurement: theory of accelerometer and vibrometers, practical accelerometers, strain gauge based and piezoelectric accelerometers	7
6.	6.1 Pressure Measurement: Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges 6.2 Flow Measurement: Bernoulli flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter 6.3 Temperature Measurement: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples, Pyrometers	7

Laboratory Syllabus:

Exercise	Details	Hrs.
Group 1: Mechanical Measurements		
1	Calibration of Displacement sensors like LVDT, Potentiometers etc.	2
2	Calibration of Pressure Gauges	2
3	Calibration of Vacuum Gauges	2
4	Torque measurement using strain gauges	2
5	Experiment on different types of tachometers and stroboscope	2
6	Vibration Measurement & Calibration of Accelerometers.	2
Group 2: Metrology & Quality control		
1	Vernier Calliper, Micrometer and Bevel Protractor for linear and angular measurement	2
2	Gear measurement – Gear tooth Vernier calliper / Parkinson gear tester	2
3	Screw Thread Measurement – screw thread Micrometer, Floating carriage micrometer /bench micrometer	2
4	Optical profile projector for miniature linear / angular measurements of screw / gear or components	2
5	Comparator – Mechanical / Pneumatic type	2
6	QC charts for 50 sample readings of OD / ID of specimen and printouts	2

Theory Assessment:
Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests **-** 40 Marks
2. Continuous evaluation- Class Test/ Assignments /Quiz/Case studies/Seminar presentation - 40 Marks

End Semester Examination: 60 Marks
Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Laboratory Assessment:
Term Work Submission: 25 Marks

1. Term work shall consists of minimum Eight Experiments, taken from Two groups mentioned below
2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
3. Students work along with evaluation reports to be preserved till the next examination.

End Semester Practical/Oral Examination: 25 Marks
Pair of Internal and External Examiners should conduct practical/viva based on contents.
Distribution of marks for practical/viva examination shall be as follows:

Practical Examination : 15 Marks
Oral Examination : 10 Marks

Books/References:

1. Engineering. Metrology, I.C. GUPTA, Dhanpat Rai Publications.
2. Engineering. Metrology, R. K. Jain, Khanna Publisher.
3. Measurement Systems: Applications and Design, by EO Doebelin,5th Edition, McGraw Hill
4. Mechanical Engineering Measurements, A. K. Sawhney, Dhanpat Rai & Sons, New Delhi
5. Instrumentation & Mechanical Measurements, A. K. Thayal

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Course Code	Course Name	Credits
ME 304	**Machine Design I**	**3+1**

Prerequisites:

1. Engineering Mechanics
2. Strength of Materials
3. Materials Science and Metallurgy
4. Machine Drawing
5. Theory of Mechanisms
6. 3D-Modelling & Drafting using SolidWorks software
7. FEA simulation using ANSYS software

Course Objectives:

1. Understand the basic principles of mechanical design.
2. Understand the various types of stresses.
3. Understand the basic strength & rigidity
4. Familiarize with the use of design data book and standard codes.
5. Understand the design procedure and convert it into computer drawings.
6. Perform design calculations and simulate stresses using analysis software.

Course Outcomes:

Upon successful completion of this course, learner will be able to

1. Understand various mechanical design considerations.
2. Apply strength and rigidity for basic design of machine components.
3. Use Design data books for various component designs.
4. Acquire production drawing skills using CAD software.
5. Compare the analytical results with simulation results.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	**Introduction to Machine Design:** Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design. Material properties and their uses in design. Manufacturing consideration in design. Design considerations of casting and forging. Basic principles of Machine Design, Modes of failures, Factor of safety, Design stresses, Principal stresses and strains, Theories of failures. Standards, I. S. codes, Preferred Series and Numbers. Variables stresses, reversed, repeated, fluctuating stresses.	7
2.	**Fatigue Failure:** Static and fatigue stress concentration factors, Methods of stress concentrations, Endurance limit - estimation of endurance limit. Design for Soderberg and Goodman criteria.	6
3.	**Design of curved beams and Thick Cylinders:** Curved Beams: Assumptions made in the analysis of curved beams. Design of curved beams: Bending stresses in curved beams, such as crane hook, C-frame, etc. Thick Cylinders: Design of thick cylinders subjected to an internal pressure using Lame's equation.	7

4.	**Design against Static Loads:** Cotter joint, knuckle joint, Turn Buckle, Bolted and welded joints under eccentric loading. Power Screw - Screw Presses, C- Clamps along with the Frame.	7
5.	**Design of Shafts, Keys and Couplings:** Shafts: Design under static and fatigue criteria. Keys: Types of keys and their selection based on shafting condition. Couplings: Classification of couplings. Design of split, muff couplings, flange couplings, bush pin flexible coupling.	8
6.	**Design of Springs:** Helical compression, tension springs under static and variable loads. Design of Leaf springs.	4

Laboratory Syllabus:

Module	Details	Hrs.
1.	Design exercise and drawing of Knuckle or Cotter joint	5
2.	Design exercise and drawing of Turn buckle or Screw jack	5
3.	Design exercise and drawing of bush pin type flexible coupling	5
4.	Design exercise on leaf spring	5
5.	Analysis of any one component described above, in ANSYS, and comparison of results.	5

Theory Assessment:
Internal Assessment: 40 marks.

1. Consisting of One Compulsory Class Tests - 40 Marks
2. Continuous evaluation- Class Test/ Assignments /Quiz/Case studies/Seminar presentation - 40 Marks

End-Semester Examination: 60 marks.
Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Laboratory Assessment:
Term Work: 25 marks
Students have to submit signed and completed assignments based on the modules listed in the table, as a part of the term work. They can also avail NPTEL Certification for this course, for which the assignment work may be suitably reduced, at the discretion of the Instructor.

Books/References:

1. Design of Machine Elements - V.B. Bhandari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design by Pandya & Shah, Charotar Publishing
4. Recommended Data Books - PSG
5. Machine Design by R.C.Patel, Pandya, Sikh, Vol - I & II C. Jamnadas & Co.
6. Mechanical Engineering Design by J.E.Shigley, McGraw Hill

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Course Code	Course Name	Credits
ME 305	**Professional Communication and Ethics II**	**2**

Prerequisite: Basic language skills

Course Objectives: To provide practice in

1. Drafting effective written discourse with specific emphasis on report, proposal writing and documentation of business meetings.
2. Fluent speaking, developing confidence, positive approach, responsibility, empathy and presentation skills in social, academic and professional settings.
3. Writing resume and statement of purpose for academic and professional development.
4. Fostering ethical decisions and behaviour in academic and professional settings.
5. Skillful questioning, organizing information, learning to find credible sources and verifying information from several sources.
6. Using imagination and out of the box thinking to create something unique and extraordinary.

Course Outcomes: Learners will be able to

1. Write reports,technical proposals and document business meetings with ease and accuracy.
2. Speak fluently with confidence, have a positive approach, develop empathetic skills and make effective professional presentations.
3. Demonstrate their skills in resume writing and statement of purpose.
4. Conduct themselves with zest and zeal required in academic and professional situations.
5. Acquire research skills necessary for addressing problems and finding effective solutions to it.
6. Write blogs to express their opinion with ease and also connect to the audience.

Theory Syllabus:

Module	Detailed Content	Hrs.
1	**Structure, Style and Language of Report Writing** 1.1 Introducing the purpose , aim, objective and format of report 1.2 Literature review-ability to gather and analyze information from different sources and summarize. Specific emphasis on plagiarism, use of quotation marks appropriately . 1.3 Research Methodology 1.4 Presenting data-figures, diagrams and labeling 1.5 How and why to write discussion 1.6 Citing and referencing- IEEE format 1.7 Writing an abstract	4
2	**Writing Technical Proposals** 2.1 Format 2.2 Executive summary 2.3 Defining the problem and presenting the solution 2.4 Summarizing a technical proposal	3

3	**Oral Skills for Employability** 3.1 Group Discussion- with special reference to leadership qualities, assertiveness, analyzing the topic, developing different perspectives, introducing and concluding the discussion. 3.2 Interview-with special reference to introducing oneself and answering questions with confidence. 3.3 Presentation Skills-with special reference to preparing slides, dress code, non-verbal communication including paralinguistic features, introduction and conclusion.	2
4	**Personality Development and Social Etiquettes** 4.1. Personality Development • Improving self-awareness- analyzing our own experiences, looking at ourselves through the eyes of others • Knowing and Building your own identity • Discovering and Developing your talents • Teamwork/collaboration 4.2. Social Étiquettes • Formal Dining Etiquettes • Cubicle Etiquettes • Responsibility in Using Social Media • Showing Empathy and Respect • Learning Accountability and Accepting Criticism • Demonstrating Flexibility and Cooperation • Selecting Effective Communication Channels	2
5	**Ethics and Ethical codes of conduct** 5.1Writing Resume and statement of purpose 5.2 Business and corporate activities(special emphasis on business meetings) 5.3 Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions.	2
6	**Content writing** 6.1 Research Skills 6.2 Organisational skills 6.3 Creative Writing- Blog posts, Web pages etc.	2

Lab Syllabus:

Sr. No.	Details of Assignments	Details of Activities	Hrs.
1	Written assignment on Literature Review 20 page report on technical topic-(to be included as part of term work)	Sample IEEE papers to be shared with students and train them to identify contributions of each author. These contributions can then be written in the format required in journals.	4
2	Written assignment on summarising a technical proposal, 4 page technical proposal (to be included as part of term work)	Example of summarising techniques to be demonstrated.	4

3	Oral Skills for Employability- to be included in term work.	Role play and mock interviews Mock group discussion Mock presentation	6
4	Written Assignment on Documentation of Business Meeting	Mock meetings	2
5	Written Assignment on Resume writing/ Statement of Purpose.	NA	2
6	Written Assignment on Blog Posts	NA	2

Assessment:
Term work will consist of:

1. Assignments : 10 marks
2. Group Discussion : 10 marks
3. Interviews : 5 marks
4. Report : 5 marks
5. Technical Proposal : 5 marks
6. Attendance : 5 marks
7. Presentation : 10 marks

Books/References:

1. Raman Meenakshi & Sharma Sangeeta, Communication Skills, Oxford University Press
2. Kumar Sanjay & Lata Pushp, Communication Skills, Oxford University Press
3. Virendra Singh Nirban, Krishna Mohan, RC Sharma, Business Correspondence and Report Writing

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Course Code	Course Name	Credits
ME 306	**Advanced Fluid Mechanics**	**3**

Course Objectives:

1. To study application of mass, momentum and energy equations in fluid flow.
2. To study different types of turbulent model
3. To study incompressible and compressible fluid flow
4. To familiarize with dimensional analysis of Thermal and Fluid systems.

Outcomes: Upon successful completion of this course, the learner will be able to

1. Formulate and solve equations of the control volume for fluid flow systems
2. Calculate resistance to flow of incompressible fluids through closed conduits and over surfaces.
3. Select suitable turbulent model for fluid flow problem
4. Apply fundamentals of compressible fluid flows to relevant systems
5. Illustrate understanding of dimensional analysis of Fluid systems.

Module	Detail Content	Hrs.
1.	Eulerian & Lagrangian coordinates, Definition and equations for source, sink, irrotational vortex, circulation concept of circulation. Navier-Stokes equations-differential & integral approach, energy equations, governing equations for Newtonian fluids, boundary conditions Momentum of fluid in motion: impulse momentum relationship and its applications for determination of thrust for pipe bend	7
2.	Viscous Incompressible Flows: Exact solutions for Couette flow, Poiseuille flow, flow between rotating cylinders, Stokes first problem, Stokes second problem, pulsating flow between parallel surfaces, stagnation-point flow, flow over porous wall. Stokes approximation,	6
3.	Introduction to dimensional analysis of thermal and fluid systems, Methods of dimensional analysis - Buckingham π Theorem and Rayleigh's Method (Only derivations, no numerical) Boundary Layer Theory: Review of boundary layers: laminar and turbulent boundary layers; transition; separation, Blasius' solution for boundary layer	6
4.	Potential Flows: Stokes stream functions, solution of potential equation, flow in a sector, flow around a sharp edge, flow near a blunt nose force and moment on a circular cylinder and sphere, conformal transformations, Joukowski transformations, Elements of airfoil and wing theory.	6
5.	Introduction to turbulence: Transition of flows, Origin of turbulence- its consequences; Physics of turbulent motion- concept of Reynolds stress, mean flow equations, Turbulence models RANS, LES. DNS	6
6.	Compressible Fluid flow: Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Stagnation properties, Application of continuity, momentum and energy equations for steady-state conditions; Steady flow through the nozzle, Isentropic flow through ducts of varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio.. Application to subsonic, transonic and supersonic flow around a two-dimensional aerofoil.	7

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Class Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. Advanced Fluid Mechanics, K. Muralidhar& G. Biswas, Narosa Publishing, 2005.
2. Boundary Layer Theory, H. Schlichting, 6th Edition, McGraw-Hill Inc., 1986.
3. Turbulent Flow, R. J. Garde, 2nd Edition, New Age International Publishers.
4. Foundations of Fluid Mechanics, S.W. Yuan, Prentice-Hall India Pvt. Ltd, New Delhi.
5. Modern Compressible Flow with Historical Perspective, John D. Anderson, McGraw Hill.
6. Fundamentals of Aerodynamics (2nd ed), J. D. Anderson, McGraw Hill.
7. Viscous Fluid Flow, F. M. White, 2nd Edition, McGraw-Hill, 1991.
8. Fundamentals of Fluid Mechanics , B.R. Munson, D.F. Young & T.H. Okiishi, 2nd Ed., John Wiley.
9. Introduction to Fluid Mechanics, R.W. Fox & A.T. McDonald, 5th Edition, John Wiley, 2001.

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Course Code	Course Name	Credits
ME 307	**Design for Excellence**	**3**

Prerequisites:

1. Basic concepts of Design, Manufacturing and Product Management practices.

Course Objectives:

1. Learn various knowledge-based techniques in addition to low manufacturing cost, for a sound product design.
2. Understand the need of DFX and its basic principles.
3. Understand how to manage to make a transition to DFM/DFX from the traditional approach.
4. Understand methods to evaluate various product designs for DFX.
5. Learn various design guidelines for designing, based on different DFX attributes.
6. Realize the use of DFX in low quantity production, some success stories, and the merging of DFX with CAD/CAE.

Course Outcomes: Upon successful completion of this course, learner will be able to:

1. Appreciate that manufacturing is a key element in the wealth of nations and individuals, but the major contributor of total product's cost is in the design phase itself.
2. Appreciate that for best product design results, attributes in addition to DFM, are also required in current competitive market climates.
3. Understand that careful, dedicated, well-planned management of a design team is a requirement, with equal emphasis on training and education of all concerned.
4. Design the product in the conceptual stage, for various attributes of DFX.
5. Realize that computer technology and the art of programming are essential for the integration of DFX and CAD/CAE to assist in the product design process.

Module	Detail Content	Hrs.
1.	**1.1 Basic Concepts of DFM-Design for Manufacturability:** Need of DFM, History of DFM **1.2 DFM/DFX Related Approaches:** Definitions of some approaches (management systems) which are either part of DFM/DFX, related to it, or provide alternative means of improving product designs and manufacturing operations–-DFA, DFMA, manufacturability or producibility, design to cost, concurrent or simultaneous engineering or concurrent design, value Analysis or value engineering, life cycle costs, fractional factorial experiments, benchmarking, SPC, QFD, quality loss function, synchronized manufacturing, continuous improvement, TQM, FMEA, group technology.	5
2.	**2.1 Expansion & Evolution of DFM to DFX:** Desirable objectives of sound product design other than manufacturability. Objectives in conflict and in concert with manufacturability.	6
3.	**Basic Principles of DFM/DFX:** Discussion on major design principles or guidelines which guide the product designer to a more satisfactory design, and include—simplify	6

	and improve the assembly, minimize the number of parts, standardize, use processible materials etc.	
4.	**Managing a transition to DFM/DFX:** Management's role in implementing DFM/DFX, cultural change, training and indoctrination. **Applicability, Advantages and Disadvantages of some methods of evaluating product designs for DFX:** Parts count, assembly time and cost, design efficiency rating for assembly, estimated life cycle product costs, formal product cost estimate, producibility assessment (PA), disassembly time data, weighted factor matrix.	8
5.	**The Dimensions of DFX:** Improving assemblies, improving individual components, designing for higher quality, designing for -- reliability, serviceability/maintainability, safety, environment, user-friendliness, short time-to-market.	8
6.	**Other Aspects of DFX:** DFX for Low Quantity Production Some Success Stories The Future of DFX—Integration of DFX with computer	6

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Class Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. Design for Excellence, by James G. Bralla, Technicraft Publication, Pennsylvania.
2. Design for Manufacturability Handbook, by James G. Bralla, 2nd Edition, McGraw Hill Publications.
3. ICoRD'15 – Research into Design Across Boundaries Volume 2 - Creativity, Sustainability, DfX, Enabling Technologies, Management and Applications, Edited by Amaresh Chakrabarti, Smart Innovation, Systems and Technologies 35, Springer.
4. Product Design for Manufacture and Assembly, by Geoffrey Boothroyd, Peter Dewhurst, and Winston Knight, 3rd Edition, CRC Press.
5. Product Development and Design for Manufacturing, by John W. Priest and Jose M. Sanchez, 2nd Edition, Quality and Reliability – 58.
6. Design for Manufacturing and Assembly: Concepts, architectures and implementation, by O. Molloy, S. Tilley and E. Warman, Springer–Science+Business Media, B.V. Publications.
7. Design for Manufacturing: A Structured Approach, by Corrado Poli, Butterworth-Heinemann Publications.

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Course Code	Course Name	Credits
ME 308	**Signal Processing**	**3**

Course Objectives:

1. To identify, classify and analyse various types of signals and systems
2. To analyse time Domain analysis of continuous and discrete time signals and systems.
3. To Analyse the Continuous signals in frequency domain using Fourier series and Fourier Transform.
4. To Analyse the Discrete signals in frequency domain using Fourier series and Fourier Transform.
5. To analyse, formulate and solve problems on frequency domain analysis of continuous time systems using Laplace Transform.
6. To analyse, formulate and solve problems on frequency domain analysis of discrete time systems using Z- Transform

Course Outcomes:

Upon successful completion of this course, the learner will be able to

1. Classify and analyse various types of signals and systems.
2. Determine convolution integral and convolution sum.
3. Analyse the continuous time signals in frequency domain using Fourier series and Fourier Transform.
4. Analyse the discrete time signals in frequency domain using Fourier series and Fourier Transform.
5. Analyse, formulate and solve problems on frequency domain analysis of continuous time systems using Laplace Transform.
6. Analyse, formulate and solve problems on frequency domain analysis of discrete time systems using Z- Transform.

Module	Detail Content	Hrs.
1.	**Introduction of Continuous and Discrete Time Signals and systems:** Introduction to Signals: Definition of Signals , Representation of continuous time signals and discrete time signals, Sampling theorem, sampling of continuous time signals Basic Elementary signals , Arithmetic operations on the signals- Time Shifting, Time scaling, Time Reversal of signals Classification of Continuous time signals and Discrete time signal Introduction to Systems: Definition of Systems , Classification of Continuous time systems and Discrete time systems Applications of Signals and Systems	7
2.	**Time domain analysis of continuous time and discrete time systems** **Linear Time Invariant (L**TI) systems, Impulse signal and Properties of impulse signal, impulse response, step response, Convolution integral and Convolution sum for analysis of LTI systems, properties of convolution integral/sum, impulse response of interconnected systems Correlation of Signals: Auto-correlation and Cross correlation of Continuous time signals and Discrete time signal	6

3.	**Frequency domain analysis of continuous time signals :**Fourier series (FS) representation of periodic Continuous Time (CT) signals, Trigonometric and Exponential Fourier series Frequency Domain Analysis of aperiodic Signals-Introduction, Properties of Fourier Transform, Inverse Fourier Transform	6
4.	**Frequency Domain Analysis of Discrete Time signals** Discrete Time Fourier Series, Evaluation of DTFS coefficients, Magnitude and Phase Spectrum of Discrete time periodic signals, Discrete Time Fourier Transform – Definition of DTFT, Determination of magnitude and phase functions using DTFT, Properties of DTFT	6
5.	**Frequency domain analysis of continuous time system using Laplace transform-** Definition of Laplace Transform (LT), Region of Convergence (ROC), and Properties of Laplace transform, Inverse Laplace transform. Analysis of continuous time LTI systems using Laplace Transform: Causality and stability of systems in s-domain, Total Response of the system, Relation between LT and FT	6
6.	**Frequency domain analysis of discrete time system using Z-transform** System Realization structure using DT system - definition of unilateral and bilateral Z Transform, Region of Convergence (ROC),Properties of Z-Transform, Inverse Z-Transform Analysis and characterization of the LTI system using Z transform: Transfer Function and difference equation, plotting Poles and Zeros of a transfer function, impulse and step response, causality, stability, Total response of a system. Relation between Laplace Transform and Z–Transform.	8

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Class Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. NagoorKani, “Signals and Systems”, Tata McGraw Hill, Third Edition, 2011
2. Tarun Kumar Rawat, “Signals and Systems”, Oxford University Press 2016.
3. Simon Haykin and Barry Van Veen, “Signals and Sytems”, John Wiley and Sons, Second Edition,2004.
4. Hwei. P Hsu, “Signals and Systems”, Tata McGraw Hill, Third edition, 2010
5. Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, “Signals and Systems”, Pearson Education, Fourth Edition 2009.
6. Alan V. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, “Signals and Systems”, Prentice-Hall of India, Second Edition, 2002.

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Course Code	Course Name	Credits
ME 391	**Minor Project III**	**2**

Course Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcomes: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as a member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
9. Demonstrate project management principles during project work.

Guidelines for Minor Project:

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do surveys and identify needs, which shall be converted into a problem statement for minor-project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Student groups shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of the minor project.
- A log book has to be prepared by each group, wherein the group can record weekly work progress, and the guide/supervisor can verify and record notes/comments.
- Faculty supervisors may give inputs to students during minor project activity; however, focus shall be on self-learning.
- Students in a group shall understand the problem effectively, propose multiple solutions and select the best possible solution in consultation with the guide/supervisor.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
- The solution has to be validated with proper justification and the report has to be compiled in the standard format.
- With the focus on self-learning and innovation, addressing societal problems and entrepreneurship quality development within the students through the Minor Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Minor Project 1 in semester III and IV. Similarly, Minor Project 2 in semesters V and VI may be considered. In other words, based on the individual students' or group's capability, with the mentor's recommendations, if the proposed Minor Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group

can be allowed to work on the extension of the Minor Project, in even semester with suitable improvements/modifications.

- Alternatively, student groups can work completely on a new project idea in the even semester, bearing no resemblance with the topic of odd semester. This policy can be adopted on a case to case basis.

Assessment:
Term Work - 25 marks
Mid Semester Evaluation - 25 marks
Practical/Oral Examination - 25 marks

Guidelines for Assessment of Minor Project:
Term Work

- The review/ progress monitoring committee shall be constituted by heads of departments of each institute. The progress of the minor project to be evaluated on a continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In the first semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the student group.
    - If the problem is based on development of a mechanism or a simple device for attaining a desired objective, the first presentation shall be reviewed based on generation of multiple feasible solutions to the given problem and identification of the best possible solution based on various parameters which may include one of more of the following viz., the total weight, volume, power consumption, mechanical advantage, efficiency, cost (including labour) per piece once manufactured, and so on. This may include creation of unique free-hand sketches by each and every member of the group to contribute to the solution of the given problem. The best possible solution has to be finalized during one or more brainstorming sessions by the members of the student group. In case the problem is of a programming/coding type, then the first presentation may be dedicated to the understanding of the theory behind the problem related to a particular domain subject, including the drafting of an algorithm and/or flowchart, and may also include the introductory part of the programming.
    - Second review shall be based on the computerization (3D CAD model of parts and assembly), and possibly the animation, depicting the working characteristics of the proposed solution to the given problem, allocating material properties to each part, identifying mass properties of the assembled parts, and so on. Checking interference is one of the important criteria that can be used when assembling the parts. For software based projects, this may include the presentation based on the extension of the programming work so as to cover the major portion of the remaining part of the topic.

- In the second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work

completed in an earlier semester. For those selecting software based projects, this may include completing the other half of the programming related work, identifying the errors, optimizing the software code, customization, creating a graphical user interface of input and output (GUI), displaying output data in the form of graphs/tables/figures/diagrams, creation of the code in executable (.exe) format or in the form of a mobile App, etc.
    - First review shall be conducted based on the readiness of the working prototype, or programming of the remaining code for software based projects.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester. This may also include the testing and validation of tests with the literature/available data/theory. For software based projects, the presentation includes the remaining work other than the programming, as described above.
- Apart from the hardware type (development of device) and software (program/coding) type of projects, the topics may also include computer based work, viz., generation of virtual laboratory (for one or more experiments) for any subject/domain of choice, or CAD modeling, analysis, optimization, and/or product design, without any relevance to developing any physical product.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including:
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solutions.

Assessment criteria of Minor Project:

1. Quality of survey/need identification
2. Clarity of problem definition based on need
3. Innovativeness/uniqueness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness/uniqueness
8. Cost effectiveness and societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual as member or leader
13. Clarity in written and oral communication

- In a **one year project**, the first semester evaluation may be based on the first six criteria as highlighted above and the remaining criteria may be used for second semester evaluation of performance of students in the minor project.
- In the case of a **half year project,** all criteria in general may be considered for evaluation of performance of students in the minor project.

Guidelines for Assessment of Minor Project Practical/Oral Examination:

- Report should be prepared as per the guidelines.
- Minor project shall be assessed through a presentation and demonstration of working model or the execution of programme code by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by the Head of Institution.
- Students shall be motivated to publish a paper based on the work in conferences or student competitions.

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Course Code	Course Name	Credits
ME 309	**Mechatronics**	**3+1**

Course Objectives:

1. To study key elements of Mechatronics system and its integration
2. To familiarise concepts of sensors characterization and its interfacing with microcontrollers
3. To acquaint with concepts of actuators and its interfacing with microcontrollers
4. To study discrete control logics in PLC systems and its industrial applications
5. To acquaint with control of mechanical operations involving pneumatic, electric, hydraulic and electronic systems

Course Outcomes: Upon successful completion of this course, the learner will be able to

1. Design a mechatronics system
2. Identify the suitable sensor and actuator for a mechatronics system
3. Demonstrate use of automated controls using pneumatic and hydraulic systems.
4. Demonstrate applicability of PLC in process industry
5. Identity and learn different types of controllers
6. Understand data acquisition and signal conditioning.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	**Introduction of Mechatronics** and its block diagram representation Key elements of mechatronics, Applications of Mechatronics domestic, industrial etc. Representation of mechatronic system in block diagram and concept of transfer function for each element of mechatronic system, Reduction methods and its numerical treatment for represented block diagram	06
2.	**Selection of Sensors & Actuators Sensors:** Criteria for selection of sensors based on requirements, principle of measurement, sensing method, performance chart etc. (Displacement, temperature, acceleration, force/pressure) based on static and dynamic characteristics. Actuators: Selection of actuators based on principle of operation, performance characteristics, maximum loading conditions, safety etc. Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	08
3.	**Pneumatics and hydraulics**: Hydraulic and pneumatic devices-Different types of valves , Actuators and auxiliary elements in Pneumatics & hydraulics , their applications and use of their ISO symbols Synthesis and design of circuits (up to 3 cylinders)–pneumatic, electro pneumatics and hydraulics Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping	10
4.	**PLC and its applications:** Process industries versus discrete manufacturing industries, Continuous versus discrete control, Computer process control, Forms of computer process control Discrete control using PLC- discrete process control, Programmable logic controller, its architecture,ladder digs, Ladder Logic Programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming	06

5.	**Control System** Control system design and analysis by Root Locus Method, Control system Design by Frequency response method, stability margin, Nyquist diagram, Bode diagram P, I and D control actions, P, PI, PD and PID control systems, Transient response:- Percentage overshoot, Rise time, Delay time, Steady state error, PID tuning (manual), Zigler Method	06
6.	**Data Acquisition, Signal Conditioning & Microcontroller System** **Theory:** Concept of Bit accuracy/width and Sampling speed, sampling theorem, aliasing, Nyquist criteria, ADC (Analog to Digital Convertor) Successive approximation method and sample and hold circuitry, DAC (Digital to Analog Convertor) R-2R circuit and DAC resolution Signal Filters: Low pass, High Pass and Band Pass with circuit diagrams for simple cases	04

Laboratory Syllabus:

Exercise	Details	Hrs.
Group 1: Sensors & Actuators		
1	Theoretical & Experimental Implementation of Interfacing of Sensors using microcontroller and determination of sensor characteristics such as Static Characteristics (Sensitivity, Accuracy, Range, Resolution etc.), Dynamic Characteristics (Transient Response and Frequency Response)	2
2	Measurement and Calibration of Load / Force (It is suggested to determine all characteristics of sensor mentioned in previous experiments)	2
3	Measurement, Calibration and Comparison of Temperature Sensors (Thermocouple, RTD and Thermistor) (It is suggested to determine all characteristics of sensor mentioned in previous experiments)	2
4	Interfacing of Stepper Motor with microcontroller and its programming for Rotational or XY table (It is suggested to program to vary the position of rotary or XY table and compare the positioning accuracy using standard calibrated angular or linear sensor)	2
5	Interfacing of DC Motor with microcontroller and its programming for characterization of DC motor setup (It is suggested to program to vary the speed of DC motor and determine its load-speed characteristics)	2
Group 2: Automation		
1	Designing sequential operation for two cylinders using electro-hydraulic circuits	2
2	Designing sequential operation for two cylinders using electro-pneumatic circuits	2
3	Development of pneumatic circuits to understand pneumatic components and their working	2
4	IOT: Real time interfacing of sensors (temperature, humidity, position, level etc.) and actuator (stepper motor, dc motor, servo motor etc.) with microcontroller and Ethernet shield and controlling the actuator and monitoring of sensor output remotely using internet.	2
5	Robotics: Real Time demonstration of line following robot using standard robotic kit	2
6	Demonstration and study of functions of components of the robotics arm.	2

Theory Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests - 40 Marks
2. Continuous evaluation- Assignments /Quiz/Case studies/Seminar presentation- 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Laboratory Assessment:

Term Work Submission: 25 Marks

1. Term work shall consists of minimum Eight Experiments, taken from Two groups mentioned above
2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
3. Students work along with evaluation reports to be preserved till the next examination.
4. Course projects can be given in groups of 2-3 students to build practical systems for mechatronics / Robotics / Automation application using arduino / Festo training kit etc.

The distribution of marks for Term work shall be as follows:

Part A : 10 marks (Experiments)
Part B : 5 marks (Attendance)
Part C : 10 marks (Course Project)

End Semester Practical/Oral Examination: 25 Marks

Pair of Internal and External Examiner should conduct practical/viva based on contents.
Distribution of marks for practical/viva examination shall be as follows:

Practical Examination : 15 Marks
Oral Examination : 10 Marks

Books/References:-

1. Mechatronics System Design , Shetty and Kolk, Cengage Learning, India Edition
2. Mechatronics - Electromechanics and Control Mechanics , Mill Springer-Verlag
3. Mechatronics - Electronic Control Systems in Mechanical Engineering , Bolton Pearson education
4. Mechatronics - Electronics in products and processes , Bradley, et al. Chapman and Hall
5. Pneumatic Circuits and Low Cost Automation by Fawcett JR
6. Electromechanical Design Handbook , Walsh, McGraw-Hill
7. Electro-mechanical Engineering - An Integrated Approach , Fraser and Milne
8. Handbook of Electromechanical Product Design , Hurricks Longman, John Wiley, Addison Wesley.
9. Modeling and control of Dynamic Systems, Macia and Thaler, Cengage Learning, India Edition
10. Hydraulics and Pneumatics for Production: Stewart
11. Hydraulic Valves and Controls: Pippenger
12. Fundamentals of pneumatics: Festo series

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Course Code	Course Name	Credits
ME 310	**Machine Design II**	**3+1**

Prerequisites:

1. Machine Design-I
2. Theory of Machines
3. Strength of Materials

Course Objectives:

1. To design and analyse various machine components considering strength, wear and thermal considerations.
2. To understand the selection of various components based on catalogues/design data books.
3. To apply computer based techniques in the design and analysis of machine components, and create drawings.

Course Outcomes: Upon successful completion of this course, learner will be able to

1. Design various gears based on strength, wear and thermal considerations.
2. Design bearings and select for a particular load and life.
3. Understand the basic principles of cams and their design.
4. Use 3D modeling and analysis software to create computerized designs and create the drawing database.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	**Gears:** Design of spur, helical, bevel and worm gears with strength, wear and thermal considerations. Design of two stage gear box.	10
2.	**Rolling Contact Bearings:** Types of rolling contact bearings, Static and dynamic load carrying capacities, equivalent bearing load, load-life relationship, selection of bearing life, selection of rolling contact bearings from manufacturer's catalogues, selection of bearing for cyclic loads and speeds—bearing with probability of survival.	6
3.	**Sliding Contact Bearings:** Design of hydrodynamically lubricated bearings (self-contained), Introduction to hydrostatic bearings, types and selection of bearings.	6
4.	**Belt, Flywheel & Chain Drives:** Belt Drive: Materials and construction of flat and V belts, geometric relationships for length of belt, power rating of belts, concept of slip & creep, initial tension, effect of centrifugal force, maximum power condition, Selection of Flat and V-belts from manufacturer's catalogue. Flywheel: Energy stored in flywheel, maximum fluctuation of speed, maximum fluctuation of energy. Chain Drive: Types of chains and its geometry, selection criteria for chain drive.	6
5.	**Cams and Followers:** Design of Cam and Roller follower mechanisms with spring and shaft.	5

6.	**Brakes and Clutches:** Brakes: Design of single, double shoe brakes, introduction to hydraulic and pneumatic brakes. Clutches: Introduction, types, basic theory of plate clutches, design of single plate, multi-plate clutches, with spring, lever design and thermal, wear considerations.	6

Laboratory Syllabus:

Module	Details	Hrs.
1.	Design and drawing on two stage gear box	12
2.	Design and drawing on cam and follower	6
3.	Design and drawing of single plate clutch	8

Theory Assessment:

Internal Assessment: 40 marks.

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

End-Semester Examination: 60 marks.

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Laboratory Assessment:

Term Work: 25 marks.

Students have to submit signed and completed assignments based on the modules listed in the table, as a part of the term work. They can also avail NPTEL Certification for this course, for which the assignment work may be suitably reduced, at the discretion of the Instructor.

Viva-você: 25 marks.

Viva-você exam shall be conducted at the end of the course.

Books/References:

1. Design of Machine Elements - V.B. Bhandari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohit. Prentice Hall India Publication
3. Machine Design by Pandya & Shah, Charotar Publishing
4. PSG Design Data Book
5. Machine Design by R.C. Patel, Pandya, Sikh, Vol-I & II C. Jamnadas & Co
6. Mechanical Engineering Design by J.E. Shigley, McGraw Hill

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Course Code	Course Name	Credits
ME 311	**Engineering Vibrations**	**3+1**

Prerequisites:

1. Strength of Materials
2. Differential and Integral Calculus
3. Ordinary Differential Equations
4. Elementary Matrix theory

Course Objectives:

1. Formulate linear mathematical models of free (damped and undamped) vibration systems using Newton's second law or energy principles.
2. Solve free undamped multi-degree of freedom vibration problems using exact and numerical techniques to derive natural frequencies, and draw corresponding mode shapes.
3. Understand the behaviour of 1 degree of freedom vibration systems under harmonic excitation.
4. Understand the basic principles of balancing of rotating and reciprocating masses using analytical and graphical approaches.
5. Conduct experiments on free undamped and damped, one degree of freedom vibration systems, for comparing and validating the time period of small vibrations/oscillations.
6. Perform virtual experiments using Sakshat Virtual Laboratory.

Course Outcomes: Upon successful completion of this course, learner will be able to:

1. Develop mathematical models of vibration systems using various methods.
2. Balance an existing unbalanced rotating/reciprocating system completely/partially.
3. Program using scientific mathematical software or using basic programming software, to obtain the necessary plots in time and frequency domains, and interpret the results thus obtained.
4. Perform vibration measurement using accelerometer, DAQ and LabView software or similar.
5. Perform simulation of experiments through Sakshat Virtual Laboratory interface.
6. Comprehend the application of condition monitoring and fault diagnosis on a live project/case study based on rotating machinery equipment.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	**1.1 Basic concepts of vibrations:** Vibration and oscillation, causes and effects of vibrations, vibration parameters—spring, mass, damper; damper models, Vibration Terminology—periodic motion, non-periodic motion, aperiodic motion, Simple harmonic motion (SHM), degree of freedom, static equilibrium position, vibration classification, steps involved in vibration analysis.	7
2.	**2.1 Free undamped one degree of freedom vibration systems:** Formulation of differential equation or undamped natural frequency by Newton's second law or D'Alembert's principle, and by various energy principles, for longitudinal, transverse, and torsional vibration systems. Springs in series and parallel combination, inclined springs, effect of spring's self-mass in calculating system's natural frequency.	7

3.	**3.1 Free damped one degree of freedom vibration systems:** Viscous damping: Underdamped, critically-damped, overdamped systems, Logarithmic decrement for underdamped system. Dampers in series and parallel combination, inclined dampers. Coulomb damping.	6
4.	**4.1 Forced vibration of one degree of freedom systems:** Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (viscous damping only). **4.2 Isolation and Transmissibility:** Force Transmissibility, motion Transmissibility, typical vibration isolators & mounts. **4.3 Vibration measuring instruments:** Principle of seismic instruments. Vibrometer, accelerometer, velometer with and without measurement errors. Principle of frequency-measuring instruments. Fullarton tachometer, Frahm's reed tachometer.	7
5.	**5.1 Free undamped multi-degree of freedom vibration systems:** Eigenvalues and eigenvectors for linear and torsional systems (limited to a maximum of three degrees of freedom), Holzer method for linear and torsional unbranched systems, Two rotor system. Maxwell's reciprocal theorem, Influence Coefficient, Dunkerley's and Rayleigh's methods for estimating fundamental frequency of transverse vibration.	6
6.	**6.1 Balancing of Rotating and Reciprocating Masses:** Static and dynamic balancing of multi-rotor systems. Approximate analytical method for finding acceleration of reciprocating piston (mass of connecting rod and crank neglected). Primary and secondary unbalanced forces, in-line engines, V-engines (excluding radial engines). Direct and reverse crank method. **6.2 Rotor Dynamics** Critical speed of a single rotor - undamped and damped. **6.3 Condition Monitoring and Fault Diagnosis** At least one case study in detail based on conditioning monitoring and fault diagnosis on rotating machinery equipment.	6

Laboratory Syllabus:

Sr. No.	Title of the Experiment	Hrs.
1.	Determining the undamped natural frequency / time period of free undamped vibrations/oscillations of the following systems, theoretically and experimentally: (a) Simple spring-mass system (b) Simple pendulum (c) Compound pendulum (d) Single rotor-shaft system (e) Bifilar suspension system	10
2.	Free damped torsional oscillations.	2
3.	Forced vibration of one degree of freedom system, subjected to frequency-squared excitations (rotating unbalance).	2
4.	Computer program on frequency-domain plots of dimensionless steady-state amplitudes for various values of damping ratio.	2
5.	Vibration measurement of rotating machinery using accelerometer, DAQ system and LabView software; or similar.	2
6.	Balancing of rotating masses.	2
7.	Virtual Laboratory Experiments using Sakshat VLab portal.	2

Theory Assessment:
Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

End-Semester Examination: 60 marks
Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Laboratory Assessment:
Term Work: 25 marks
Term Work consists of an ample number of assignments and experiments as decided by the Instructor. Mini-project based on this subject may be undertaken for which the number of assignments may be suitably reduced. Students can also avail NPTEL Certification for this course, which shall be considered in place of the assignment work.
Viva-voce / Practical: 25 marks
Viva-voce (on the entire syllabus) or Practical exam (on at least one experiment) shall be conducted at the end of the course. In case both viva-voce and practical exams are conducted, 15 marks shall be allotted to viva-voce and 10 marks to the practical exam.

Books/References:

1. Mechanical Vibrations - S. S. Rao - Pearson Education
2. Mechanical Vibrations - G. K. Grover
3. Fundamentals of Mechanical Vibrations - S. Graham Kelly - Tata McGraw Hill
4. Mechanical Vibrations - Schaum's outline series - S.Graham Kelly- McGraw Hill
5. Mechanical Vibrations - Den, Chambil, Hinckle
6. Mechanical Vibrations - J.P. Den Hartog - McGrawhill Book Company Inc.
7. Introduction to Dynamics and Control - Leonard Meirovitch - Wiley, New York
8. Elements of Vibration Analysis - Leonard Meirovitch - McGraw-Hill, New York
9. Principles of Vibrations - Benson H. Tongue - Oxford University Press.
10. Theory of Vibrations with Applications - W. Thomson - Pearson Education
11. Vibrations - Balakumar Balachandran, Edward Magrab - CENGAGE Learning.
12. Vibration Monitoring, Testing, and Instrumentation (Mechanical Engineering Series) - Clarence W. deSilva - CRC Press.
13. Vibration Testing: Theory and Practice - Kenneth G. McConnell, Wiley.
14. Modal Testing: A Practitioner's Guide - Peter Avitabile - Wiley.

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Course Code	Course Name	Credits
ME 312	**Advanced Heat Transfer**	**3**

Course Objectives:

1. Solve multidimensional practical heat conduction problems using conduction shape factors.
2. Know the primary considerations in the selection of heat exchangers.
3. Analyze natural convection inside enclosures such as double-pane windows

Course Outcomes: Upon successful completion of this course, the learner will be able to

Able to evaluate heat conduction in solids with temperature dependent thermal conductivity.

1. Able to derive a relation for the heat transfer coefficient in laminar film condensation over a vertical plate.
2. Able to derive the governing equations of natural convection, and obtain the dimensionless Grashof number by non-dimensionalizing them.
3. Able to determine the friction factor and Nusselt number in fully developed turbulent flow using empirical relations, and calculate the pressure drop and heat transfer.
4. Able to explain the mechanism and application of film cooling mechanism.
5. Able to design the heat exchanger for the specific requirements.

Module	Detail Content	Hrs.
1.	**Steady heat conduction:** Heat conduction considering variable thermal conductivity, bio heat transfer equation, heat transfer in common configuration. **Transient Heat Conduction:** transient heat conduction in large, plane walls, long cylinders, and spheres with spatial effects,	6
2.	**Thermal Radiation:** Radiation exchange between two and many diffuse gray surfaces, radiation transfer through passages, radiation transfer through gases – equation of transfer, gas radiation properties, effective beam lengths for an isothermal gas, radiation exchange between an isothermal gas and a black enclosure.	6
3.	**Convection Heat Transfer – Natural Convection:** Dimensionless parameters of natural convection, approximate analysis of laminar natural convection on a vertical plate, empirical correlation for various shapes, rotating cylinders, disks and spheres, natural convection in enclosed spaces, combined force and natural convection, **Convection Heat Transfer – Forced Convection:** Forced convection inside tubes and ducts, analysis of laminar forced convection in a long tube, analysis of coutte flow for laminar forced convection, velocity distribution in turbulent flow through a pipe, empirical correlations, flow across a single circular cylinder, forced convection over exterior surfaces, heat transfer enhancement.	7
4.	**Condensation :** Heat Transfer Correlations for Film Condensation - the average heat transfer coefficient for the case of laminar film condensation over vertical plate, inclined plate, vertical tubes, horizontal tubes, horizontal tube banks, effect of presence of non-condensable gases in condensers, film condensation inside horizontal tubes.	6

5.	**Heat Exchangers:** Energy balances and overall heat transfer coefficient, exchanger energy balance, overall heat transfer coefficient, Single stream steady flow heat exchanger – analysis of an evaporator, Two stream steady flow heat exchangers, Regenerators, Elements of heat exchanger design surface selection for compact heat exchanger, economic analysis.	7
6.	**Special Heat Transfer:** Heat transfer in high velocity flows, heat transfer in rarefied gases, transpiration and film cooling, ablative cooling, Heat Pipes, Liquid cooling, thermoelectric coolers, electro-hydrodynamic flow and synthetic jet	6

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:-

1. D.P. Incropera, P.P. and Dewitt, Fundamentals of Heat and Mass Transfer, Wiley Eastern
2. Adrian Bejan, Convective Heat Transfer, Wiley India.
3. Cengel Y A, Heat Transfer – A Practical Approach, McGraw Hill
4. Kays, W.M. and M.E. Crawford, Convective Heat and Mass Transfer, McGraw-Hill (1993).
5. Siegel and Howell, Thermal Radiation, McGraw Hill. 6. Kraus A.D., Aziz, A., and Welty, J., Extended Surface Heat Transfer, McGraw Hill
6. Adrian Bejan, Allan D. Krams, Heat Transfer Handbook, John Wiley & Sons. 8. J. P. Holman, Heat Transfer, McGraw Hill
7. Heat Transfer by A F Mills and V Ganeshan, Pearson education, second edition, 2009

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Course Code	Course Name	Credits
ME 313	**Experimental Methods for Thermal and Fluid Systems**	**3**

Course Objectives:

1. To convince the importance of experimentation
2. To familiarize the various instruments
3. To enable the students to design the experiments
4. To develop the instrument selection skill.

Course Outcomes: Upon successful completion of this course, the learner will be able to

1. Able to plan and execute the experiment.
2. Learn the different strategies of experiments.
3. Able to select the electrical measurements and sensing devices.
4. Able to select and measure the flow, pressure and thermal conductivity.
5. Able to calibrate the instruments.
6. Able to measure the heat flux.

Module	Detail Content	Hrs.
1.	Experiment versus simulation, need of experimentation, Experimental planning and analysis of results: Importance of experiments in engineering and science, stages of typical experiment, Experimental planning, literature survey and equipment identification, test section design, fabrication and instrumentation, test facility calibration and measurements, Analysis of Results: and Data reduction, Using Excel to present and analyse data, spreadsheets for data analysis.	6
2.	Design of experiments: Strategy of experimentation, Typical applications of experimental design, Types of experiments, guidelines for designing experiments, experiment design factors & protocol and examples. Analysis of Experimental Data, Causes and Types of Experimental Errors, Error Analysis on a Commonsense Basis, Uncertainty Analysis and Propagation of Uncertainty Graphical Analysis and Curve Fitting, Choice of Graph Formats	7
3.	Basic electrical measurements and sensing devices, basic analog & digital meters, power supplies, signal conditioning, digital voltmeter, output recorders, counters-time and frequency measurements, difference between analog and digital instruments. Temporal response of probes and transducers: measurement system model, system response, amplitude response, frequency response, zeroth, first, and second order systems; examples of thermocouple response, anemometer. Probe compensation in the frequency domain.	6
4.	Flow measurements: Positive displacement and flow obstruction methods, flow measurement by drag effects, magnetic flow meters, flow visualisation methods, the shadowgraph. Thermal conductivity measurements, thermal conductivity of liquids and gases, heat flux meters, detection of thermal radiation, detection of nuclear radiation	6
5.	Probes and transducers: Pressure transducers; noise measurement Velocity - Pitot static tube (low as well as high speeds), 5-hole probe,	6

	Hotwire anemometer, CCA, CTA, Laser Doppler velocimetry, Particle image velocimetry. Temperature measurement: thermocouples, RTD, thermister, infrared thermography, Heat flux measurement.	
6.	Calibration of measuring sensors and instruments, Principles of calibration, control of calibration environment, calibration chain and traceability, calibration records,	6

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. C. Tropea, A.L. Yarin, and J.F. Foss, Editors, Springer Handbook of Experimental Fluid Mechanics, 2007.
2. T.G. Beckwith and N.L. Buck, Mechanical Measurements, Addison-Wesley, MA (USA), 1969.
3. H.W. Coleman and W.G. Steele Jr., Experiments and Uncertainty Analysis for Engineers, Wiley & Sons, New York, 1989.
4. E.O. Doeblin, Measurement Systems, McGraw-Hill, New York, 1986.
5. R.J. Goldstein (Editor), Fluid Mechanics Measurements, Hemisphere Publishing Corporation, New York, 1983; second edition, 1996.
6. J. Hecht, The Laser Guidebook, McGraw-Hill, New York, 1986.
7. B.E. Jones, Instrumentation Measurement and Feedback, Tata McGraw-Hill, New Delhi, 2000.
8. M. Lehner and D. Mewes, Applied Optical Measurements, Springer-Verlag, Berlin, (1999).
9. F. Mayinger, Editor, Optical Measurements: Techniques and Applications, SpringerVerlag, Berlin, 1994.
10. D.C. Montgomery, Design and Analysis of Experiments, John Wiley, New York, 2001.
11. A.S. Morris, Principles of Measurement and Instrumentation, Prentice Hall of India, New Delhi, 1999.
12. F. Natterer, The Mathematics of Computerized Tomography, John Wiley & Sons, New York, 1986.
13. P.K. Rastogi, Ed., Photomechanics, Springer, Berlin, 2000.
14. M. Van Dyke, An Album of Fluid Motion, The Parabolic Press, California, 1982
15. Langari, R., Morris, A. S. (2015). Measurement and Instrumentation: Theory and Application. Netherlands: Elsevier Science.
16. Wright, L. M., Han, J. (2020). Experimental Methods in Heat Transfer and Fluid Mechanics. United States: CRC Press.
17. Kirkup, L. (2019). Experimental Methods for Science and Engineering Students: An Introduction to the Analysis and Presentation of Data. United Kingdom: Cambridge University Press.
18. Experimental Methods in Heat Transfer and Fluid Mechanics By Je-Chin Han, Lesley M. Wright, CRC Press.

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Course Code	Course Name	Credits
ME 314	**Reliability Engineering**	**3**

Prerequisites:

1. Industrial Engineering and Management

Course Objectives:

1. Demonstrate the approaches and techniques to assess and improve process and/or product quality and reliability.
2. Illustrate the basic concepts and techniques of modern reliability engineering tools.

Course Outcomes: Upon successful completion of this course, learner will be able to

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Theory Syllabus:

Module	Detailed Content	Hrs.
1	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness, Kurtosis.	06
2	**Reliability Concepts:** Reliability definitions, Reliability functions, Importance of Reliability, Quality Assurance and Reliability. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTTF in terms of failure Density, Mean time in failure in integral form. Mean time between failure (MTBF).	06
3	**Reliability Hazard Models**: Hazard rate, derivative of the Reliability functions in terms of the hazard rate, Hazard Models – Bathtub curve Constant Failure Rate, linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution MTTF in terms of failure Density, Mean time in failure in integral form functions and reliability analysis.	08
4	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k- out of n structure, Complex systems, Markov models.	06
5	**Reliability Improvement:** Reliability improvement of component, Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method	06

6	**Maintainability and Availability:** Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	08

Theory Assessment:
Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks
Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engineering”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

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Course Code	Course Name	Credits
ME 315	**Failure Analysis**	**3**

Prerequisites: Basic knowledge of the following subjects:

1. Engineering Mathematics
2. Strength of Materials
3. Theory of Elasticity
4. Theory of Plasticity
5. Machine Design

Course Objectives:

1. Students will be able to identify, document, and research materials related failures while understanding differences between manufacturing, design defects and/or product degradation or misuse.
2. Students will become familiar with and have access to materials characterization equipment as part of a hands-on project.
3. Students will be familiar with a general review of stress analysis, modes of failure, engineering materials and will shift into identifying failures, fractography, failure research publications and litigation/liability issues.

Course Outcomes: Upon successful completion of this course, learner will be able to:

1. Understand factors responsible for failure of materials.
2. Differentiate fracture modes and failure mechanisms for ductile, brittle, fatigue, creep, corrosion and wear failure.
3. Determine fracture toughness of brittle and ductile materials.
4. Predict life of materials under fatigue loading.
5. Analyze failure through case studies and select tools for failure analysis.

Module	Detail Content	Hrs.
1.	**Introduction:** Importance of failure analysis at design stage, modes of mechanical failure, introduction to linear elastic fracture mechanics	7
2.	**High Cycle Fatigue**: Introduction, fatigue loading, Stress Cycles, the S-N curves, effect of mean stress on fatigue, multi axial fatigue stresses, using multi axial fatigue failure theories.	7
3.	**Low-Cycle Fatigue**: Introduction, the strain cycling concept, the strain life curve and low cycle fatigue relationships, the influence of nonzero mean strain and nonzero mean stress, cumulative damage rule in low-cycle fatigue.	7
4.	**Fracture Mechanics**: Introduction, the Linear damage theory, cumulative damage theories, life prediction based on local stress-strain and fracture mechanics concepts, service loading simulation and full scale fatigue testing, damage tolerance and fracture control.	8
5.	**Creep, Stress Rupture and Fatigue**: Introduction, prediction of long-term creep behaviour, theories for predicting creep behaviour, creep under uniaxial state of stress and multi axial state of stress, cumulative creep concept, combined creep and fatigue.	7

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. F. Madoyag, Metal Fatigue Design and Theory.
2. L. Sors, Fatigue Design of Machine Components, Pergamon Press.
3. S. T. Rolfe and J. M. Barson, Fracture and Fatigue Control Structures, Prentice Hall.
4. David Broek, Elementary Engineering Fracture Mechanics, Noordnoff.
5. G. E. Dieter, Mechanical Metallurgy, Tata McGraw Hill Book Co., New Delhi.

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Course Code	Course Name	Credits
ME 316	**Micro Electro Mechanical Systems**	**3**

Course Objectives:

1. To provide a basic knowledge of MEMS processing steps and processing modules.
2. To provide information on various MEMS materials and their characteristics
3. To demonstrate the use of semiconductor based processing modules used in the fabrication of a variety of sensors and actuators (e.g. pressure sensors, accelerometers, etc.) at the micro-scale.
4. To provide an understanding of basic design and operation of MEMS sensors and transducers.
5. To provide understanding of MEMS reliability and Device characterization.

Course Outcomes:

Upon successful completion of this course, the learner will be able to

1. Understand basics of MEMS technology
2. Knowledge of various MEMS materials
3. Understand the underlying fundamental principles of MEMS devices including physical operation, mathematical modeling and fabrication.
4. Design and simulate MEMS devices and systems using standard simulation tools.
5. Develop different concepts of micro system sensors and actuators for real-world applications.
6. Understand MEMS Device characterization parameters

Module	Detail Content	Hrs.
1.	**Introduction to MEMS** Introduction to MEMS & Real world Sensor/Actuator examples (DMD, Air-bag, pressure sensors). MEMS Sensors in Internet of Things (IoT), BioMedical Applications, Optical MEMS	4
2.	**MEMS Materials and Their Properties** Materials (eg. Si, SiO2, SiN, Cr, Au, Ti, SU8, PMMA, Pt, SOI-GEI); Important properties: Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure. Understanding Selection of materials based on applications	8
3.	**MEMS Fab Processes – 1** Understanding MEMS Processes & Process parameters for: Cleaning, Growth & Deposition, Ion Implantation & Diffusion, Annealing, Lithography. Understanding selection of Fab processes based on Applications	8
4.	**MEMS Fab Processes – 2** Understanding MEMS Processes & Process parameters for: Wet & Dry etching, Bulk & Surface Micromachining, Die, Wire & Wafer Bonding, Dicing, Packaging. Understanding selection of Fab processes based on Applications	8
5.	**MEMS Devices** Architecture, working and basic quantitative behaviour of Cantilevers, Microheaters, Accelerometers, Pressure Sensors, Micromirrors in DMD, Inkjet printer-head. Understanding steps involved in Fabricating above devices	8

6.	**MEMS Device Characterization** Piezoresistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, & importance of these measurements in studying device behavior, MEMS Reliability	4

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. An Introduction to Microelectromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc
2. Practical MEMS - by Ville Kaajakari; Publisher: Small Gear Publishing
3. Microsystem Design - by S. Senturia; Publisher: Springer
4. Analysis and Design Principles of MEMS Devices - Minhang Bao; Publisher: Elsevier Science
5. Fundamentals of Microfabrication - by M. Madou; Publisher: CRC Press; 2 edition
6. Micro Electro Mechanical System Design - by J. Allen; Publisher: CRC Press
7. Micromachined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

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Course Code	Course Name	Credits
ME 317	**Control Systems**	**3**

Course Objectives:

1. To study concept of mathematical modelling of the control system
2. To acquaint with control system under different time domain
3. To study concepts of stability & various methods.
4. To study Multi-Input Multi-Output systems using state space
5. To study application of control systems for mechanical systems.

Course Outcomes: Upon successful completion of this course, the learner will be able to

1. Design mathematical models of system/process.
2. Analyse error and differentiate various types of control systems using time domain specifications
3. Analyse various methods and problems associated with stability
4. Analyse systems using graphical methods in frequency response
5. Understand the concept of state space methods for system analysis
6. Comprehend and apply concepts of control systems in mechanical Engineering.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	Introduction to the Control Problem Examples of control systems; introduction to the control problem; open loop and closed loop systems; feed-forward control structure. Differential equation models of physical systems, deriving models of physical systems (electrical, mechanical, thermal) Types of models; Impulse response model; Transfer function model for Electrical, Mechanical and Thermal systems Block diagram and Signal Flow Graph (SFG) representation of control systems; Block diagram reductions; Mason's gain formula.	06
2.	Time Response Analysis Standard test signals; Transient and steady state behaviour of first and second order systems Performance Specifications for a second order system and derivations for rise time, settling time, peak time, peak overshoot and steady state error Steady State errors in feedback control systems and their types, Error constants and type of system.	07
3.	Stability Analysis in Time Domain Concepts of Stability: Concept of absolute, relative and robust stability; Routh stability criterion. Root Locus Analysis: Root-locus concepts; General rules for constructing root-locus; Root-locus analysis of control systems.	08
4.	Stability Analysis in Frequency Domain Introduction: Frequency domain specifications, Response peak and peak resonating frequency; Relationship between time and frequency domain specifications of system; Stability margins. Bode plot: Magnitude and phase plot; Method of plotting Bode plot; Stability margins on the Bode plots; Stability analysis using Bode plot.	08

	Nyquist Criterion: Polar plots, Nyquist stability criterions; Nyquist plot; Gain and phase margins.	
5.	**State-space Analysis** Concept of state variables; State-space model; Canonical forms; Conversion between canonical forms using similarity transforms. Solution of state-space equation; Eigen-values and eigenvectors; Stability in state-space; Concept of controllability and observability. **Controllers**: Concept of ON/OFF controllers; Concept of P, PI, PD and PID Controllers	06
6.	**Advances in Control Systems:** Introduction to Robust Control, Adaptive Control and Model Predictive control. **Applications of Control system** Analysis of Spring mass damper system,Analysis of motor controller (DC, Stepper, PMSM, Induction motor),Analysis of cruise control system	04

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Text Books:

1. M. Gopal, "Control Systems: Principles and Design", 3rd edition, Tata McGraw Hill, 2008.
2. Richard Dorf, Robert Bishop, "Modern Control Systems", 11th edition, Pearson Education, 2008

Reference Books:

1. Golnaraghi Farid, B. C. Kuo, "Automatic Control Systems", 10th edition, McGraw Hill, 2017.
2. K. Ogata, "Modern Control Engineering", 6th edition, Prentice Hall, 2010.
3. I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International, 2009.
4. Norman Nise, "Control Systems Engineering", Wiley, 8th edition, 2019.

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Course Code	Course Name	Credits
ME 318	**Advanced Composites and Polymeric Materials**	**3**

Prerequisites:

1. Chemistry of Engineering materials
2. Materials science and metallurgy

Course Objectives:

1. To equip students with fundamental knowledge of polymeric and composite materials.
2. To achieve an understanding of principles of design in plastics and composites, and to explore the multiple new opportunities .

Course Outcomes:

Upon successful completion of this course, learner will be able to

1. Differentiate the behaviour and specialties of orthotropic materials.
2. Apply theory of elasticity and mechanics of orthotropic materials and behavior under bi-axial stress conditions.
3. Understand the concept of design optimization with proper material selection and its application.
4. Choose or design a material system to reduce the weight of a car and improve its fuel efficiency.
5. Make a good selection of materials for engineering applications

Module	Detail Content	Hrs.
1.	Introduction to composite materials, evolution and applications in engineering. Characteristics and classification of composite materials; Fibrous, laminated and particulate composites. Basic terminologies; volume fraction and weight fraction. Laminae and laminates. Different fibres, matrices and their properties. Advantages and disadvantages of polymer matrix composites, metal matrix composites and ceramic matrix composites. Mechanical properties of unidirectional composite lamina. Longitudinal and transverse Young modulus, shear modulus, Poisson ratio.	7
2.	Empirical relationship of Halpin-Tsai. Longitudinal and transverse Strength. Composites under compressive loading. Properties of angle ply lamina. Transformation of Young moduli, shear modulus. Concept of coupling coefficients. General and special orthotropic materials. Psai Pagano invariants Strength of orthotropic lamina. Biaxial strength theories. Maximum strength, maximum strain theory. Tsai-Hill maximum work theory. Tsai Wu tensor theory.	6
3.	Applications of the above theories to pressure vessels, composite shafts etc. Codes and engineering representation of Laminates. Macro mechanical behavior of a laminate. Laminate stiffness for different types; symmetric, anti-symmetric, cross ply laminates. Stresses in different laminae in a laminate.	6
4.	High Performance plastics and Composites in Automobile Industry, Processing of polymer composites, Hand-layup, Spray-layup, Compression molding Injection molding. Reaction injection molding, Autoclaving, Resin transfer molding, Filament winding, Pultrusion.	6

	Sheet molding, Pre-pegging	
5.	Challenges in primary processing of composites, Secondary processing of polymer composites, Joining of polymer composites, Adhesive joining Mechanical joining, Microwave joining, Induction and resistance welding, Drilling of polymer composites. Conventional vs ultrasonic drilling, Remedies for reducing drilling induced damages,	6
6.	Applications of advanced composites and polymers -Aerospace and biomedical field.Case studies on development of new systems for improved performance.Emerging 3D printable composites and polymer matrix composites	6

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Class Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. Mallick, P. K. , “Fibre-Reinforced Composites, CRC press,” New York, 2007
2. Jones, R.M., “Mechanics of Composite Materials,” Mc Graw Hill, New Delhi
3. Broutman and Agarwal, “Analysis and Performance of Composite materials”, John Willey and Sons, New York
4. Ehsan Bafekrpour, “Advanced Composite Materials:Properties and Applications2017
5. Sohel Rana; Raul Fangueiro,”Advanced composite materials for aerospace engineering : processing, properties and applications,Woodhead Publishing,2016

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Course Code	Course Name	Credits
ME 319	**Biomaterials & Tissue Engineering**	**3**

Prerequisites:

1. XII Biology
2. XII Chemistry
3. Chemistry of materials

Course Objectives:

1. To understand the role of materials in development of implants
2. To know the biocompatibility of different implant materials
3. To understand the the use of scaffolds
4. To use nanotechnology to develop new tissues

Course Outcomes: Upon successful completion of this course, learner will be able to

1. Differentiate and understand methods for categorisation of biomaterials.
2. Understand common use of biomaterials as metals, ceramics and polymers and its chemical structure, properties and morphology.
3. Develop nature motivated systems for human body
4. Design new strategies for validation and testing of biomaterials
5. Design and develop alternatives to bone implant materials

Module	Detail Content	Hrs.
1.	Basic concepts: General overview of components in the human body used to construct tissue.Introduction to Biomaterials-Classification based on materials classes, based on host response and their applications on human body-Importance of Regenerative medicine	6
2.	Biomimetics -approach, biomimetic polymers,Lessons from nature, Role of surface modification/tecturing. methods of surface modifications and texturing	6
3.	Structural and mechanical properties for scaffold design,Biomaterials for scaffold making,Processing techniques for scaffolds ,Scaffolds applications in human	8
4.	Bone tissue Engineering-current applications and trends. Synthesis of artificial bones,advantages and disadvantages of the processing route	5
5.	Nanobiotechnology-enabled tissue engineering strategies-Gold nanoparticles in cancer drug,Role of Nanogenotoxicology Studies in Safety Evaluation of Nanomaterials	6
6.	Invitro and Invivo studies of biomaterials-methods used for invitro and invivo studies with some case studies	5

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. Biomaterials,an Introduction-J.Park,R.S.Lakes, 1979
2. Nanotechnology Applications for Tissue Engineering, -Sabu Thomas,Yves Grohens,Neethu Ninan, 2015
3. Biomaterials Science and Engineering-Rosario Pignatello,2011
4. Biomaterials Science - Ratner, Hoffman, Schoen, Lemons (Elsevier; ISBN 0-12-582461)
5. Biomaterials - Temenoff and Mikos (Pearson Prentice Hall; ISBN 0-13-009710-1)

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Course Code	Course Name	Credits
ME 320	**Manufacturing Analytics**	**3**

Course Objectives:

1. To understand different manufacturing systems and its performance measures
2. To acquaint students with cellular manufacturing system
3. To familiarize students with flexible manufacturing system
4. To understand synchronous manufacturing and theory of constraints
5. To understand discrete and continuous manufacturing
6. To familiarize students with modelling and simulation of manufacturing systems and softwares used

Course Outcomes: Upon successful completion of this course, the learner will be able to

1. Analyse different manufacturing systems for its performance measures
2. Design of cellular manufacturing system
3. Illustrate loading and scheduling problems in FMS
4. Apply theory of constraints to improve the process performance
5. Develop simulation models of the manufacturing system

Module	Detail Content	Hrs.
1.	Models of manufacturing systems, including transfer lines and flexible manufacturing systems, multistage manufacturing process Calculation of performance measures, including throughput, in-process inventory, and meeting production commitments; real-time control of scheduling; effects of machine failure, set-ups, and other disruptions on system performance. Data analytics tools	06
2.	Cellular manufacturing, cell formation methods: Rank order clustering, similarity coefficient and optimization based,	06
3.	Flexible Manufacturing Systems, Concepts, FMS loading problems, FMS scheduling problems	06
4.	Synchronous Manufacturing, Principles of SM, Theory of Constraints and Linear Programming, Scheduling	06
5.	Event verses activity, General principles of event-driven simulation, Use of Pseudo-Random numbers in simulation of queuing systems, Simulation of manufacturing systems and other examples	08
6.	Introduction to modeling and simulation concepts, System analysis and components, Simulation terminology, Model of a system and types of models, Discrete *verses* continuous systems, Static and Dynamic System simulation, Pros and cons of simulation. Simulation of manufacturing and material handling systems, Modeling downtime and failures, Case studies Introduction to simulation software and languages for manufacturing and material handling like Extend, Areana, Technomatix etc	10

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests - 40 Marks
2. Continuous evaluation- Class Test/ Assignments /Quiz/Case studies/Seminar presentation- 40 Marks

End Semester Examination: 60 Marks
Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:-

1. Modeling and Analysis of Manufacturing Systems by Ronald G. Askin, Charles R. Standridge
2. Production Planning and Inventory Control by Seetharama L Narasimhan, Dennis W.McLeavey and Peter J Billington
3. Discrete-Event System Simulation by Jerry Banks, Carson and Nelson, Prentice Hall of India Pvt. Ltd.
4. Simulation Modelling and Analysis by Law and Kelton, McGraw Hill, New York.

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Course Code	Course Name	Credits
ME 321	**Optimization Techniques**	**3**

Course Objectives:

1. To Understand the need and origin of the optimization methods.
2. To understand various linear, nonlinear and other optimization techniques.
3. To understand various multi criterion and multi-objective decision making methods.
4. To understand recent tools in optimization

Course Outcomes: Upon successful completion of this course, the learner will be able to

1. Identify and apply calculus method to single variable problem
2. Formulate the problem as LPP and analyse the sensitivity of a decision variable.
3. Apply various linear and non-linear techniques for problem solving in various domain.
4. Apply multi-objective decision making methods for problem in manufacturing environment and other domain.
5. Apply multi criterion decision making methods for problem in manufacturing environment and other domain.
6. Apply Design of Experiments for Optimization

Module	Detail Content	Hrs.
1.	Basic Concepts: Statement of the Optimization Problem, Basic Definitions, Optimality Criteria for Unconstrained Optimization, Optimality Criteria for Constrained Optimization, Engineering Application of Optimization, Classification of Optimization Problems Classical Optimization Techniques: Single variable optimization	6
2.	Linear Programming Problem: Formulation, Simplex method, Big M Method, Two Phase, Primal to Dual, Dual Simplex method, Sensitivity Analysis and applications of LP (Transportation and Assignment Models)	7
3.	Integer Programming, Model: Gomory's cutting plane method, Branch & Bound Technique. Non L.P. Model: Lagrangian method & Kuhn tucker Method, Newton's method Discrete Event Simulation: Generation of Random Variable, Simulation Processes, Monte-Carlo Technique.	7
4.	Multi Objective Decision making (MODM) Methods: Introduction to Multi objective optimization, Traditional Techniques such as, quadratic programming, geometric programming, Numerical on goal programming and dynamic programming. Introduction to Non-traditional optimization Techniques such as Genetic Algorithm, particle swarm, genetic algorithms, simulated annealing and Techniques based on Neural network & Fuzziness.	7
5.	Multi Criterion Decision-making (MCDM) Methods: Introduction to multi criterion optimization Simple Additive Weighting (SAW) Method Weighted Product Method (WPM) Analytic Network Process (ANP) Analytic Hierarchy Process (AHP) Method	6

	TOPSIS Method PROMETHEE	
6.	Robust Design Methods: DOE and Taguchi techniques Full Factorial Design: The basics of "full factorials", ANOVA, Factorial effects and plots, and Model evaluation Fractional Factorial Design: The one-half fraction and one-quarter of the 2^k design, The general 2^{k-p} fractional factorial design Application of related software (Mini Tab or MATLAB)	7

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. S.S. Rao, "Engineering Optimization - Theory and Practice", John Wiley and Sons Inc.
2. Ranjan Ganguli, "Engineering Optimization - A Modern Approach" Universities Press
3. Pablo Pedregal, "Introduction to Optimization", Springer
4. L.C. Jhamb, "Quantitative Techniques Vol. 1 and 2", Everest Pub. House
5. Pierre D.A., "Optimization, Theory with Application", John Wiley & sons.
6. Decision Making in the Manufacturing Environment Using Graph Theory and Fuzzy Multiple Attribute Decision Making by R V Rao (Springer Publication).
7. Neural Computation and Self-Organizing Maps by Ritter, H., Martinetz, T., & Schulten, K., Addison-Wesley Publishing Company
8. Design and analysis of experiments by Douglas C.Montgomery (John Wiley & Sons Inc.)

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Course Code	Course Name	Credits
ME 322	**Wind Energy & Conversion Systems**	**3**

Course Objectives:

1. Understand the technologies that are used to harness the power of the wind.
2. Develop an intuitive understanding of wind turbine design criterion and its conversion system.
3. Discuss the positive and negative aspects of wind energy in relation to natural and human aspects of the environment.

Course Outcomes: Upon successful completion of this course, the learner will be able to

1. Explain the existing wind energy potential..
2. Analyse the various aerodynamic loads and its design criterion on wind turbine systems.
3. Describe the existing Wind Energy Conversion System.
4. Analyze the control mechanism of wind turbines.
5. Understand the application of wind energy with case studies and its environmental impacts.

Module	Detail Content	Hrs.
1.	**Basics of Wind Energy Technology** Wind statistics- Measurements and data Presentation, Historical developments, latest developments, state of art of wind energy technology, turbine rating, economic analysis of wind turbine, Indian scenario and worldwide developments, present status and future trends. Wind turbine aerodynamics.	8
2.	**Characteristics of Wind Energy** Nature of atmospheric winds- Wind resource characteristics and assessment– Anemometry, speed frequency distribution, effect of height, wind rose, Weibull distribution, atmospheric turbulence, gust wind speed, effect of topography. Effect of Reynolds's number, actuator disc, Betz coefficient, design of wind turbine blade, effect of stall and blade tip speed ratio and coefficient of torque.	8
3.	**Wind Energy Conversion System (WECS)** Rotor Selection, Annual Energy Output, HAWT, VAWT, Rotor Design Considerations-Number of Blades, Blade Profile -2/3 Blades and Teetering, Coning- Upwind/Downwind, Power Regulation, Yaw System-Tower, Synchronous and Asynchronous Generators and Loads, Integration of Wind Energy Converters to Electrical Networks, Inverters- Testing of WECS, WECS Control System - Requirements and Strategies.	10
4.	**Control Mechanisms** Pitch control, yaw control, Electrical and Mechanical aerodynamic braking, teeter mechanism. Wind turbine dynamics with DC and AC generators: induction and synchronous generators, variable speed operation, effect of wind turbulence. Case study of design of wind mill.	7
5.	**Wind Energy Application** Wind pumps - Performance analysis, design concept and testing, Principle of WEG- Stand alone, grid connected and hybrid applications of WECS,	7

	Economics of wind energy utilization, Wind energy in India- Case studies, environmental impacts of wind farms.	

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. Spera D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press, NY 1994.
2. Martin OL Hansen: Aerodynamics of Wind Turbines, 2nd ed. Earthscan, London.
3. B.H.Khan: Non Conventional Energy Sources, Tata McGraw-Hill Education, 2006.
4. Johnson, G.L., Wind Energy Systems, Prentice Hall, 1985.
5. Martin OL Hansen: Aerodynamics of Wind Turbines, 2nd ed. Earthscan, London.
6. L. L. Freris, Wind Energy Conversion systems, Prentice Hall, UK, 1990.
7. Steve Parker, “Wind power”, Gareth Stevens Publishing, 2004.

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Course Code	Course Name	Credits
ME 323	**Thermal Energy Storage Systems and Applications**	**3**

Course Objectives:

1. Learn various thermal energy storage methods.
2. To understand impact of various energy storage on environment.
3. To learn mathematical modelling of thermal storage systems

Course Outcomes: Upon successful completion of this course, the learner will be able to

1. Choose the best suited method from available methods of energy storage to reduce impact on environment.
2. Carry out Energy and Exergy Analyses of Thermal Energy Storage Systems.
3. Understand recent advancements in energy storage technologies.

Module	Detail Content	Hrs.
1.	**Energy storage systems :-** Introduction , Energy Demand , Energy Storage , Energy Storage Methods , Hydrogen for Energy Storage, Comparison of Energy Storage Technologies.	04
2.	**Thermal Energy Storage (TES) Methods and Environmental Impact** Introduction to Thermal Energy, Thermal Energy Storage, Solar Energy and TES Methods , Sensible and Latent , Cold Thermal Energy Storage (CTES), Seasonal TES. **Thermal Energy Storage and Environmental Impact:-** Introduction , Energy and the Environment Major Environmental Problems, Environmental Impact and TES Systems and Applications , Potential Solutions to Environmental Problems , Sustainable Development.	08
3.	**Thermal Energy Storage and Energy Savings:-** Introduction, TES and Energy Savings , Additional Energy Savings Considerations for TES , Energy Conservation with TES: Planning and Implementation , Some Limitations on Increased Efficiency , Energy Savings for Cold TES	04
4.	**Energy and Exergy Analyses of Thermal Energy Storage Systems** Introduction , Theory: Energy and Exergy Analyses , Thermodynamic Considerations in TES Evaluation , Exergy Evaluation of a Closed TES System , Appropriate Efficiency Measures for Closed TES Systems , Importance of Temperature in Performance Evaluations for Sensible TES Systems , Exergy Analysis of Aquifer TES Systems , Exergy Analysis of Thermally Stratified Storages , Energy and Exergy Analyses of Cold TES Systems , Exergy Analysis of Solar Ponds.	08
5.	**Numerical Modeling and Simulation of Thermal Energy Storage Systems** Introduction, Approaches and Methods, Selected Applications , Numerical Modeling, Simulation, and Analysis of Sensible TES Systems, Numerical Modeling, Simulation, and Analysis of Latent TES Systems, Illustrative Application for a Complex System: Numerical Assessment of Encapsulated Ice TES with Variable Heat Transfer Coefficients.	08
6.	**Recent Advances in TES Methods, Technologies, and Applications:-** Introduction , Recent TES Investigations , Developments in TES Types and Performance , Micro- and Macro-Level Advances in TES Systems	08

	and Applications, Micro-Level Advances in TES Systems, Macro-Level Advances in TES Systems and Applications , Performance Enhancement Techniques, Innovative Applications of TES Systems, Advanced Applications of Exergy Methods.	

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. Thermal Energy Storage: Systems and Applications, 2nd Edition , Ibrahim Dincer, Marc A. Rosen , John Wiley & Sons
2. Exergy Method: Technical and Ecological Applications: No.18 (Developments in Heat Transfer) by J. Szargut , WIT Press
3. Thermal Design and Optimization 1st Edition, by Adrian Bejan, George Tsatsaronis, Michael J. Moran John Wiley & Sons, Inc
4. Advances in Thermal Energy Storage Systems , Methods and Applications by Luisa F. Cabeza, Woodhead Publishing,
5. Thermal Energy Storage Technologies for Sustainability: Systems Design, Assessment and Applications by S. Kalaiselvam Dr. (Author), R. Parameshwaran, Academic Press
6. Thermal Energy Storage Analyses and Designs by Pei-Wen Li (Author), Cho Lik Chan , Academic Press.
7. Latent Heat-Based Thermal Energy Storage Systems: Materials, Applications, and the Energy Market**,** by Amritanshu Shukla (Editor), Atul Sharma (Editor), Pascal Henry Biwolé , CRC Press
8. Thermal, Mechanical, and Hybrid Chemical Energy Storage Systems 1st Edition, by Klaus Brun, Timothy C. Allison, Richard Dennis, Academic Press

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Course Code	Course Name	Credits
ME 324	**Vehicle Systems**	**3**

Course Objectives :

1. To study basic and advanced automotive systems.
2. To study working of different automotive systems and subsystems.
3. To study different types of frames and vehicle layout.
4. To have a basic idea about how automotive systems are developed.

Course Outcomes: Learner will be able to…

1. Interpret underlying mechanics of the automotive systems.
2. Compare different chassis and transmission systems.
3. Select an automotive system for diverse automotive applications.
4. Understand different Vehicle Body systems and layouts.
5. Understand the working of different Vehicle Systems and Subsystems.
6. Comprehend the different technological advances in vehicle systems.

Theory Syllabus:

Module	Content	Hrs.
1	**Frames and Axles** Frames-Layouts,types,material,construction,loads acting Front and Rear axles – Types of Front Axles and Stub axles , Construction and Materials **Automotive Clutch**- Necessity of clutch in a automobile, Working and Construction of Single plate,Multi-plate,Centrifugal,Semi Centrifugal, Electromagnetic clutches, Fluid Flywheel	05
2	**Automotive Transmission**- Purpose and Elements of Gear Box, Characteristic Curves, Types-Sliding mesh, Constant Mesh, Synchromesh, Determination of gear ratios for vehicles, **Hydrodynamic Transmissions**-Torque converter - Principle - constructional details, Multistage torque converters and Polyphase torque converters. **Epicylclic Gearboxes used in automatic transmissions-** Principle of Planetary gear trains-Wilson,Cotal electromagnetic transmission, Continuously Variable Transmission-Types and Operation of typical CVT, Automotive Powertrain, Powertrain Analysis and Transmission Matching	10
3	**Drive Line**: UV joint, CV joint, Propeller Shaft construction and arrangement, Elements of drive line, 2WD, 4WD, Part time and Full time 2WD and 4WD.Driving thrust and its effects, Torque reaction and Side thrust, Hotchkiss drive, Torque tube drive, Radius rods, Stabilizers **Final Drive** –Types of Final drive gears and Bearing **Differential** –Principle, Constructional details of Differential unit,Housing,Non slip differential and differential locks, gears and bearing	06
4	**Steering**-Introduction to steering systems, Manual Steering, Ackerman and Davis Steering Mechanisms, Steering Linkages Different types of Steering gear boxes, Reversible and Irreversible steering, Slip angle,	06

	Over and under steer Power steering systems, Front Wheel Geometry, Wheel alignment	
5	**Brakes**- Introduction to Brake System, Components of Brake System, Hydraulic Brake, Air Brake, Antilock Brake System, Braking Analysis.	06
6	**Suspension**- Introduction to Suspension System, Components of Suspension System, Dependent and Independent Suspension, Types of Suspension Springs-Single leaf, Multileaf spring, Coil, Torsion Bar, Rubber, Pneumatic and Hydro elastic suspension spring systems. **Wheels and Tyres**- Tire requirement, tire characteristics, Constructional detail and retreading, tire dimensions and specifications, Types of wheels and Hubs.	06

Laboratory Syllabus:
Term Work : (Comprises both A & B)
A. List of Experiments

1. Dismantling and reassembling of Clutch.
2. Dismantling and reassembling Gear box.
3. Dismantling and reassembling of the Propeller Shaft.
4. Dismantling and reassembling of Differential.
5. Dismantling and reassembling of Steering gear linkages and steering gear box.
6. Dismantling and reassembling any one type of braking system.

B. Case Study
Case study and detail report explaining all systems and subsystems on any two of following

A. Passenger Vehicle
B. 2/3 Wheeler
C. Off Road Vehicles
D. Military vehicles

Theory Assessment:
Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks
Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Laboratory Assessment:
The distribution of marks for term work shall be as follows:

1. Part A : 10 marks
2. Part B : 10 marks
3. Attendance (Theory and Practical) : 05 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Text Books:

1. Newton, Steed & Garret, Motor Vehicles, Butterworth Heinemann.
2. N. K. Giri, Automotive Mechanics, Khanna Publishers.
3. D. Crolla, D. E. Foster, T. Kobayashi and N. Vaughan (Editors-in-Chief), Encyclopedia of Automotive Engineering, Parts 1-6, Wiley, 2015.

Books/References:

1. Crouse. W. H, Automotive Chassis and Body, McGraw Hill New York.
2. Jack Erjavec, Automotive Technology – A systems approach, Cengage Learning.
3. M. J. Nunny, Automotive Technology, SAE Publication.

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Course Code	Course Name	Credits
ME 325	**Automotive Chassis and Body Systems**	**3**

Course Objectives:

1. To Understand fundamentals of Vehicle Body design
2. To Study different vehicle structural design and their requirements.
3. To Study Vehicle Aerodynamics.
4. To Study different vehicle body structures and Loads acting on them.
5. To study various materials related to body structures

Course Outcomes: Learner will be able to

1. Apply aerodynamics principles while vehicle body designs.
2. Apply Aesthetic and Ergonomic principles while designing vehicle body.
3. Differentiate different vehicle body styles.
4. Select material for different vehicle components.
5. Identify and draw various types of body design according to shape and frame structures.
6. Design passenger and commercial vehicle bodies for different loading conditions.

Module	Content	Hrs.
1	**Aerodynamics** Vehicle Body Styles, Vehicle drag and types, Various types of forces and moments, Effect of forces and moments, Side wind effect on forces and moments, Body optimization techniques to reduce drag, Wind tunnels-Principle of operation and types, Wind tunnel testing such as: Flow visualization techniques, Air flow management test - measurement of various forces and moment by using wind tunnel.	07
2	**Car Body Details** Types of Car Bodies,Visibility,Drivers Visibility, Improvement in visibility and test for visibility, Driver Seat design, Car body construction, Various panels used in car bodies Safety -Safety aspects during design, Safety equipment, Design criteria, Prototype making, Initial tests, crash test on full models, Dummies and Instrumentation.	06
3	**Bus Body Details** Types of bus body: based on capacity, distance travelled and based on construction:Mini bus, Single decker,Double decker,Two level and articulated, Bus body layout-Floor height, Engine location, Entry and exit location, seating dimensions. Constructional details-Conventional and Integral, Frame construction, Double skin construction, metal sections types,	06
4	**Commercial vehicle detail** Types of commercial vehicle bodies-Flat platform, drop side, fix side, tipper body, tanker body, Trailer body, Light commercial vehicle body types, Dimensions of driver seat in relation to controls, Drivers cab design and Regulations Special commercial vehicles: Refrigerated vehicles, paramedic ambulances, pickup van.	06

5	**Body Materials, Trim and Mechanisms** Types of materials used in body construction-Sheet steel, timber, plastics, GRP, Carbon fiber, fibreglass, Shape memory alloys, technologies to reduce NVH properties of materials, Corrosion- anti corrosion methods, Selection of paint and painting procedure and paint problems. Body trim items and Body mechanisms, Body repair tools - Hand tools, power tools, repairing sheet metal, repairing plastic body fillers, passenger compartment service.	07
6	**Vehicle structure and Body design** Loads on frames, Construction and cross sections of frame, Basic requirement of strength and stiffness, Vehicle structure types, Demonstration of Simple structural surface (SSS),Idealized structure-structure surface, shear panel method, Layout of design, preliminary design, vehicle body weight analysis and Vehicle Weight distribution **Body loads** Symmetric and asymmetrical vertical loads in car, longitudinal loads, Different loading situations, Calculation of loading cases, Stress analysis of vehicle body structure under bending and torsion.	07

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Text Books:

1. J.Powloski-“Vehicle Body Engineering”-Business Books Ltd, London,1989
2. John Fenton-“Vehicle Body Layout and analysis-Mechanical Engg. Publications Ltd, London, 1982.
3. J.Reimpell-“The Automotive Chassis: Engineering Principles “Reed Elsevier and Professional publishing Ltd, 2001.

Books/References:

1. Crouse. W. H, Automotive Chassis and Body, McGraw Hill New York.
2. Wolf Heinrich Hucho, Aerodynamics of Road Vehicles, SAE International, USA
3. Giles J.C Body Construction and Design, Illife Books Butterworth & Co., 1971

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Course Code	Course Name	Credits
IL 360	**Entrepreneurship**	**3**

Course Objectives:

1. To understand the basic concepts of entrepreneurship.
2. To understand the role of entrepreneurship in economic development
3. To understand the importance of opportunity recognition and internal and external analyses to the success of a business venture
4. To enable the learners to know the factors contributed in failure of the enterprise

Course Outcomes: Learner will be able to

1. Analyse the business environment in order to identify business opportunities
2. Identify the elements of success of entrepreneurial ventures
3. Evaluate the effectiveness of different entrepreneurial strategies,
4. Interpret their own business plan

Module	Detailed Contents	Hrs
1	Conceptual definition of entrepreneurs and entrepreneurship, Advantages and Disadvantages of Being an Entrepreneur , Entrepreneurial motivation, Entrepreneurial characteristics	8
2	Recognizing, assessment and Exploiting the Opportunity, Conducting Internal and External Analyses, Determining the Feasibility of the Concept, Selecting a Marketing Strategy	6
3	Entrepreneurial Business Types A. Overview of Franchising and Their Advantages and Disadvantages B. Overview of Buyouts & Their Advantages and Disadvantages C. Overview of Family Businesses and Their Advantages and Disadvantages	6
4	The Overall Business Plan, Purpose of the Business Plan, Components of the Business Plan, Presentation of the Business Plan, Matching the Business Plan to the Needs of the Firm	6
5	The Marketing Plan, Conducting a Market Analysis, Understanding the Target Market, Reaching the Target Market through Locale and Engagement	8
6	Entrepreneurial failure, early stage failure, late stage failure	6

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Reference Books:

1. Fundamentals of Entrepreneurship by H. Nandan, PHI
2. Entrepreneurship by Robert Hisrich, Michael Peters, Dean Shepherd, Sabyasachi Sinha, Mc Graw Hill
3. Why startups fail: A new roadmap for entrepreneurial success by Tom Eisenmann

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Course Code	Course Name	Credits
IL 361	**IPR and Patenting**	**3**

Course Objectives:

1. To introduce fundamental aspects of Intellectual property Rights to learner who are going to play a major role in development and management of innovative projects in industries.
2. To get acquaintance with Patent search, patent filing and copyright filing procedure and applications, and can make career as a patent or copyright attorney.
3. To make aware about current trends in IPR and Govt. steps in fostering IPR,

Course Outcomes: Learner will be able to…

1. Understand the importance of IPR, types of Patent type and its importance in industries.
2. Able to search, draft and file the patent and copyright application to patent office.
3. Learn the recent trends of IPR and can open the way for the students to catch up Intellectual Property (IP) as a career option:
   a) R&D IP Counsel in research organization
   b) Government Jobs – Patent Examiner
   c) Private Jobs
   d) Patent agent and Trademark agent.

Module	Detail Content	Hrs.
1	**Overview of Intellectual Property:** Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967,the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994	9
2	**Patents:** Patents - Elements of Patentability: Novelty, Non-Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board	7
3	**Copyright:** Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights	6
4	**Trademark:** Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non-Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademark's registry and appellate board.	6
5	**Patent Acts:** Section 21 of the Indian Patent Act, 1970 (and corresponding Rules and Forms) with specific focus on Definitions, Criteria of Patentability,	9

	Non-Patentable Subject Matters, Types of Applications, and Powers of Controllers. Section 25 - Section 66 of the Indian Patent Act, 1970 with specific focus on the Oppositions, Anticipation, Provisions of Secrecy, Revocations, Patent of Addition, and Restoration of Patents. Section 67 - Section 115 of the Indian Patent Act, 1970 with specific focus on Patent Assignments, Compulsory Licensing, Power of Central Government, and Infringement Proceedings. Section 116 - Section 162 of the Indian Patent Act, 1970 with specific focus on Convention/PCT Applications, Functions of Appellate Board and other Provisions. Amendment Rules 2016 with emphasis on important revisions to examination and Hearing procedures; provisions for start-ups and fees.	
6	**Indian IP Policy:** India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP – IPR.	3

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
4. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf

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Course Code	Course Name	Credits
IL 362	**Introduction to Bioengineering**	**3**

Course Objectives:

1. To understand and analyze the human body as a mechanical assembly of linkages and describe the fundamentals of biomechanics.
2. To Study the deformability, strength, visco elasticity of bone and flexible tissues, modes of loading and failure and describe the types and mechanics of skeletal joints.
3. To describe movement precisely, using well defined terms (kinematics) and also to consider the role of force in movement (kinetics).
4. To teach students the unique features of biological flows, especially constitutive laws and boundaries.
5. To teach students approximation methods in fluid mechanics and their constraints.
6. To consider the mechanics of orthopedic implants and joint replacement , mechanical properties of blood vessels and Alveoli mechanics

Course Outcomes: Learner will be able to

1. Apply a broad and coherent knowledge of the underlying principles and concepts of biomechanics, particularly in the fields of kinematics and kinetics as applied to human and projectile motion.
2. Understand and describe the properties of blood , bone and soft tissues like articular cartilage tendons and ligaments.
3. Gain broad knowledge about the mechanics of moving systems and familiarity with human anatomy to competently analyze gross movement of the human body.
4. Be able to computationally analyze the dynamics of human movement from the most commonly used measurement devices in the field, such as motion capture and force platform systems.
5. Use knowledge gained to competently interpret the current understanding of human movement and present recommendations for further study.

Module	Detail Content	Hrs.
1	**Introduction:** Definition of Biomechanics, Selected Historical highlights, The Italian Renaissance, Gait century, Engineering Physiology & Anatomy	6
2	**Tissue Biomechanics:** Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models – anisotropy. Structure and functions of Soft Tissues: Cartilage, Tendon, Ligament, and Muscle	8
3	**Joints Biomechanics:** Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, hip, knee and ankle.	7
4	**Biomaterials:** Brief Anatomy, Bone, cartilage, ligament, tendon, Muscles, biofluid their physical properties	6
5	**Implants:** General concepts of Implants, classification of implants, Soft tissues	6
6	Application of advanced engineering techniques to the human body, case studies.	6

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Books/References:

1. Nigg, B.M.and Herzog, W., "BIOMECHANICS of Musculo skeleton system", John Willey & Sons, 1st Edition.
2. Saltzman, W.L., "BIOMEDICAL ENGINEERING: Bridging medicine and Technology", Cambridge Text, First Edition.
3. Winter, D., "BIOMECHANICS and Motor Control of Human Movement", WILEY Interscience Second edition
4. Prof. Ghista,Biomechanics, Private Publication UAF, 2009
5. White &Puyator, Biomechanics, Private publication UAE, 2010
6. R. M. Kennedy, A textbook of Biomedical Engineering, GTU, 2010
7. Richard Shalak & ShuChien, Handbook of Bioengineering,
8. Sean P. Flanagan, Flanagan, Biomechanics: A case based Approach, Jones & Bartlett Publishers, 2013
9. Y. C. Fung, Yuan-Cheng Fung, Biomechanics: mechanical Property of living Tissue, Springer, 1996.
10. Carol A. Oatis, The Mechanics and Pathomechanics of Human Movement, Lippincott Williams & Wilkins, 2010

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Course Code	Course Name	Credits
IL 363	**Product Design**	**3**

Course Objectives:

1. To familiarize with fundamental product design concepts
2. To acquaint with product design methodologies
3. To understand product design needs and issues in industry

Course Outcomes: Learner will be able to

1. Demonstrate product design and development process.
2. Analyze a product in perspective of aesthetic and ergonomic considerations.
3. Illustrate considerations of Design for Manufacturing and Assembly in product development.
4. Apply appropriate tools and techniques in the design of solutions that are usable and functional for various applications.
5. Design the products as per the customer/industry requirements
6. Apply principles of economy and demonstrate legal and social issues pertaining to product development.

Module	Detail Content	Hrs.
1	Product definition, specification, Phases of product development: conceptual, embodiment and detailed design, product and technology development cycle, Concept generation and evaluation methods, product architecture, Product life cycle Management with case studies, Product analysis. Creativity and Idea generation technique, importance of Quality Dimensions: Performance, Features, aesthetics, Ergonomics, Reliability, Sustainability, Serviceability, Brand value, Value Vs cost, Importance of shape, color, feature & Resemblance.	06
2	Design Factors: Ergonomics, Aesthetics, Anthropometry, Comforts, Economic factors Axiomatic design principles and case studies. Design Thinking, Design by Innovation and collaboration Material and Process selection Methods, Expert systems. Computer Database Approach, performance indices decision matrix, AHP and fuzzy approach, Introduction to material and process selection software.	06
3	Design for Manufacturing (DFM) and Design for Assembly (DFA) Designs for Maintainability and Reliability and some methods for reliability assessment, Designs for Environment, Design for Robustness: Taguchi Designs & Design of Experiments (DOE).	08
4	Product Design Tools and Techniques: Value Engineering / Value Analysis: definition, methodology- FAST, Benchmarking, Supplier involvement robust design, QFD, Design & process FMEA. Reverse Engineering, Concurrent engineering & Sequential engineering, Case studies.	08

5	Product Development Cycle and Importance of Prototyping. Types of prototypes. Principal and advantages & Different Type of Generative Manufacturing process, Viz. Stereo lithography. FDM, SLS etc. Factors Concerning to RP: Consideration for Adoptions, Advantages, Accuracy and Economic Consideration. Introduction to Assembly Modeling, Top-Down and Bottom-Up Approaches of AM, Mating Conditions, representation Schemes. Generation of Assembly Sequences. Case studies	06
6	Economics of Product Development: Product costing, Principals of Economy, Engineering Economy and Design Process, Economic Analysis, Inflation, Time Value of Money, Numerical on Internal Rate of Return and Net Present Value (NPV) method. Legal and social issues, Patents and IP acts.	06

Assessment:
Internal Assessment: 40 marks
Mini project on product design from idea generation to prototyping
End Semester Examination: 60 marks
Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

Reference Books:

1. Product Design and Manufacturing by A.K.Chitale, R.C.Gupta, PHI.
2. Product Design and Development by Ulirich Karl T. and Eppinger Steven D, McGraw Hill.
3. Engineering Design by Dieter George E., McGraw Hill.
4. Handbook of Product Design for Manufacturing by Bralla, James G, McGraw Hill.
5. Product Design by Kevin Otto & Kristin Wood

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Course Code	Course Name	Credits
IL 364	**Visual Art**	**3**

Course Objectives:

1. To enable learners to develop aesthetic judgement, visual perception, critical thinking skills in the different forms of art and understand its application.
2. To promote the concept of visual design and understand the different meanings assigned to colours, its impact and problems.
3. To provide the opportunity and scope to use the image editing software for creating images for Web and Video.
4. To inculcate the basic skills required in drawing and painting through exposure in nature and study of still objects.
5. To train students to express their feelings and write imaginatively.
6. To prepare the learners for the use of clay modelling techniques and its industrial applications.

Course Outcomes: Learner will be able to

1. Acquire the skills necessary for aesthetic judgement, visual perception and critical thinking required in different forms of art.
2. Demonstrate the understanding of the concept of visual design with respect to the different meanings assigned to colours and the problems associated.
3. Illustrate effective use of image editing software for creating images for the Web and Video.
4. Determine the importance of drawing and painting with respect to nature and still objects.
5. Perform successfully in expressing their feelings creatively.
6. Develop the techniques required for clay modelling and sculpture for industrial use.

Module	Detail Content	Hrs.
1	History of Art and Architecture- Changing needs and forms of art from the Palaeolithic period to The Renaissance period with special reference to Roman, Indian and Chinese art	4
2	Introduction and concepts of visual design with special emphasis on the psychological impact of colour	5
3	Introduction to image editing software, tools, application and creating Images for Web and Video. With special reference to Adobe Photoshop	7
4	Fundamentals of Drawing- study of forms in nature, study of objects and study from life, creative painting- basic techniques, tools and equipment, medium of painting.	6
5	Creative writing- Movie critique, book reviews, Poems, short plays and skits, Humorous Essays, Autobiography and short stories.	7
6	Creative sculpture- Introduction to clay modelling techniques, study of natural and man-made objects in clay, Sculpture with various materials - Relief in Metal Sheets – Relief on Wood – Paper Pulp - Thermocol. Sculpture with readymade materials.	7

Assessment:

Internal Assessment:

Test 1	: 10 marks (Practical)
Test 2	: 10 marks (Practical)
Total	: 20 marks

End Semester Examination:

Theory	: 40 marks
Practical	: 40 marks

Reference Books:

1. Gill Martha. (2000). Color Harmony Pastels: A Guidebook for Creating Great Color Combinations. Rockport Publishers.
2. Janson, Anthony F. (1977). History of art, second edition, H.W. Janson. Instructor's manual. Englewood Cliffs, N.J.: Prentice-Hall.
3. Brommer, Gerald F. (1988). Exploring Drawing. Worcester, Massachusetts: Davis Publications.
4. Wendy Burt Thomas. (2010). The Everything Creative Writing Book: All you need to know to write novels, plays, short stories, screenplays, poems, articles, or blogs: All You Need ... - Stories, Screenplays, Blogs and More. Fw Media; 2nd edition.
5. Élisabeth Bonvalot. (2020). Sculpting Book: A Complete Introduction to Modeling the Human Figure.

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Course Code	Course Name	Credits
IL 365	**Journalism, Media and Communication studies**	**3**

Course Objectives:

1. Provide a good grounding in the basic concepts of Journalism, Mass communication and Media.
2. Familiarize learners with reporting and editing practices.
3. Teach students to write editorials, feature articles, interviews, reviews, criticism etc.
4. To inculcate the skills required for writing in online newspapers, blogs, email and cell phone.
5. To prepare the learners for understanding the importance of Press laws and Ethics.
6. To train learners in advertising techniques and Public Relation Communication

Course Outcomes: Learner will be able to

1. Acquire conceptual and theoretical knowledge of Journalism, Mass Communication and Media Studies and learn to think critically about issues and topics of the subject.
2. Demonstrate the understanding of reporting and editing from Newspaper and the Organization.
3. Perform successfully in writing effective editorials, featured articles reviews etc.
4. Illustrate the skills required for writing in online newspapers, blogs, emails etc.
5. Determine the importance of Press Laws and Ethics.
6. Develop an understanding of the techniques required for advertising and Public Relation Communication.

Module	Detail Content	Hrs.
1	Introduction to Journalism, Communication, Media and Cultural Studies- Basics of Mass communication, Pioneers of Indian Journalism, Introduction to newspapers, magazines and other publications. Introduction to broadcast journalism with special reference to television	5
2	Reporting and Editing Practices-Reporting different news, stories from Newspaper, and Organization. Principles of editing, rewriting, and translation	7
3	Writing for Print- Newspaper Content Writing Opinion pieces, editorials, feature articles, interviews, profiles, reviews, criticism etc.	7
4	Writing for Media- Introduction to New Media Writing for Online newspapers Blogs Cell phone Communication E-mail	6
5	Press Laws and Ethics- Origin and definition of Law, Law and Morality, Types of Law – Civil and Criminal, Press Legislations, Freedom of the Press Defamation Contempt of Court	4
6	Public Relations and Advertising- Introduction to Public Relations Stages of PR Communication with Public Need and Meaning of Advertising, Advertising strategies and Sales Promotion	7

Assessments:

Internal Assessment:

Test 1 : 15 marks
Test 2 : 15 marks
Total : 30 marks

End Semester Examination:

Theory : 45 marks

Term work:
25 marks (10 marks for assignment, 10 marks for practical and 5 marks for attendance)

Books/References:

1. Rangaswamy, Parthasaratihi, (1985). *Journalism in India*, Sterling Publication, New Delhi.
2. Jeffrey, Robin, (2009). *India's Newspaper Evolution*, Oxford University Press, Delhi.
3. Singh, Devvrat. (2012). *Indian Television: Content, Issues and Challenges*, HarAnand Publications Delhi.
4. Daryl L. Frazell, George Tuck. (1996). *Principles of Editing: A Comprehensive Guide for Students and Journalists Principles of Editing: A Comprehensive Guide for Students and Journalists.* McGraw-Hill
5. Barry Newman. (2015). *News to Me: Finding and Writing Colorful Feature Stories*. Paperback
6. The Associated Press. (2017). *The Associated Press Stylebook: and Briefing on Media Law*. Revised, Updated Edition. Paperback.
7. Kristina Halvorson. (2012) *Content Strategy for the Web*, 2nd Edition. New Riders

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Course Code	Course Name	Credits
IL 366	**Computational Physics**	**3**

Course Objectives:

1. To expose the students to the vast field of computational physics.

Course Outcomes: Learner will be able to

1. To understand various approaches of simulating physical systems on a computer.
2. To choose the correct method to solve a computational problem.

Module	Detail Content	Hrs.
1	**Introduction to Statistical Mechanics :** Thermodynamics and kinetic theory, specification of state of system, Concept of ensemble, phase space, microcanonical ensemble (NVE), statistical concept of temperature, canonical ensemble (NVT), equipartition theorem, Maxwell-Boltzmann velocity distribution, grand canonical ensemble (μVT), chemical potential	6
2	**Molecular Dynamics (MD):** Integrating equation of motion of a few variables, role of molecular dynamics (MD), the basic machinery, Lennard-Jones potentials modeling physical system, boundary conditions, time integration algorithm	7
3	Starting a simulation, simulation of microcanonical (NVE) and canonical ensemble (NVT), controlling the system (temperature, pressure), thermostats and barostats, equilibration, running, measuring and analyzing MD simulation data, measurement of statistical quantities, interatomic potentials, force fields.	7
4	**Monte Carlo (MC) Method :** Random number: Definition, True and Pseudo random number generators (RNG), uniform and non-uniform RNG, Linux RNG, testing a RNG.	6
5	**Monte Carlo simulations :** Buffon's needles, MC Integration, hit and miss (estimation of pi and e), stochastic processes, sample mean integration, importance sampling, Markov Chain, Metropolis method, master equation, introduction to 2D-Ising model. **Random walk:** 1-D and 2-D random walk, calculation of rms displacement.	7
6	Introduction to Simulations of quantum systems	3

Internal Assessment:

Internal Examination : 20 marks
Internal Term work : 20 marks

End Semester Examination:

Theory : 40 marks
Practical Examination : 20 Marks

Books/References:

1. Statistical Physics – Vol. 5 (from the series of Berkeley Physics Course)
2. Introduction to Computational Physics by Tao Pang (Cambridge University Press)
3. An Introduction to Computer Simulation Methods : Applications to Physical Systems by Harvey Gould and
4. Jan Tobochnik, (Pearsom Publications)
5. Understanding Molecular Simulations by Frenkel and Smit (Academic Press)

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Course Code	Course Name	Credits
IL 367	**Polymers and Polymeric Materials**	**3**

Course Objectives:

1. To impart a scientific approach and to familiarize the applications of polymeric materials in the field of engineering.
2. The student with the knowledge of the basic polymer science will understand and explain scientifically the various problems related to polymeric materials in the industry/engineering field.
3. To develop abilities and skills that are relevant to the study and practice of polymer science and engineering.

Course Outcomes: Learner will be able to

1. To understand and analyze various polymeric materials and to establish the structure property relationship.
2. To select the proper polymeric material for specific industrial applications.
3. To become familiarized with various characterization techniques related to polymeric materials.

Module	Detail Content	Hrs.
1	**Basic understanding of Polymeric aspects:** Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness, polymerization methods: addition and condensation; metallocene polymers and other newer techniques of polymerization, copolymerization, monomer reactivity ratios and its significance, different copolymers, random, alternating, azeotropic copolymerization, block and graft copolymers, concept of average molecular weight, determination of number average, weight average	9
2	**Polymer Technology:** Compounding of plastics, Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization	5
3	**Polymer Processing:** Fabrication of plastics by different moulding process, Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer	6
4	**Polymer blends:** Thermo- dynamical aspects of polymer blends and its miscibility, Role of compatibilizer, Composition based structure (dispersed and co-continuous), properties and its application, choice of polymers for blending, thermodynamics, phase morphology, polymer alloys, polymer eutectics, plastic-plastic, rubber-plastic and rubber-rubber blends	6
5	**Polymer composites:** Fundamentals of polymer composites, Advanced polymer nanocomposites, Fillers used for polymer composites, Effect of processing condition and composition, Polymer composites structure,	6

	characterisation and design, physical and chemical modification of polymer composites. 1-D and 2-D random walk, calculation of rms displacement.	
6	**Testing of Polymeric Materials:** Samples preparation, Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness. Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, aging resistance, establishment of structure property relationship	7

Assessments:

Internal Assessment:

Assessment consists of two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test student may need to perform experiments related to polymeric material synthesis or polymer testing depending on the available facilities.

End Semester Examination:

In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 4 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

Books/References:

1. “Fundamentals of Polymer Engineering” by Anil Kumar and Rakesh Gupta.
2. “ Principles of Polymer Systems” by F Rodriguez.
3. “ Polymer Science” by V R Gorwankar.
4. “ Textbook of Polymer Science” by F W Billmeyer. 5. “ Polymer Chemistry” by P C Heimenz.

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Course Code	Course Name	Credits
IL 368	**Vehicle Safety**	**3**

Course Objectives:

1. To familiarize basic concepts of vehicle safety.
2. To familiarize accident reconstruction analysis methods
3. To acquaint with different issues related to vehicle safety in India

Course Outcomes: Learner will be able to

1. Comprehend Vehicle design from safety point of view.
2. Apply concepts of accident reconstruction analysis in real world.
3. Enumerate interrelationship among occupant, restraint systems and vehicles in accidents.
4. Illustrate role and significance of seat in Rear crash safety
5. Demonstrate different active and passive safety systems available in vehicles
6. Contribute to the society by being proactive to the cause of safety on roads and in vehicles

Module	Detailed Contents	Hrs.
1	Introduction to vehicle safety-the integrated approach and its classification SAVE LIVES- by WHO, Importance of Risk evaluation and communication, Concepts of Universal design, India's BNVSAP and its outcomes	6
2	Crash and distracted driver, Human error control, Crash Testing, Use of Dummies, evolution and build of dummies. Relevance of Star ratings, NCAPs around the world-Accident Data, Biomechanics and Occupant Simulation, Vehicle Body Testing, Dynamic Vehicle Simulation Tests Occupant Protection, Compatibility, Interrelationship Among Occupants, Restraint Systems and Vehicle in Accidents	7
3	Significance of Rear Crash Safety, Role of seat in Rear crash safety, Self-aligning head restraints, Pedestrian Protection testing and systems , Under run Protection Devices	5
4	Introduction to Accident Analysis Reconstruction methods, Skid distances and Critical speed from Tire Yaw marks, Reconstruction of Vehicular Rollover Accidents, Analysis of Collisions, Reconstruction Applications Impulse Momentum Theory, Crush Energy, Photogrammetry for accident constructions	8
5	Anti-Lock braking system, Electronic Stability Program, Low tire pressure warning system, Collision avoidance systems	4
6	Basic Vehicle Operations and Road/Helmet Safety Activity	5

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

References Books:

1. Automotive vehicle safety by George Peters and Barbara Peters, CRC Press, 2002.
2. Vehicle Accident Analysis and Reconstruction Methods by Raymond M. Brach and R. Matthew Brach, SAE International, Second Edition, 2011.
3. Role of the seat in rear crash safety by David C. Viano, SAE International, 2002.
4. Automotive Safety Handbook by Ulrich W. Seiffert and LotharWech, SAE International, 2007.
5. Public Safety Standards of the Republic of India

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Course Code	Course Name	Credits
IL 369	**Maintenance of Electronics Equipment**	**3**

Lab Objectives:

1. To demonstrate use of different types of hand tools
2. To understand testing of different active and passive components mounted on PCB
3. To understand functionality TTL and CMOS digital IC tester
4. To demonstrate computer assembling, troubleshooting and software installation
5. To understand/demonstrate concept of circuit diagram of LED/LCD TV, DTH and mobile phone troubleshooting
6. To understand concept of medical equipments

Lab Outcomes:

1. Demonstrate use of different types of hand tools
2. Understand testing of different active and passive components mounted on PCB
3. Understand functionality TTL and CMOS digital IC tester
4. Demonstrate computer assembling, troubleshooting and software installation
5. Understand/demonstrate concept of circuit diagram of LED/LCD TV, DTH and mobile phone troubleshooting
6. Understand concept of medical equipments

Sr. No.	Detailed Lab/Tutorial Description	Hrs.
1	Demonstrate use of various hand held tools.	2
2	Test the performance of different passive electronic components (fixed/variable)	2
3	Test the performance of active electronic components like general purpose transistor/FET/MOSFET/SCR/ DIAC/TRIAC with DMM and CRO OR Components Tester	4
4	Verify the functionality of TTL and CMOS Digital IC's using IC tester	4
5	Explore a datasheet of minimum any five electronics components and analog/ Digital IC's.	2
6	Draw the given regulated power supply circuit/ SMPS (from any television/fridge/ computer system/ laboratory etc)	2
7	Identify basic sections of a personal computer/Laptop	2
8	Demonstrate Assembling of Personal Computer/Laptop	4
9	Troubleshoot the booting process of computer system and install different hardware associated with computer (HDD, LAN Card, Audio System etc)	4
10	Study Installation of Software and Configure Internet	4
11	Explore circuit diagram of LED/LCD TV.	2
12	Demonstrate Installation of DTH system	4
13	Demonstrate installation Solar power system	4
14	Practice steps for mobile troubleshooting	4
15	Visit to Medical Equipment Industry/Laboratory	8

Assessment:

Internal Assessment:

Internal Assessment 1	: 20 marks
Internal Assessment 2	: 20 marks
Internal Term work	: 30 marks

End Semester Examination:

Practical Examination	: 30 Marks

Books/References:

1. Troubleshooting and Maintenance of Electronics Equipment, Singh K. Sudeep, Katson Book ,New Delhi ,II edition , Reprint 2014
2. Mobile repairing Books, Manohar Lotia, BPB Publication, New Delhi , latest edition
3. Troubleshooting Electronic Equipment: Includes Repair and Maintenance, Second Edition, Khandpur R. S. , Tata McGraw-Hill Education, New Delhi ,India , latest edition.
4. Data Books, National semiconductor.

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Course Code	Course Name	Credits
ME 392	**Minor Project IV**	**2**

Course Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcomes: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as a member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
9. Demonstrate project management principles during project work.

Guidelines for Minor Project:

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do surveys and identify needs, which shall be converted into a problem statement for minor-project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Student groups shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of the minor project.
- A log book has to be prepared by each group, wherein the group can record weekly work progress, and the guide/supervisor can verify and record notes/comments.
- Faculty supervisors may give inputs to students during minor project activity; however, focus shall be on self-learning.
- Students in a group shall understand the problem effectively, propose multiple solutions and select the best possible solution in consultation with the guide/supervisor.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
- The solution has to be validated with proper justification and the report has to be compiled in the standard format.
- With the focus on self-learning and innovation, addressing societal problems and entrepreneurship quality development within the students through the Minor Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Minor Project 1 in semester III and IV. Similarly, Minor Project 2 in semesters V and VI may be considered. In other words, based on the individual students' or group's capability, with the mentor's recommendations, if the proposed Minor Project adhering to the

qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Minor Project, in even semester with suitable improvements/modifications.

- Alternatively, student groups can work completely on a new project idea in the even semester, bearing no resemblance with the topic of odd semester. This policy can be adopted on a case to case basis.

Assessment:
Term Work - 25 marks
Mid Semester Evaluation - 25 marks
Practical/Oral Examination - 25 marks

Guidelines for Assessment of Minor Project:
Term Work

- The review/ progress monitoring committee shall be constituted by heads of departments of each institute. The progress of the minor project to be evaluated on a continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In the first semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the student group.
  - If the problem is based on development of a mechanism or a simple device for attaining a desired objective, the first presentation shall be reviewed based on generation of multiple feasible solutions to the given problem and identification of the best possible solution based on various parameters which may include one of more of the following viz., the total weight, volume, power consumption, mechanical advantage, efficiency, cost (including labour) per piece once manufactured, and so on. This may include creation of unique free-hand sketches by each and every member of the group to contribute to the solution of the given problem. The best possible solution has to be finalized during one or more brainstorming sessions by the members of the student group. In case the problem is of a programming/coding type, then the first presentation may be dedicated to the understanding of the theory behind the problem related to a particular domain subject, including the drafting of an algorithm and/or flowchart, and may also include the introductory part of the programming.
  - Second review shall be based on the computerization (3D CAD model of parts and assembly), and possibly the animation, depicting the working characteristics of the proposed solution to the given problem, allocating material properties to each part, identifying mass properties of the assembled parts, and so on. Checking interference is one of the important criteria that can be used when assembling the parts. For software based projects, this may include the presentation based on the extension of the programming work so as to cover the major portion of the remaining part of the topic.

- In the second semester expected work shall be procurement of components/systems,

building of working prototype, testing and validation of results based on work completed in an earlier semester. For those selecting software based projects, this may include completing the other half of the programming related work, identifying the errors, optimizing the software code, customization, creating a graphical user interface of input and output (GUI), displaying output data in the form of graphs/tables/figures/diagrams, creation of the code in executable (.exe) format or in the form of a mobile App, etc.
    - First review shall be conducted based on the readiness of the working prototype, or programming of the remaining code for software based projects.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester. This may also include the testing and validation of tests with the literature/available data/theory. For software based projects, the presentation includes the remaining work other than the programming, as described above.
- Apart from the hardware type (development of device) and software (program/coding) type of projects, the topics may also include computer based work, viz., generation of virtual laboratory (for one or more experiments) for any subject/domain of choice, or CAD modeling, analysis, optimization, and/or product design, without any relevance to developing any physical product.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including:
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solutions.

Assessment criteria of Minor Project:

1. Quality of survey/need identification
2. Clarity of problem definition based on need
3. Innovativeness/uniqueness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness/uniqueness
8. Cost effectiveness and societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual as member or leader
13. Clarity in written and oral communication

- In a **one year project**, the first semester evaluation may be based on the first six criteria as highlighted above and the remaining criteria may be used for second semester evaluation of performance of students in the minor project.
- In the case of a **half year project,** all criteria in general may be considered for evaluation of performance of students in the minor project.

Guidelines for Assessment of Minor Project Practical/Oral Examination:

- Report should be prepared as per the guidelines.
- Minor project shall be assessed through a presentation and demonstration of working model or the execution of programme code by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by the Head of Institution.
- Students shall be motivated to publish a paper based on the work in conferences or student competitions.

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