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

Academic Year 2025-26

as per

Choice Based Credit and Grading System

Mahatma Education Society's

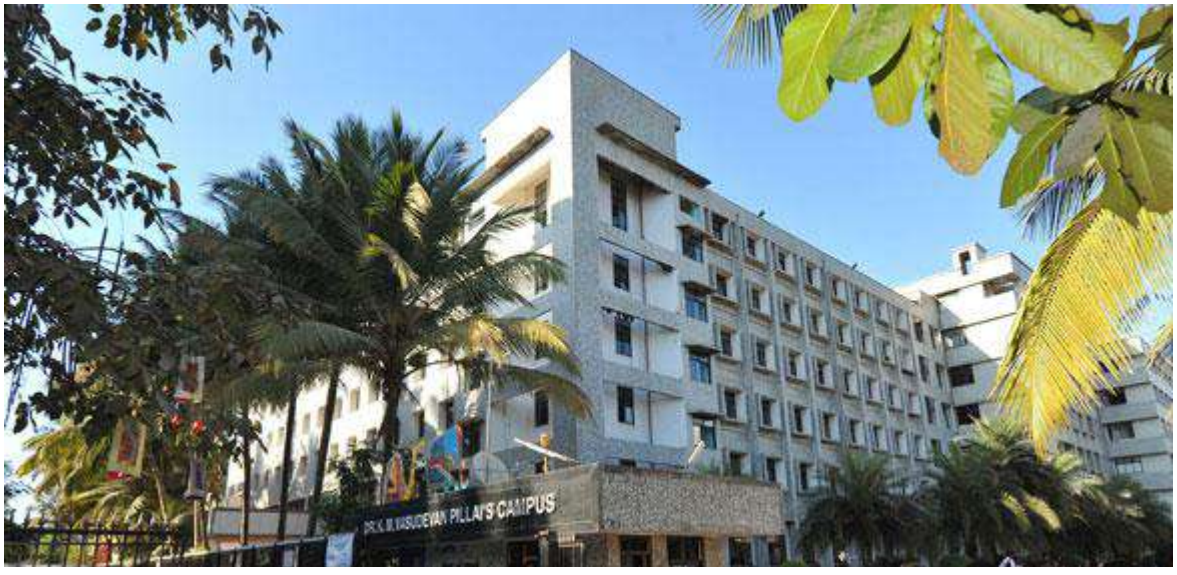
Pillai College of Engineering

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 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.
III. To provide opportunity for students to work in their individual capacity as well as to function as teams on multidisciplinary projects.
IV. To enable students for lifelong learning and introduce them to professional ethics and sustainable development.
V. To develop among students an attitude towards self-employment through entrepreneurship

Program Outcomes:

Engineering Graduates will be able to:

1. **Engineering Knowledge:** Apply knowledge of mathematics, natural science,computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3. **Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/ components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

4. **Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)
5. **Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
6. **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)
7. **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
8. **Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9. **Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
10. **Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
11. **Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Program Specific Outcomes (PSOs):

1. 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.
2. Students should be able to model and develop solutions for problems relevant to industry and the society at large.

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,

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

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester I
(Admitted to FY in 25-26)

Course Code	Course Name	Category	Teaching Scheme				
			Contact Hours		Credits Assigned		
			Theory	Pract/ Tut	Theory	Pract/ Tut	Total
MATH 101	Engineering Mathematics I	BSC	3	2	3	1	4
PHY 101	Engineering Physics I	BSC	2	1	2	0.5	2.5
CHEM 101	Engineering Chemistry I	BSC	2	1	2	0.5	2.5
MECH 101	Engineering Mechanics	ESC	3	2	3	1	4
ENGG 102	Introduction to Electrical Engineering*	ESC	3	-	3	-	3
ENGG 103	Electrical Engineering Lab*	VSEC	-	2	-	1	1
HUM 103	Ancient Indian Engineering (IKS)	HSSM	1	2	1	1	2
ENGG 104	Engineering Workshop I	VSEC	-	2	-	1	1
ENGG 108	Co-curricular Course I	Liberal learning	1	2	1	1	2
Total			**15**	**14**	**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					
MATH 101	Engineering Mathematics I	40	40	40	60	2	25	-	125
PHY 101	Engineering Physics I	30	30	30	45	2	25	-	100
CHEM 101	Engineering Chemistry I	30	30	30	45	2	25	-	100
MECH 101	Engineering Mechanics	40	40	40	60	2	25	25	150
ENGG 102	Introduction to Electrical Engineering*	40	40	40	60	2	-	-	100
ENGG 103	Electrical Engineering Lab*	-	-	-	-	-	25	25	50
HUM 103	Ancient Indian Engineering (IKS)	-	-	-	-	-	50	-	50
ENGG 104	Engineering Workshop I	-	-	-	-	-	50	-	50
ENGG 108	Co-curricular Course I	-	-	-	-		50	-	50
Total				**180**	**270**	**-**	**275**	**50**	**775**

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester II
(Admitted to FY in 25-26)

Course Code	Course Name	Category	Teaching Scheme				
			Contact Hours		Credits Assigned		
			Theory	Pract/ Tut	Theory	Pract/ Tut	Total
MATH 102	Engineering Mathematics II	BSC	3	2	3	1	4
PHY 102	Engineering Physics II	BSC	2	1	2	0.5	2.5
CHEM 102	Engineering Chemistry II	BSC	2	1	2	0.5	2.5
MECH 102	Engineering Drawing	ESC	3	2	3	1	4
CE 106	Introduction to Python Programming	ESC	3	-	3	-	3
CE 107	Python Programming Lab	VSEC	-	2	-	1	1
COMM 104	Professional Communication and Ethics I	AEC	1	2	1	1	2
ENGG 105	Engineering Workshop II	VSEC	-	2	-	1	1
ENGG 109	Co-curricular Course II	Liberal learning	1	2	1	1	2
Total			**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
MATH 102	Engineering Mathematics II	40	40	40	60	2	25	-	125
PHY 102	Engineering Physics II	30	30	30	45	2	25	-	100
CHEM 102	Engineering Chemistry II	30	30	30	45	2	25	-	100
MECH 102	Engineering Drawing	40	40	40	60	3	25	25	150
CE 106	Introduction to Python Programming	40	40	40	60	2	-	-	100
CE 107	Python Programming Lab	-	-	-	-	-	25	25	50
COMM 104	Professional Communication and Ethics I	20	20	20	30	1	25	-	75
ENGG 105	Engineering Workshop II	-	-	-	-	-	50	-	50
ENGG 109	Co-curricular Course II	-	-	-	-	-	50	-	50
Total				**200**	**300**	**-**	**250**	**50**	**800**

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester III
(Admitted to FY in 24-25)

Course Code	Course Name	Category	Teaching Scheme				
			Contact Hours		Credits Assigned		
			Theory	Pract/ Tut	Theory	Pract/ Tut	Total
MECH 201	Manufacturing Processes and Technology	PCC	3	2	3	1	4
MATH 202M	Mathematics for Mechanical and Automobile Engineers*	MDM	3	-	3	-	3
MECH 203	Strength of Materials*	PCC	3	2	3	1	4
MECH 204	Thermodynamics*	PCC	3	-	3	-	3
MECH 205	Engineering Metallurgy and Materials	PCC	3	2	3	1	4
MECH 206	Computer Aided Drafting	VSEC	-	2	-	1	1
HUM 201	Human Values and Social Ethics	VAC	2	-	2	-	2
MECH 291	Minor Project I	CEP	-	2	-	1	1
Total			**17**	**10**	**17**	**5**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
MECH 201	Manufacturing Processes and Technology	40	40	40	60	2	25	25	150
MATH 202M	Mathematics for Mechanical and Automobile Engineers*	40	40	40	60	2	-	-	100
MECH 203	Strength of Materials*	40	40	40	60	2	25	25	150
MECH 204	Thermodynamics*	40	40	40	60	2	-	-	100
MECH 205	Engineering Metallurgy and Materials	40	40	40	60	2	25	-	125
MECH 206	Computer Aided Drafting	-	-	-	-	-	25	50	75
HUM 201	Human Values and Social Ethics	-	-	-	-	-	50	-	50
MECH 291	Minor Project I	25 (Mid Sem assessment)			-	-	25	25	75
Total		**225**			**300**	**-**	**200**	**100**	**825**

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

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester IV
(Admitted to FY in 24-25)

Course Code	Course Name	Category	Teaching Scheme				
			Contact Hours		Credits Assigned		
			Theory	Pract /Tut	Theory	Pract/ Tut	Total
MECH 207	Finite Element Analysis	PCC	3	2	3	1	4
MECH 208	Theory of Machines and Mechanisms*	PCC	3	1	3	1	4
MECH 209	Fluid Mechanics and Machinery*	PCC	3	2	3	1	4
MECH 210	Data Science Lab	LP	-	4	-	2	2
MECH 211	Internet of Things	TL	-	4	-	2	2
ENGG 201	Entrepreneurship	HSSM	2	-	2	-	2
MGMT 290	Personal Finance Management		2	-	2	-	2
MECH 292	Minor Project II	LC	-	4	-	2	2
Total			**13**	**18**	**13**	**9**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
MECH 207	Finite Element Analysis	40	40	40	60	2	25	-	125
MECH 208	Theory of Machines and Mechanisms*	40	40	40	60	2	25	-	125
MECH 209	Fluid Mechanics and Machinery*	40	40	40	60	2	25	25	150
MECH 210	Data Science Lab	-	-	-	-	-	25	50	75
MECH 211	Internet of Things	-	-	-	-	-	50	25	75
ENGG 201	Entrepreneurship	20	20	20	40	2	-	-	60
MGMT 290	Personal Finance Management	20	20	20	40	2	-	-	60
MECH 292	Minor Project II	25 (Mid Sem assessment)			-	-	25	25	75
Total		**185**			**260**	**-**	**175**	**125**	**745**

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

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester V
(Admitted to FY in 23-24)

Course Code	Course Name	Category	Teaching Scheme				
			Contact Hours		Credits Assigned		
			Theory	Pract/ Tut	Theory	Pract/ Tut	Total
ME 301	Finite Element Analysis*	PCC	3	2	3	1	4
ME 302	Heat Transfer*	PCC	3	2	3	1	4
ME 303	Mechanical Measurements and Instrumentation	MDM	3	1	3	1	4
ME 304	Professional Communication and Ethics II	AEC	1	2	1	1	2
ME 30x	DLOC I	PEC	3	-	3	-	3
IL 3xx	ILOC I	OE	3	-	3	-	3
ME 391	Minor Project III	CEP	-	4	-	2	2
Total			**16**	**11**	**16**	**6**	**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 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	Mechanical Measurements and Instrumentation	40	40	40	60	2	25	25	150
ME 304	Professional Communication and Ethics II	-	-	-	-	-	50	-	50
ME 30x	DLOC I	40	40	40	60	2	-	-	100
IL 3xx	ILOC I	40	40	40	60	2	-	-	100
ME 391	Minor Project III	25 (Mid Sem assessment)			-	-	25	25	75
Total		**225**			**300**	**-**	**150**	**100**	**775**

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

Group	Department Specialization	Course Code	DLOC I
1	Thermal Engineering and Energy Science	ME 305	Advanced Fluid Mechanics
2	Design Engineering	ME 306	Design for Excellence
3	Mechatronics & Robotics	ME 307	Control Systems
4	Non Destructive Testing	ME 308	Introduction to welding and NDT

Group	Institute Specialization	Course Code	ILOC I
1	IP Management and Digital Business	IL 360	IPR and Patenting
2	Business Management	IL 361	E- Commerce and E-Business
3	Bio Engineering	IL 362	Introduction to Bioengineering
4	Bio Instrumentation	IL 363	Biomedical Instrumentation
5	Engineering Design	IL 364	Design of Experiments
6	Sustainable Technologies	IL 365	Design for Sustainability
7	Contemporary Studies	IL 366	Political Science
8	Art and Journalism	IL 367	Visual Arts
9	Applied Science	IL 368	Modern Day Sensor Physics
10	Green Technologies	IL 369	Energy Audit and Management
11	Maintenance Engineering	IL 370	Maintenance of Electronics Equipment
12	Life Skills	IL 371	Cooking and Nutrition
13	Environment	IL 372	Environmental Management
14	Safety	IL 373	Vehicle Safety
15	Quantum Computing and Quantum Technologies	IL 388	Quantum Computing and Quantum Technologies – Part 1

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester VI
(Admitted to FY in 23-24)

Course Code	Course Name	Category	Teaching Scheme				
			Contact Hours		Credits Assigned		
			Theory	Pract/ Tut	Theory	Pract/ Tut	Total
ME 309	Mechatronics	MDM	3	2	3	1	4
ME 310	Machine Design I	PCC	3	2	3	1	4
ME 311	Power Engineering	PCC	3	2	3	1	4
ME 3xx	DLOC II	PEC	3	-	3	-	3
IL 3xx	ILOC II	OE	3	-	3	-	3
ME 392	Major Project I	CEP	3	-	3	-	3
Total			**18**	**6**	**18**	**3**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ME 309	Mechatronics	40	40	40	60	2	25	25	150
ME 310	Machine Design I	40	40	40	60	2	25	-	125
ME 311	Power Engineering	40	40	40	60	2	25	25	150
ME 3xx	DLOC II	40	40	40	60	2	-	-	100
IL 3xx	ILOC II	40	40	40	60	2	-	-	100
ME 392	Major Project I	-			-	-	25	50	75
Total		**200**			**300**	**-**	**100**	**100**	**700**

Group	Department Specialization	Course Code	DLOC II
1	Thermal Engineering and Energy Science	ME 312	Design of Heat Exchangers
		ME 313	Computational Fluid Dynamics
2	Design Engineering	ME 314	Reliability Engineering
		ME 315	Failure Analysis
3	Mechatronics & Robotics	ME 316	Micro Electro Mechanical Systems
		ME 317	Signal Processing
4	Non Destructive Testing	ME 318	Non Destructive Testing Techniques

Group	Institute Specialization	Course Code	ILOC II
1	IP Management and Digital Business	IL 374	Digital Business Management and Digital Marketing
2	Business Management	IL 375	Business Analytics
3	Bio Engineering	IL 376	Biomechanics
4	Bio Instrumentation	IL 377	Medical Image Processing
5	Engineering Design	IL 378	Product Design
6	Sustainable Technologies	IL 379	Technologies for Rural Development
7	Contemporary Studies	IL 380	Economics
8	Art and Journalism	IL 381	Journalism, Media and Communication studies
9	Applied Science	IL 382	Operation Research
10	Green Technologies	IL 383	Climate Informatics
11	Maintenance Engineering	IL 384	Maintenance of Mechanical Equipment
12	Life Skills	IL 385	Physical Education
13	Environment	IL 386	Industrial Regulations and Laws
14	Safety	IL 387	Industrial and high voltage Safety
15	Quantum Computing and Quantum Technologies	IL 389	Quantum Computing and Quantum Technologies – Part 2

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester VII
(Admitted to FY in 22-23)

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	Refrigeration and Air Conditioning	TL	3	2	3	1	4
ME 4xx	DLOC IV	T/TL	3	-	3	-	3
ME 4xx	DLOC V	T/TL	3	-	3	-	3
IL 4xx	ILOC II	T	3	-	3	-	3
ME 491	Major Project II	LC	-	8	-	4	4
Total			**15**	**10**	**15**	**5**	**20**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ME 401	Production Planning and Systems	40	40	40	60	2	-	-	100
ME 402	Refrigeration and Air Conditioning	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	-	-	100
IL 4xx	ILOC II	40	40	40	60	2	-	-	100
ME 491	Major Project II	-	-	-	-	-	50	50	100
Total				**200**	**300**	**-**	**75**	**75**	**650**

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

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

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

Group	Institute Specialization	Course Code	ILOC II
1	Entrepreneurship Development and Management	IL 470	Digital Business Management and Digital Marketing
2	Business Management	IL 471	Business Analytics
3	IP Management	IL 472	IPR and Patenting
4	Bioengineering	IL 473	Bio Mechanics
5	Bio Instrumentation	IL 474	Medical Image Processing
6	Engineering Design	IL 475	Product Design
7	Sustainable Technologies	IL 476	Technologies for Rural Development
8	Contemporary Studies	IL 477	Economics
9	Art and Journalism	IL 478	Journalism, Media and Communication studies
10	Applied Science	IL 479	Operation Research for Management
11	Green Technologies	IL 480	Weather and Climate Informatics
12	Maintenance Engineering	IL 481	Maintenance of Mechanical Equipment
13	Life Skills	IL 482	Physical Education
14	Environment & Safety	IL 483	Vehicle Safety

Program Structure for
Bachelor of Technology in Mechanical Engineering

Semester VIII
(Admitted to FY in 22-23)

Course Code	Course Name	Course Component	Teaching Scheme				
			Contact Hours		Credits Assigned		
			Theory	Pract /Tut	Theory	Pract /Tut	Total
ME 417	Personal Financial Management	T	2	-	2	-	2
ME 4xx	DLOC VI	T	3	-	3	-	3
ME 492	Major Project III	LC	-	4	-	2	2
ME 493	Internship*	LC	-	-	-	8	8
Total			**5**	**4**	**5**	**10**	**15**

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	Personal Financial Management	20	20	20	40	2	-	-	60
ME 4xx	DLOC VI	40	40	40	60	2	-	-	100
ME 492	Major Project III	-	-	-	-	-	25	-	25
ME 493	Internship	-	-	-	-	-	200	-	200
Total				**60**	**100**	**-**	**225**	**-**	**385**

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

*** - Six months internship to be undertaken by the student during the semester**

Group	Department Specialization	Course Code	DLOC VI
4	Materials Science and Nanotechnology	ME 418	Characterization Techniques
		ME 419	Processing and Testing of Materials
5	Manufacturing Engineering	ME 420	Tool Engineering
		ME 421	Additive Manufacturing
6	Energy Science and Engineering	ME 422	Energy Audit and Management
		ME 423	Solar Energy Engineering
7	Automotive System	ME 424	Hybrid & Electric Vehicles
		ME 425	Vehicle Dynamics and Control

Course Code	Course Name	Credits
MECH 201	**Manufacturing Processes and Technology**	**3+1**

Course Objectives:

1. To familiarize with the various production processes used on shop floors and their applications.
2. To introduce to the learner various machine tools used for manufacturing including CNC systems.
3. To familiarize with various additive manufacturing processes
4. To familiarize with the principle and working of Non-traditional Manufacturing
5. To familiarize with subtractive manufacturing processes in particular CNC systems.
6. To familiarize with various additive manufacturing processes

Course Outcomes: Learner will be able to

1. Explain the fundamental principles of casting and forming processes used in manufacturing.
2. Apply knowledge of various welding processes to select appropriate methods for joining applications.
3. Classify different forming processes and describe their key elements and operational characteristics.
4. Illustrate the working principles of non-traditional manufacturing processes and choose suitable processes based on manufacturing requirements.
5. Develop and execute CNC part programs for performing various machining operations.
6. Identify and apply appropriate additive manufacturing techniques for the development of components.

Theory Syllabus:

Module	Detail Content	Hrs.
1	**Introduction to Manufacturing Processes and Metal Casting** Classification of Manufacturing Processes and applications areas, Pattern making materials, Types of pattern and allowances, Machine moulding, Special casting processes : CO2 and shell moulding, Investment casting,Die casting, Vacuum casting, Inspection & casting defects and remedies. Introduction to Jigs and Fixtures and types, P3-2-1 principle of location and principles of clamping and guiding.	6
2	**Joining Processes-** Classification of various joining processes; Applicability, advantages and limitations of Adhesive bonding, Mechanical Fastening; Welding and allied processes, Hybrid joining processes. Classification and Working of various welding methods: Gas, Arc, Chemical, Radiant, Solid State etc. Welding Joints, Welding Positions, Welding defects and their remedies.	8
3	**Forming processes** Introduction and classification of metalworking processes, hot and cold working processes**.** Introduction, classification and analysis of Different Bulk Forming Processes. Classification of Sheet metal operations, types of	8

	Presses used in sheet metal operations, types of dies, metal cutting in a punch and die set up, die details	
4	**Non-traditional Manufacturing processes** – Introduction, Construction, Working principle, Types, Process parameters, problems, merits, demerits and applications of : Ultrasonic Machining, Abrasive Jet Machining, Water Jet machining, Electro-Chemical Machining, Electric Discharge Machining, Electron Beam Machining, Laser beam Machining	06
5	**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
6	**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.	08

Laboratory Syllabus:

Module	Details	Hrs.
	Part A	
1.	Rack and Pinion for Gear Manufacturing	4
2.	Lathe Machine maintenance activity, like apron overhauling, tailstock overhaul etc.	2
	Part B	
3.	Part programming and part fabrication on CNC Turning trainer (Involving processes like Step turning, facing, Taper turning, threading, etc.)	2
4.	Part programming and part fabrication on CNC Milling trainer (Involving processes like contouring, drilling, facing, pocketing etc.)	2
5.	Tool-path generation by translation of part geometry from computer aided design (CAD) to computer aided manufacturing (CAM) systems.	4
6.	Development of physical 3D mechanical structure using any one of additive manufacturing processes. https://3dp-dei.vlabs.ac.in/	4
7.	Demonstration/Part Programming Simulation for any Unconventional Machining Process (Electric Discharge Machining, laser cutting Machining, Plasma Cutting Machining etc.) https://mm-coep.vlabs.ac.in/exp/electrochemical-machining-process/	4
	Part C	
9.	Case Study: Report on a visit conducted to any Commercial Advance Manufacturing Facility	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: 25 marks

1. All exercises mentioned above
2. The distribution of marks for Term work shall be as follows:

   Part A …….**15 marks**

   Part B …….**10 marks**

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. 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. Production Technology by WAJ Chapman Vol I, II, III
8. Production Technology by P C Sharma.
9. Production Technology by Raghuvanshi.
10. Nontraditional Manufacturing Processes", G.F.Benedict, Marcel Dekker, Inc. New York (ISBN 0-8247-7352-7)
11. CNC Programming for Machining, Kaushik Kumar, Chikesh Ranjan, J. Paulo Davim, Springer Publication.
12. CNC Technology and Programming, Krar, S., and Gill, A., McGraw Hill Publishers.
13. Rapid Manufacturing –An Industrial revolution for the digital age by N.Hopkinson, R.J.M.Hauge, P M, Dickens, Wiley
14. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, I. Gibson l D. W. Rosen l B. Stucker, Springer Publication.

Recommended NPTEL Courses : https://archive.nptel.ac.in/courses/112/107/112107078/

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	0	1	2	0	0	0	0	0	0	0	1
CO2	3	2	2	0	2	1	0	0	0	0	0	0	1
C03	3	2	2	2	3	0	0	0	0	0	0	0	1
C04	3	2	0	2	3	0	1	0	0	0	0	0	2
C05	2	1	0	0	3	0	0	0	0	1	2	2	2
C06	2	0	1	0	3	0	0	0	0	0	0	3	2

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MATH 202M	**Mathematics for Mechanical and Automobile Engineers**	**3**

Course Objectives:

1. To learn the Laplace Transform & Inverse Laplace Transform of various functions, and its applications.
2. To learn the concept of Fourier Series, complex form of Fourier series and Fourier Transform and enhance problem-solving skills
3. To Learn the concepts of probability distribution & expectation.
4. To Learn the various probability distributions..
5. To Learn the regression analysis, interpolation methods, correlation & matrices's eigen values and eigen vectors & its applications..
6. To learn the partial differential equations and Analytical methods to solve it which are used in engineering problems & To learn numerical methods to solve the partial differential equations which are used in engineering problems.

Course Outcomes

1. Able to solve examples of Laplace transform, Inverse Laplace transform & apply the concept of Laplace transform and its application to solve the real integrals.
2. Able to solve examples of Fourier Series, complex form of Fourier series and Fourier Transform and apply the knowledge to enhance problem-solving skills .
3. Able to solve examples of probability distribution and expectation for decision making & apply the concepts of probability distribution and expectation for decision making.
4. Able to solve examples of various probability distributions & apply various probability distributions in data science.
5. Able to solve examples of eigen values and eigen vectors of matrices & apply concept of eigen values and eigen vectors of matrices in diagonalization of matrix & engineering problems.
6. Able to solve examples of regression, correlation, rank correlation, interpolation and fitting of curves & Apply the concept of regression, correlation, rank correlation, interpolation and fitting of curves in engineering problems.

Module	Details	Hours
1	**Laplace Transform** 1.1 Definition, Laplace Transforms of Standard Functions, Linearity properties of Laplace Transform, First Shifting theorem 1.2 Change of scale Property, Effect of multiplication by t, Effect of Division by t. 1.3 Use of standard formulae of Inverse Laplace Transform, First shift property, 1.4 Convolution theorem (without proof, examples of upto polynomials of degree 2 in denominator) , Partial fractions method.	6

	Topics for Self Learning/Home learning: Laplace transform of derivative of a function & integral, Evaluation of Integral using Laplace Transform, Solution of Differential Equation using Laplace transform & Inverse Laplace Transform, Solving examples of Laplace transform using MATLAB, MATLAB SIMULINK.	6
2	**Fourier Series, Fourier Transform** 2.1 Orthogonal and orthonormal set of functions, Fourier series of periodic function with period 2π , 2.2 Fourier series of even and odd functions with period 2π, Half range Sine and Cosine Series with period π, Half range Sine and Cosine Series with period L, where (Definition only for $L \neq \pi$). 2.3 Complex form of Fourier Series with period 2π , Fourier Integrals (Definition only). 2.4 Fourier transform of constant and exponential function, Fourier cosine and sine transform of constant and exponential function.	6
	Topics for Self Learning/Home learning: Fourier series, Complex form of Fourier series, Half range Fourier series in (0,2L), (-L,L), Inverse Fourier Transform, , Solving examples of Fourier series & Fourier transform using MATLAB, MATLAB SIMULINK.	6
3	**Probability Theory** **Prerequisites -** Probability, Conditional probability, Total Probability , Baye's Theorem. 3.1 Discrete and Continuous random variables, 3.2 Probability mass and density function, 3.3 Probability distribution for random variables, 3.4 Mean of probability distribution, also as Expectation.	6
	Topics for Self Learning/Home learning: Variance, as expectation, Moments - Skewness and Kurtosis, Moment generating function , Covariance, Solving examples of Probability Theory using MATLAB, MATLAB SIMULINK.	6
4	**Probability Distribution** 4.1 Binomial distribution, 4.2 Poisson distribution, 4.3 Normal distribution .	7
	Topics for Self Learning/Home learning: Applications of various distributions in engineering problems & real life, Solving examples of Probability distribution using MATLAB, MATLAB SIMULINK.	7

5	**Prerequisite:** Inverse of a matrix, addition, multiplication and transpose of a matrix , Elementary row and column transformation, System of homogeneous and non –homogeneous equations, their consistency and solutions **Interpolation, Regression , Correlation , Fitting of Curves, Linear Algebra- Eigen values , Eigen vectors of Matrices** 5.1 Interpolation - Lagrange's Linear and Quadratic, Linear Regression, Lines of regression, Fitting of Curves : Fitting of straight line and Second degree curve by Method of least squares. 5.2 Karl Pearson's Coefficient of correlation (r) , Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems) 5.3 Eigenvalues and Eigenvectors of Matrices, Properties of Eigenvalues (Without proof). 5.4 Cayley Hamilton theorem(Without Proof): Verification of Cayley Hamilton theorem (CHT), Application of CHT to find inverse of a matrix .	7
	Topics for Self Learning/Home learning: Derogatory matrix, Functions of matrices, Diagonalization of a matrix, Applications of Interpolation, Regression , Correlation , Fitting of Curves, Linear Algebra- Eigen values , Eigen vectors of Matrices in engineering problems, Solving examples of Interpolation, Regression , Correlation , Fitting of Curves, Linear Algebra- Eigen values, Eigen vectors of Matrices using MATLAB, MATLAB SIMULINK, Linear Algebra Machine Learning.	7
6	**Partial Differential Equations - Numerical methods** 6.1 Introduction of Partial Differential equations(PDE) & it's Classification. 6.2 1-D Heat Equation (Without Derivation), 1-D Wave Equation (Without Derivation) 6.3 Numerical methods to solve PDE -Bender Schmidt scheme , Simplified Crank Nicholson scheme.	7
	Topics for Self Learning/Home learning: Analytical methods to solve PDE, 2-D Heat equation, Solving examples of Partial Differential Equations - Numerical methods using MATLAB, MATLAB SIMULINK.	7

Theory Assessment:
Internal Assessment(IA): 40 Marks
IA1. Consisting of One Compulsory Class Test- approx. 40% syllabus should be completed - 40 Marks.
Questions from **Topics for Self Learning/Home learning** should not be asked.

IA2. Continuous Evaluation- Average of at least 8-Tutorials of 40 marks each with at least one on each of the six modules along with MATLAB experiments/commands execution during each Tutorial / NPTEL course Certification / Test on 40% syllabus - 40 Marks

Questions from **Topics for Self Learning/Home learning** should not be asked.
The final IA marks will be average of IA1 & IA2

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

1. Question paper will comprise of four questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only three questions need to be solved.
5. Questions from **Topics for Self Learning/Home learning** should not be asked.

Duration of test will be two hours and would be for 60 marks

Tutorial Assessment: The final certification and acceptance of Term Work(TW) ensures the satisfactory performance of assigned work and minimum passing in the TW.

Term Work:
Term Work shall consist of at least 6 tutorials, at least one tutorial on each of the six modules separately, based on the above syllabus .
Also Term work Journal/File must include at least 6 assignments, at least one assignment on each of the six modules separately, based on the above syllabus.
Questions from **Topics for Self Learning/Home learning** should not be asked.

Term Work Marks: 25 Marks
The distribution of marks for term work shall be as follows:
Tutorials : 15 marks
Assignments : 05 marks
Attendance : 05 marks

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
6. Matrices, Shanti Narayan, S. Chand publication.
7. Introductory Methods of Numerical Analysis, S. S. Sastry, Prentice-Hall of India Private Limited.
8. Statistics for Machine Learning, Pratap Dangeti, Packt Publishing Ltd.
9. Deep Learning, Yoshua Bengio, Ian J. Goodfellow, Aaron Courville, MIT Press (2016).
10. Introduction to Machine Learning, Ethem Alpaydin, The MIT Press (2004).

Recommended NPTEL Courses :
1. Advanced Engineering Mathematics By Prof. P. N. Agarwal | IIT Roorkee
https://onlinecourses.nptel.ac.in/noc25_ma85/preview
https://onlinecourses.nptel.ac.in/noc24_ma68/preview
https://nptel.ac.in/courses/111107119
2. Mathematics for Machine Learning By Prof. Debjani Chakraborty, Prof. Debashree Guha Adhya | IIT Kharagpur
https://onlinecourses.nptel.ac.in/noc25_ma61/preview
https://onlinecourses.nptel.ac.in/noc24_ma61/preview
https://nptel.ac.in/courses/111105489

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	3	2	0	0	0	0	0	1	0	0	1		1	1
CO2	3	2	0	0	0	0	0	1	0	0	1		1	1
C03	3	2	0	0	0	0	0	1	0	0	1		1	1
C04	3	2	0	0	0	0	0	1	0	0	1		1	1
C05	3	2	0	0	0	0	0	1	0	0	1		1	1
C06	3	2	0	0	0	0	0	1	0	0	1		1	1

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MECH 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 the mechanical behavior of the body by determining the stresses, strains and deformations 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 thin cylindrical and spherical shells.

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

1. Apply principles of statics to analyze the reactions & internal forces in bodies subjected to static loads.
2. Evaluate the different types of stresses and strains developed in the members subjected to axial, bending, shear & torsional loads.
3. Compute slope and deflection at various cross-sections along a beam's length.
4. Determine and compare the maximum stress and deformation in structures under gradual, sudden and impact loads.
5. Determine the stability and load carrying capacity of columns with various end conditions under compressive loads.
6. Conduct various tests on standard testing machines to determine the failure limits of materials under various loadings, and comprehend the behavior and 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 and its limitations. Macaulay's method of singularity or half-range functions to calculate slope and deflection at a cross-section along the beam's length.	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

* Recommended topics for self-learning.

Laboratory Syllabus:

SN	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. Use of graph plotting software like MS Excel or similar to plot the Load vs. Deformation plot and Stress vs. Strain plot.	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. Use of graph plotting software like MS Excel or similar to plot the Torque vs. Angular Deformation (Twist) plot.	2
8	Tensile Test on thin cross-section (rectangular/circular) specimens using	2

	Tensile Testing Machine. Use of graph plotting software like MS Excel or similar to plot the Load vs. Deformation plot and Stress vs. Strain plot.	
9	Simulation Tests on the above experiments using Virtual Laboratory.	10

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

Recommended NPTEL Courses:

1. **Strength of Materials - Prof. K Ramesh, Prof. Hariprasad, IIT Madras (can be enrolled for both theory & exam certification) - https://nptel.ac.in/courses/112106319**
2. Strength of Materials - Prof. S K Bhattacharya, IIT Kharagpur (only video learning content, no exam) - https://nptel.ac.in/courses/105105108
3. Strength of Materials - Prof. Satish C. Sharma, IIT Roorkee (only text based learning content, no exam) - https://nptel.ac.in/courses/112107146
4. Strength of Materials - Dr. S P Harsha, IIT Roorkee (no exam) - https://nptel.ac.in/courses/112107147
5. Strength of Materials - Prof. M S Sivakumar, IIT Madras (no exam) - https://nptel.ac.in/courses/112106141

Recommended Link to Virtual Lab: https://sm-nitk.vlabs.ac.in/Introduction.html

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	3	3	3	3	3	2	0	2	1	0	3		2	3
CO2	3	3	3	3	3	2	0	2	1	0	3		2	3
CO3	3	3	3	3	3	2	0	2	1	0	3		2	3
CO4	3	3	3	3	3	2	0	2	1	0	3		2	3
CO5	3	3	3	3	3	2	0	2	1	0	3		2	3
CO6	3	3	3	3	3	2	2	3	3	0	3		3	3

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MECH 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 vapor and gas.
4. To demonstrate the procedures for determining thermodynamic properties of pure substances from tables of property data.
5. To introduce the first law of thermodynamics, energy balances, and energy transfer mechanisms to or from a system.

Course Outcomes:

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

1. Describe basic concepts of thermodynamics.
2. Apply the first law of thermodynamics for closed and open systems and construct conservation of mass and energy equations.
3. Calculate thermal efficiency and coefficient of performance for heat engine, refrigerators and heat pumps.
4. Explain the available and unavailable energy.
5. Calculate the properties of the steam and analyse the vapour power cycle.
6. Analyse the gas power cycles.

Module	Detail Content	Hrs.
1	**1.1 Fundamentals** Applications of Thermodynamics, macroscopic and microscopic approach, Thermodynamic systems, properties of a system, state, path, process and cycle, point function & path function, thermodynamic equilibrium, temperature & zeroth law of thermodynamics, temperature scale, ideal gas equation of state. **1.2 Energy & Energy Transfer** Energy – a property of the system, Sources of energy, Forms of energy, internal energy, enthalpy, heat transfer, sign convention for heat transfer, Thermodynamic definition of work transfer, sign convention for work transfer, similarities & dissimilarities between heat and work transfer, Exact & inexact differentials.	7
2	**2.1 First Law of thermodynamics applied to closed system:** Statement, first law applied to the closed system undergoing a process and for a cyclic process (Joule's Experiment), PMM1. Concept of moving boundary work, Ideal gas processes, **2.2 First Law of thermodynamics applied to steady flow system:** Flow process and flow energy, steady flow process, derivation of steady flow energy equation (SFEE). Application of SFEE to the steady flow devices such as nozzle, turbine, compressor, pump, throttling process, boiler, heat exchanger, Limitations of the First Law of thermodynamics.	7

3	**3.1 Second Law of Thermodynamics:** Thermal reservoir, Concept of heat engine, Heat pump and Refrigerator, Statements of the second law of thermodynamics, equivalence between Kelvin-Planck and Clausius statement, PMM2, Reversible and irreversible Process, condition for a reversible process, Carnot cycle, Carnot theorem, **3.2 Entropy:** Clausius Inequality theorem, Entropy – a property of the system, Temperature-Entropy diagram, increase of entropy principle, Tds relations, entropy change for an ideal gas.	7
4	**4.1 Availability:** Concept of high- and low-grade energy, available and unavailable energy, dead state, useful work, availability, irreversibility. **4.2 Thermodynamic Relations** Helmholtz and Gibbs functions, Maxwell equation (without derivation), Joule Thomson coefficient – porous plug experiment.	6
5	**5.1 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 of steam & applications of steam, **5.2 Vapour Power Cycle:** Carnot cycle, Limitations of Carnot vapour cycle, Simple Rankine cycle, mean temperature of heat addition.	7
6	**6.1 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 these cycles.	5

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, 5th edition, Longman Publishers
5. Engineering Thermodynamics by P Chattopadhyay, 2nd edition, 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.

E-Books / Web References

1. Engineering Thermodynamics, Achuthan, 2nd Edition, Phi Learning, 2009
2. Fundamentals of Engineering Thermodynamics, Rathakrishnan, 2nd Edition, Phi Learning, 2005
3. http://nptel.ac.in/courses/112104113/
4. http://nptel.ac.in/courses/112108148/
5. http://nptel.ac.in/courses/112105123/

MOOCS

1. https://www.coursera.org/course/introthermodynamics
2. https://www.iitbombayx.in/courses/IITBombayX/ME209xA15/2015_T1/about
3. https://legacy.saylor.org/me103/Intro/

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	3	3	1	0	0	0	1	0	3	0	3		1	1
CO2	3	3	3	3	3	2	2	2	2	1	3		2	2
C03	3	3	3	3	3	2	2	1	2	1	3		2	2
C04	3	3	1	0	0	0	1	0	3	0	3		1	1
C05	3	3	3	3	3	2	2	2	2	1	3		2	2
C06	3	3	3	3	3	3	2	2	2	1	3		2	2

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MECH 205	**Engineering 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. Analyze 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-classification and its importance	6
2.	Stress-strain curve, Deformability and Strengthening Mechanisms-Hot and Cold working, Recrystallisation-its effects and factors affecting it.	6
3.	Concepts of solidification,difference in solidification of metals and alloys Phases,Phase diagrams, Alloying - Fe-Fe3C diagram and cooling of steels and cast irons,	8
4.	Austenite transformation-equilibrium and non equilibrium,Hardenability and its importance, Hardenability tests, Alloy Steels-stainless steels, tool steels.	8
5.	Heat treatments-Thorough and Surface. Isothermal treatments - Patenting, Austempering and martempering, Ausforming and Maraging	6
6.	Failure by fracture-micromechanisms-fatigue and creep. Non destructive evaluation to prevent failures	5

Laboratory Syllabus:

Module	Details	Hrs.
1	Metallographic sample preparation and etching	2
2	Comparison of 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	2
5	Tension test on mild steel bar (stress-strain behavior,	2

	determination of yield strength and modulus of elasticity)	
6	Impact test on metal specimen (Izod/Charpy Impact test)	2
7	Hardness test on metals – (Brinell/ Rockwell Hardness Number	2
8	Basics of Scanning electron Microscopy. https://emb-iitk.vlabs.ac.in/exp/sem-basics/	2
9	Basic operations of transmissions electron microscopy https://emb-iitk.vlabs.ac.in/exp/transmission-electron-microscope/	2
10	Sample preparation for TEM Analysis (bulk metal, powder sample,brittle)https://emb-iitk.vlabs.ac.in/exp/tem-analysis/	2
11	Electron diffraction of various materials https://emb-iitk.vlabs.ac.in/exp/electron-diffraction/	2
12	Feature size measurement porosity, grain and reinforcement https://emb-iitk.vlabs.ac.in/exp/feature-size-measurement/	2
13	Virtual Labs (virtual-labs.github.io)-Fatigue test	2

At Least 10 experiments from the above list to be performed.

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: William 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. Mechanical Metallurgy,Dieter, Tata Mcgraw Hill
6. Materials Science and Engineering, Smith,Hashemi and Prakash,Tata Mcgraw Hill

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	0	2	1	1	0	1	3	3	2
CO2	3	2	3	2	0	2	1	1	0	2	3	3	3
C03	3	2	2	2	0	1	1	1	0	1	3	3	3
C04	3	3	3	2	0	2	1	1	0	1	3	3	3
C05	3	2	3	2	0	2	1	1	0	1	3	3	3
C06	3	3	3	3	0	3	2	1	0	3	3	3	3

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MECH 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

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	3	3	1	3	3	3	0	3	2	0	2		3	3
CO2	3	3	1	3	3	3	0	3	2	0	2		3	3
C03	2	3	1	3	3	3	0	3	2	0	2		3	3
C04	1	3	0	2	3	2	0	1	2	0	2		3	3
C05	2	3	0	2	3	2	0	1	2	0	2		3	3
C06	2	2	0	2	3	2	0	1	2	0	2		3	3

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
HUM 201	**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.

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	0	0	0	0	0	3	0	3	0	0	0		1	0
CO2	0	0	0	0	0	2	0	2	3	0	2		1	0
C03	0	0	0	0	0	2	0	3	2	0	0		1	0
C04	0	0	0	2	0	0	0	1	0	3	0		0	0
C05	0	0	0	0	0	2	0	3	0	0	1		1	0
C06	0	0	0	0	0	3	0	3	0	0	0		1	0

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MECH 291	**Minor Project I**	**1**

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.

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	1	0	1	0	2	2	0	2	1	1
CO2	3	3	3	3	3	1	1	3	3	2	3	3	3
CO3	0	0	0	0	0	1	2	3	3	2	2	1	1
CO4	3	3	3	3	3	1	0	2	3	1	3	3	3
CO5	2	2	2	2	2	3	0	3	3	2	3	3	3
CO6	2	2	2	2	2	2	2	2	2	2	3	2	2
CO7	2	2	2	2	3	3	2	2	3	3	2	2	2
CO8	2	2	2	2	2	2	1	2	2	1	3	2	2
CO9	1	1	1	1	1	2	2	2	2	3	2	2	2

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MECH 207	**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 approximate 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:** Weighted Residual Methods - Galerkin Method, Variational Approach - Rayleigh-Ritz Method, Elements of Elasticity, Mathematical modeling of field problems in engineering with One dimensional second order equation	5
2.	**Elements and its shape functions:** 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.	6
3.	**1D Analysis - Bar Element:** Application of element stiffness matrix to find Solution of problems from solid mechanics , heat transfer, fluid flow etc.	8
4.	**1D Analysis - Truss and Beam Element:** Application of element stiffness matrix to find Solution of truss and beam problems	8
5.	**2D Analysis:** Introduction, Element matrix for Constant Strain Triangular elements, Shape functions for isoparametric elements - four node and eight node quadrilateral element	8

6.	**Dynamic Analysis:** Dynamic equations of motion, consistent and lumped mass matrices, free longitudinal vibration analysis.	4

Laboratory Syllabus:

Exercise	Detail Content	Hrs.
1	Introduction to ANSYS (APDL and Workbench)	2
2	Analysis of Rod subjected to axial Load (APDL)	2
3	Truss Analysis (APDL)	2
4	Beam Analysis (Workbench)	2
5	Thermal Analysis (Workbench/APDL)	2
6	Modal analysis (Workbench)	2
7	Axis-symmetry Analysis (APDL)	2
8	Convergence Study (Workbench)	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.
11. https://nptel.ac.in/courses/112104193

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	3	3	3	2	2	1	1	1	1	1	2		2	3
CO2	3	3	3	3	2	1	1	1	1	1	2		2	3
C03	3	3	3	3	2	1	1	1	1	1	2		2	3
C04	3	3	3	3	2	1	1	1	1	1	2		2	3
C05	3	3	3	3	2	1	1	1	1	1	2		2	3
C06	3	3	3	3	3	2	1	1	1	1	3		3	3

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MECH 208	**Theory of Machines & Mechanisms**	**3**

Prerequisites:

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

Course Objectives:

1. Understand the fundamentals of kinematics and mechanisms.
2. Analyze mechanisms involving lower pairs.
3. Apply graphical methods for velocity and acceleration analysis in plane mechanisms up to six links.
4. Study the kinematics of cams and followers, flexible connector mechanisms, gears and gear trains, and their applications in machines.
5. Develop problem-solving skills in designing and analyzing mechanisms for various engineering applications.

Course Outcomes:

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

1. Calculate the mobility or degree of freedom of plane mechanisms.
2. Identify plane mechanisms and their inversions, and the mechanisms with lower pairs.
3. Compute velocity and acceleration of various links of plane mechanisms by different graphical methods.
4. Analyze velocity ratios and dynamics in belt and rope drives, and determine chain drive kinematics.
5. Analyze the various follower motions and draw the corresponding cam profiles.
6. Understand gear tooth terminology, and analyze the motion of gear trains.

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)	08

	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.	
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. **Ropes:** Introduction, Advantages and disadvantages, Types, Velocity ratio and slip, power transmission.	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:

1. **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.
2. **Internal Assessment: 40 marks**
   Two compulsory in-semester class tests: 20 marks each, at least 40% of the syllabus needs to be completed before conducting each of the tests.

Laboratory Assessment:

1. **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.

Text/Reference Books:

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.

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2	2	1	2	1	1	3	1	1
CO2	3	3	3	3	2	2	1	2	1	1	3	2	2
C03	3	3	3	3	3	3	1	2	2	1	3	3	3
C04	3	3	3	3	3	3	1	2	2	1	3	3	3
C05	3	3	3	3	3	3	1	2	2	1	3	3	3
C06	3	3	3	3	3	3	1	2	2	1	3	3	3

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MECH 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:** Definition of Fluid, Properties of fluid (density, weight density, viscosity, specific gravity). No Numerical. 1.2 Newton's Law of viscosity, Classification of fluid. No Numerical on 1.2. 1.3 **Fluid Statics:** Hydrostatic pressure, Hydrostatic law, Forces on horizontal, vertical and inclined submerged plane.	6
2.	**Fluid Kinematics:** 2.1 Eulerian and Lagrangian approach, Velocity and acceleration in a Eulerian flow field. Classification of the fluid flow, streamlines, path lines and streak lines. 2.2 Definition and equations for stream function, velocity potential function, potential flow, vortex flow. No numerical on 2.2.	5
3.	**Fluid Dynamics:** 3.1 Definition of control volume and control surface, Differential equations for conservation of mass, energy and momentum, 3.2 Euler's equations in one and three dimensions. Derivation of Bernoulli's equation from principle of conservation of energy. Application of Bernoulli's equation in flow measurement device (pitot tube, venturimeter, orifice meter). Impulse momentum equation (Numerical on bent pipe only).	7
4.	**4.1 Laminar Viscous flow**: Introduction to Reynolds number, Derivation of relationship between shear stress and pressure gradient, Laminar flow between stationary parallel plates (only derivation), Laminar flow in circular pipe (Hagen-Poiseuille flow).	7

	4.2 Flow through pipes: Head loss in pipes due to friction (Darcy-Weisbach equation without proof), Loss of energy in pipe (major and minor losses), Hydraulic gradient and Energy gradient line, Pipes in series and parallel. **4.3 Hydrodynamic Boundary Layer Theory:** Concept of formation of boundary layer, boundary layer parameters. (No Numerical) **4.4 Flow around submerged objects:** Concept of drag and lift, Types of drag, Streamlined and bluff bodies. (No Numerical)	
5.	**Hydraulic Turbines:** General layout of hydro-electric power plant. Classification of hydraulic turbines, definition of various turbine parameters like head, Euler head, discharge, work done, input power, output power, efficiency, schematic representation of losses in turbine. 5.1 Pelton Turbine: Components, construction, working, workdone and efficiency, velocity triangle, Calculation of velocity of jet, speed ratio, jet ratio, number of jets, head, power and efficiency. 5.2 Francis Turbine: Components, construction and working, velocity diagram and numerical, Draft tube and its function.	7
6.	**Pumps** 6.1 Detailed classification of Pump, applications. 6.2 Reciprocating pumps: operating principle of reciprocating pump, Different types of head, discharge coefficient, slip. Calculation of work done and power input, concept of indicator diagram. 6.3 Centrifugal Pumps: Different types of head, Euler's equation and velocity triangles, pump losses and efficiency, Priming of pumps, Concept of NPSH (No Numerical) 6.4 Concept of multistage pump (No Numerical)	7

Laboratory Syllabus:

Sr. No.	Details	Hrs.
1	Calibration of pressure gauge	2
2	Calibration of venturimeter	2
3	Calibration of orifice meter	2
4	Determination of friction factor for pipes	2
5	Determination of minor losses in pipe fittings	2
6	Verification of Bernoulli's equation	2
7	Trial on Pelton Wheel	2
8	Trial on Francis turbine	2
9	Trial on positive displacement pump (reciprocating/Gear pump/Vane pump/screw pump) (any one)	2
10	Trial on single stage 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

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	3	3	2	2	3	2	0	1	1	1	1		2	2
CO2	3	3	3	3	3	0	0	1	1	1	2		2	3
C03	3	3	3	2	3	1	0	1	1	0	2		1	3
C04	3	3	2	3	3	1	0	1	1	0	2		1	3
C05	3	2	2	2	2	0	1	0	2	2	2		3	2
C06	3	2	2	2	2	0	1	0	2	2	2		3	2

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MECH 210	**Data Science Lab**	**2**

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. Recognize the importance and applications of Data Science in various domains.
2. Utilize R programming to manipulate, analyze, and visualize data efficiently.
3. Apply statistical concepts and probability distributions in data analysis tasks.
4. Perform data cleaning, handling missing values, and implementing transformations to prepare data for analysis.
5. Develop and implement basic machine learning models such as Linear Regression, Logistic Regression, and K-Means Clustering.
6. Evaluate and interpret the performance of classification and clustering models using appropriate metrics.

Module	Detail Content	Hrs.
1.	**Introduction to Data Science** What is Data Science, Importance of Data science, Data science project roles, Understanding the stages of a data science project, Application, Various programming tools to perform data analysis.	**02**
2.	**Fundamentals of R** Installation of R & R Studio, Getting started with R Script, Basic & advanced data types in R, Variable operators in R, R functions and loops, Creating Data frames, Exploring data frames, Accessing columns in a Data frame, Reading a CSV text file, Removing rows and columns, Renaming rows and columns, sorting and merging data frames.	**08**
3.	**Data visualization** Need for data visualization, Components of data visualization, Visually checking distributions for a single variable, Visually checking relationships between two variables, Introduction to grammar of graphics, Using the ggplot2 package in R to create visualizations	**06**
4.	**Basics of Statistics & Probability** Mean, Median, Mode, Variance, Standard Deviations, Skewness, Standard probability distributions: Binomial, Normal etc., Central Limit Theorem, Hypothesis testing, Significance levels & P-Value, statistical tests : t-test, chi-square test, paired t-test, ANOVA	**08**
5.	**Data Managing** **Cleaning :** Needs & methods of data preparation, Handling missing values, Imputation Methods, Outlier treatment, Transformation, Modifying data with Base R, Data processing with dplyr package **Sampling for modeling and validation:** Test and training splits	**06**

6.	**Modelling :** Linear Regression, Logistic Regression, K-Means Clustering **Evaluating models :** Evaluating classification models, Evaluating clustering models	**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.

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	2	2	1	2	2	1	0	1	1	2	3		2	2
CO2	3	2	2	3	3	2	1	2	1	2	3		2	3
C03	3	2	2	3	3	2	1	2	1	3	3		3	3
C04	3	2	2	3	3	2	1	2	2	3	3		2	2
C05	3	2	2	3	3	2	1	2	1	3	3		2	2
C06	3	2	2	3	3	1	0	2	1	2	3		2	2

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MECH 211	**Internet of Things**	**2**

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.

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	0	2	2	0	1	1	0	3	2	3
CO2	3	2	2	0	3	2	0	1	1	1	3	3	3
C03	3	2	2	1	3	1	0	0	0	0	3	3	3
C04	3	2	2	0	3	1	0	0	1	0	3	3	3
C05	3	2	2	1	3	1	0	1	1	1	3	3	3
C06	3	2	1	0	2	2	0	1	1	0	3	2	3

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
ENGG 201	**Entrepreneurship**	**2**

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. Analyze the entrepreneurial landscape to recognize and evaluate business opportunities within a given market.
2. Develop a comprehensive business plan that includes market analysis, strategic goals, and operational components.
3. Evaluate different entrepreneurial business models, such as franchising and buyouts, to determine their suitability for various ventures.
4. Formulate effective marketing strategies to identify and engage a target market.
5. Identify the key characteristics and motivations of successful entrepreneurs and apply these concepts to personal and professional development.
6. Assess common causes of entrepreneurial failure and apply strategies to mitigate risks and improve the long-term viability of a new venture.

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
End Semester Examination: 60 Marks

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

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	2	3	0	0	0	2	0	0	0	2	0		3	3
CO2	1	0	3	0	0	0	0	2	0	3	0		3	3
C03	2	0	0	0	0	2	0	0	0	3	0		3	3
C04	0	0	0	0	0	0	2	2	3	2	0		3	3
C05	0	0	0	0	0	0	2	2	0	0	3		3	3
C06	0	3	0	0	0	0	0	0	0	3	2		3	3

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MGMT 290	**Personal Finance Management**	**2**

C**ourse Objectives**: The course is aimed

1. To introduce the basic concepts of finance and their practical application.
2. To demonstrate the process of drafting a financial budget.
3. To explain investment avenues and planning of personal finance.
4. To develop portfolio strategies for individual and institutional investor
5. To discuss various components of insurance and tax management.
6. To introduce financial frauds, measures to avoid frauds and resources of frauds.

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

1. To know the basic concepts of finance and interpret current business positions by reading books of accounts.
2. To analyze investment avenues and plan personal finance to develop portfolio strategies for individuals.
3. To Develop skills to interpret current market position.
4. To Create analytical approach for financial decisions.
5. To learn and understand Tax and Insurance management.
6. To identify financial frauds and understand the level of financial aspects.

Detailed Theory Syllabus:

Module No	Module	Detailed Contents of Module	Hrs.
1	Introduction to Personal Financial Planning	Financial Planning Process: Goal, Vision and mission , Components of Personal Financial Plan, Advantages and developing personal financial plan	3
2	Financial Budget	Meaning and Process of Drafting Financial Budget,Components of Financial Budget,Drafting Financial Budget	3
3	Investment Management	Meaning of Investment,Concept of Risk and Return and Time Value of Money,Investment Avenues,Portfolio Creation and Management	6
4	Insurance and Spending Management	Components of Insurance: Life Insurance, Health Insurance, Property Insurance, Spending Management	3
5	Tax Management	Introduction to Tax Regime and Tax Returns,Introduction to Income Tax and its impact on Incomes ,Tax on property: Revenue and Capital Incomes,Tax Management, Tax Saving, Tax Avoidance	3

6	Financial Frauds	Meaning and Types of Fraud,Investment Frauds, Online Payment Frauds, Identity Theft, Mass Marketing Fraud ,Measures to avoid frauds,Recourse from frauds,Cases of Frauds	6

Theory Assessment:
Internal Assessment: 20 marks
Consisting of Two compulsory internal assessments 20 Marks each. The final marks will be the average score of both the assessments.
End Semester Examination: 40 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 and References:

1. Financial Management: I M Pandey, Vikas Publishing House.
2. Financial Management: M.Y. Khan, P.K. Jain, Tata McGraw Hill.
3. Financial Management: Prassana Chandra, Prentice Hall.
4. Investment Analysis & Portfolio Management- Prasanna Chandra, Tata McGrawHill
5. Wealth Management- Dun & Bradstreet, Tata McGrawHill
6. Wealth Management- S. K. Bagachi, Jaico publishing house

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	3	2	0	0	0	0	2	0	0	3	3		3	2
CO2	3	3	3	2	0	0	2	0	0	1	3		3	2
C03	3	3	1	3	2	3	2	0	0	1	3		3	2
C04	2	3	3	0	2	0	2	0	1	0	3		3	2
C05	2	0	0	0	0	2	2	2	0	0	3		3	2
C06	0	3	1	0	0	2	3	3	0	0	3		3	2

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

Back To Scheme

Course Code	Course Name	Credits
MECH 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.

COs - POs & PSOs Mapping (Level 0 to 3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	1	1	1	1	0	1	0	2	2	0	2		1	1
CO2	3	3	3	3	3	1	1	3	3	2	3		3	3
CO3	0	0	0	0	0	1	2	3	3	2	2		1	1
CO4	3	3	3	3	3	1	0	2	3	1	3		3	3
CO5	2	2	2	2	2	3	0	3	3	2	3		3	3
CO6	2	2	2	2	2	2	2	2	2	2	3		2	2
CO7	2	2	2	2	3	3	2	2	3	3	2		2	2
CO8	2	2	2	2	2	2	1	2	2	1	3		2	2
CO9	1	1	1	1	1	2	2	2	2	3	2		2	2

(Level 3: Strong Mapping, Level 2: Moderate Mapping, Level 1: Weak Mapping, Level 0: No Mapping)

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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 approximate 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:** Weighted Residual Methods - Galerkin Method, Variational Approach - Rayleigh-Ritz Method, Elements of Elasticity, Mathematical modeling of field problems in engineering with One dimensional second order equation	5
2.	**Elements and its shape functions:** 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.	6
3.	**1D Analysis - Bar Element:** Application of element stiffness matrix to find Solution of problems from solid mechanics , heat transfer, fluid flow etc.	8
4.	**1D Analysis - Truss and Beam Element:** Application of element stiffness matrix to find Solution of truss and beam problems	8
5.	**2D Analysis:** Introduction, Element matrix for Constant Strain Triangular elements, Shape functions for isoparametric elements - four node and eight node quadrilateral element	8

6.	**Dynamic Analysis:** Dynamic equations of motion, consistent and lumped mass matrices, free longitudinal vibration analysis.	4

Laboratory Syllabus:

Exercise	Detail Content	Hrs.
1	Introduction to ANSYS (APDL and Workbench)	2
2	Analysis of Rod subjected to axial Load (APDL)	2
3	Truss Analysis (APDL)	2
4	Beam Analysis (Workbench)	2
5	Thermal Analysis (Workbench/APDL)	2
6	Modal analysis (Workbench)	2
7	Axis-symmetry Analysis (APDL)	2
8	Convergence Study (Workbench)	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.
11. https://nptel.ac.in/courses/112104193

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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 and unsteady states.
2. To Study mathematical modeling and designing concepts of heat exchangers

Course Outcomes:

Learner will be able to

1. Describe the basic laws of heat transfer
2. Analyze problems and develop solutions for steady-state heat conduction problems in simple geometries
3. Formulating and solving heat transfer problems for unsteady state heat conduction and extended surfaces.
4. 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 the 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, governing law of convection	**3**
2	**Conduction:** Fourier law of heat conduction, Thermal conductivity, Thermal resistance, Thermal diffusivity, Generalized heat conduction equation in rectangular coordinates, 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.	**8**
3	**Heat transfer from extended surfaces:** 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.	**7**
6	**Boiling and Condensation:** Boiling heat transfer, Pool boiling: different regimes curve, Different Regimes, and Boiling curve, Condensation: 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.	**8**

Sr. 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 forced 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 Counterflow arrangement)	**2**
7	Simulation to estimate the effect of various parameters on heat transfer	**2**
8	Heat Transfer analysis/estimation using numerical methods/computational techniques.	**2**
9	Measurement of thermal conductivity by Guarded hot plate method	**2**

Theory Assessment:
Internal Assessment for 40 marks:

1. Consisting of One Compulsory Class Tests - 40 Marks
2. Class Test-II or Quiz/Case studies/ - 40 Marks

End Semester Examination: 60 Marks
The 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
Laboratory Work (Journal Completion) : 20 Marks
Attendance : 05 Marks

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

Practical Examination : 15 Marks
Viva 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. Apply the acquired knowledge for accurate and precise measurement of a given quantity by using the principle of linear and angular measuring instruments.
2. Apply the fundamentals of various methods for the measurements of screw threads, surface roughness parameters and working of optical measuring instruments.
3. Classify various types of static characteristics and types of errors occurring in the system.
4. Calibrate measuring sensors and instruments
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.	6
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.	6

	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.	8
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	6
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	5

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	Calibration of Strain Gauge using Load Cell	2
5	Experiment on different types of tachometers and stroboscope	2
6	Vibration Measurement & Calibration of Accelerometer	2
7	Virtual lab on RTD	2
8	Virtual Lab on Measurement of Torque using Torque sensor	2
Group 2: Metrology & Quality control		
1	Experiments on linear and angular measurement using Vernier calliper, micrometer and Bevel protractor.	2
2	Experiments on measurement of gear parameters using Gear tooth Vernier calliper / Parkinson gear tester.	2

3	Experiments on screw thread measurement using screw thread micrometer, Floating carriage micrometer / bench micrometer	2
4	Experiments on linear / angular measurements of screw / gear /single point tool using Optical profile projector or Tool maker's microscope.	2
5	Experiment using Mechanical / Pneumatic type Comparator.	2
6	Virtual lab experiment on Michelson Interferometer	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	**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 305	**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

Course 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. Design flow systems considering viscous effects
4. Analyze elementary potential flow patterns
5. Select suitable turbulent model for fluid flow problem
6. Apply fundamentals of compressible fluid flows to relevant systems

Module	Details	Hours
1.	Eulerian & Lagrangian coordinates, Definition and equations for source, sink, irrotational vortex, circulation concept of circulation. Reynolds transport theorem (RTT), conservation of mass, momentum and energy (No Numerical), Navier-Stokes equations-differential & integral approach, (Cartesian coordinates only) energy equations, governing equations for Newtonian fluids, boundary conditions	7
2.	Viscous Incompressible Flows: Exact solutions for Couette flow, Poiseuille flow, Stokes first problem, Stokes second problem, pulsating flow between parallel surfaces, stagnation-point flow, flow over porous wall. Stokes approximation	6
3.	Boundary Layer Flows: Review of boundary layers: laminar and turbulent boundary layers, Von Karman Momentum Integral equation for boundary layers, analysis of laminar and turbulent boundary layers, drag, boundary layer separation and methods to Control it	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, 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.	7

Assessment:
Internal Assessment: 40 marks
1. ConsistingofOneCompulsoryClassTestsof40Marks
2. Continuous Evaluation:ClassTest/Assignments/Quiz/Case Studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks
Weightageofeachmoduleintheendsemesterexaminationwillbeproportionaltothe number of respective lecture hours mentioned in the curriculum.

Books/References:

1. Advanced Fluid Mechanics, K. Muralidhar& G. Biswas, Narosa Publishing, 2005.
2. Boundary LayerTheory, H.Schlichting,6th Edition,McGraw-HillInc., 1986.
3. Turbulent Flow,R.J.Garde,2ndEdition,NewAgeInternational 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 306	**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 307	**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 308	**Introduction to welding and NDT**	**3**

Will be added soon

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 360	IPR and Patenting	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 360	IPR and Patenting	40	40	40	60	-	-	--	100

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 Cooperation 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 license, 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	6

	copyright, Assignment and license of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights	
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, 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.	9
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
End Semester Examination: 60 Marks

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	Scheme	Theory	Practical	Tutorial	Total
IL 361	E-Commerce and E-Business	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 361	E-Commerce and E-Business	40	40	40	60	-	-	--	100

Course Objectives:

1. To understand the factors needed in order to be a successful in ecommerce
2. Identify advantages and disadvantages of technology choices such as merchant server software and electronic payment options.
3. Analyse features of existing e-commerce businesses, and propose future directions or innovations for specific businesses.

Course Outcomes: Learner will be able to

1. Appreciate the global nature and issues of electronic commerce as well as understand the rapid technological changes taking place.
2. Define and differentiate various types of E-commerce
3. Discuss various E-business Strategies.

Module	Detail Content	Hrs.
1	**E-commerce system:** Introduction- scope of electronics commerce, definition of e-commerce, difference between e-commerce and e-business, business models of e-commerce transactions. E-commerce infrastructure: client server technology, two tier client server architecture for e-commerce, drawbacks, three tier architecture for e-commerce.	8
2	**Business strategies for e-commerce:** Introduction- elements of e-commerce strategy, simplicity, mobile responsiveness, choosing e-commerce store platform, user-based focus, compliance and security measures, e-commerce strategy: strategy overview, strategy task, technology issues. Case study: Flipkart v/s Amazon, competitive edge, marketing strategy, sales strategy	8
3	**Design of E-commerce systems:** e-commerce types- electronic market, electronics data interchange EDI, modeling of e-commerce system, three tier component model of e-commerce system, e-commerce system design- data model, web modeling, database structure design, process model, user friendly design of e-commerce site.	7
4	**Technologies for e-commerce systems:** Introduction- technologies for e-commerce, PHS and Java script, SEO, Social Plugins, payment processes, SSL Encryption, hosting server, Service oriented architecture.	7
5	**Scalability of e-commerce systems:** Web scalability- Vertical scalability , horizontal scalability, Load balancing- working of load balancers, global server load balancers, cloud load balancing- goals of cloud balancing, automated cloud balancing. web caching and buffering	6

6	**E-commerce system implementation:** E-commerce implementation, - website testing, web maintenance, web advertisement, copyright services, SMS alert services, bulk email services, Web personalization- techniques for gathering information, analysis techniques for website personalization, domain name registration and web hosting- different types of web hosting, different components of web hosting, features in web hosting.	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Reference Books:

1. Electronic Business and Electronic Commerce Management, 2nd edition, Dave Chaffey, Prentice Hall, 2006
2. Elias. M. Awad, " Electronic Commerce", Prentice-Hall of India Pvt Ltd.
3. E-Commerce Strategies, Technology and applications (David Whitley) Tata McGrawHill
4. E-business- theory and practise, Brahm Canzer, cengage learning
5. Secure e-commerce systems (Kindle edition), Amazon publishing, P S Lokhande, B B Meshram, first edition

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 362	Introduction to Bioengineering	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 362	Introduction to Bioengineering	40	40	40	60	-	-	--	100

Course Objectives:

1. Understand the fundamental concepts and historical development of biomechanics and its role in biomedical engineering.
2. Gain knowledge of biomedical instrumentation and medical imaging techniques used in diagnosis and treatment.
3. Study the properties of biomaterials and the design and classification of implants in relation to human anatomy.
4. Apply advanced engineering principles to solve biomedical problems through practical case studies.

Course Outcomes: Learner will be able to

1. Explain the definition, scope, and historical evolution of biomechanics and its significance in medical applications.
2. Identify and describe the operation and clinical applications of key biomedical instruments used in diagnostics and therapy.
3. Demonstrate understanding of medical imaging modalities and interpret basic imaging data for clinical relevance.
4. Characterize biomaterials based on their anatomical origin and physical properties relevant to biomedical applications.
5. Classify various types of implants and evaluate their interactions with human tissues for implant design considerations.
6. Apply engineering principles and case study insights to design solutions for biomedical engineering challenges.

Module	Detail Content	Hrs.
1	**Introduction:** Definition of Biomechanics, Selected Historical highlights, The Italian Renaissance, Gait century, Engineering Physiology & Anatomy	6
2	**Biomedical Instrumentation:** Patient monitoring system, Arrythmia and ambulatory monitoring instrumentation, cardiac pacemakers, cardiac defibrillators, physiotherapy and electrotherapy equipment, ventilators	8
3	**Medical Image Processing:** Introduction to X-rays based imaging systems, Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), Single-Photon Emission Computerized Tomography (SPECT) scan, Computed Tomography (CT) scan and Ultrasound (sonography)	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
End Semester Examination: 60 Marks

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. "Biomedical Instrumentation and Measurements" by Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer
5. W. Birkfellner, Applied Medical Image Processing: A Basic Course, CRC Press , Second Edition, 2014
6. Prof. Ghista,Biomechanics, Private Publication UAF, 2009
7. White &Puyator, Biomechanics, Private publication UAE, 2010
8. R. M. Kennedy, A textbook of Biomedical Engineering, GTU, 2010
9. Richard Shalak & ShuChien, Handbook of Bioengineering,
10. Sean P. Flanagan, Flanagan, Biomechanics: A case based Approach, Jones & Bartlett Publishers, 2013
11. Y. C. Fung, Yuan-Cheng Fung, Biomechanics: mechanical Property of living Tissue, Springer, 1996.
12. Carol A. Oatis, The Mechanics and Pathomechanics of Human Movement, Lippincott Williams & Wilkins, 2010

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 363	Biomedical Instrumentation	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 363	Biomedical Instrumentation	40	40	40	60	-	-	--	100

Course Objectives:

1. Develop a fundamental understanding of human physiology and anatomy to comprehend the sources of biomedical signals and their role in medical diagnosis and treatment.
2. Understand the origin and characteristics of bioelectric signals and learn about the various types of electrodes, biosensors, smart sensors, and biomedical recorders used in healthcare.
3. Gain knowledge of biomaterials, bone structure, composition, and the biomechanics of soft tissues and joints, as well as their applications in implants, prosthetics, and orthotics.
4. Learn about the operation and application of diagnostic instruments
5. Understand the principles and applications of therapeutic instruments
6. Study the integration of AI in healthcare

Course Outcomes: Learner will be able to

1. Explain the fundamentals of human physiology and anatomy and identify the sources of biomedical signals critical to medical diagnostics and instrumentation.
2. Analyze the structure and properties of biomaterials, bones, soft tissues, and joints, and evaluate their applications in developing implants, prosthetics, and orthotic devices.
3. Describe the principles, design, and functionality of basic and intelligent medical instrumentation systems.
4. Assess the functionality and clinical applications of diagnostic instruments.
5. Explain the working principles and applications of therapeutic instruments.
6. Illustrate the role of artificial intelligence in healthcare.

Module	Detail Content	Hrs
1	**Fundamentals of Bioengineering:** A brief on human physiology and anatomy, sources of biomedical signals, basic medical instrumentation system, intelligent medical instrumentation systems, regulation of medical devices.	6

2	**Biomaterials and Biomechanics:** Introduction to biomaterials, Bone structure & composition, Structure and functions of Soft Tissues, types of joint , Implants, Prosthetics and orthotics.	6
3	**Bioelectric signals and electrodes:** Origin of Bioelectrical signals, Recording electrodes, Microelectrodes, Biosensors, Smart Sensors, Biomedical recorders.	8
4	**Introduction to Diagnostics Instruments:** Patient monitoring system, Arrythmia and ambulatory monitoring instrumentation, oximeters, Blood flowmeter, Cardiac output measurement, Pulmonary analyzers, Blood gas analyzers, Blood cell counters.	7
5	**Introduction to Therapeutic Instruments:** cardiac pacemakers, cardiac defibrillators, instruments for surgery, physiotherapy and electrotherapy equipment, hemodialysis machine, ventilators	6
6	**AI for Health care:** Medical Imaging, Surgical Assistance, Personalized medicine, Wearable Devices and monitoring, Healthcare management system	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. "Handbook of Biomedical Instrumentation" by R. S. Khandpur
2. "Biomedical Instrumentation and Measurements" by Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer
3. "Medical Instrumentation: Application and Design" by John G. Webster
4. "Biomechanics: Principles and Applications" by Donald R. Peterson and Joseph D. Bronzino
5. "Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again" by Eric Topol

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 364	Design of Experiments	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 364	Design of Experiments	40	40	40	60	-	-	--	100

Course Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Course Outcomes: Learner will be able to…

1. Fundamentals of experiments and its uses
2. Basic statistics including ANOVA and regression
3. Experimental designs such as RCBD, BIBD, Latin square, factorial and fractional factorial designs.
4. Apply statistical models in analyzing experimental data
5. RSM to optimize response of interest from an experiment
6. Use software such as Minitab

Module	Detailed Contents	Hrs
1	**Introduction** 1. Why experiment? 2. Terms and Component of Experiment 3. Experimental Units and Responses 4. Types of Data ,Plots and Charts 5. Importance of Product Reliability 6. Uncertainty of Measurement 7. Classification of DOE 8. Software for DOE 9. Principle of Experimental Design 10. Types of Experimental Design	08
2	**Basic Statistics and ANOVA** 1. Random Variable and Probability Distribution 2. Normal Distribution 3. Sampling Distribution 4. Estimation	08

	5. Hypothesis Testing 6. Determination of Sample size 7. Analysis of Variance(ANOVA) 8. Estimation of model parameters and Adequacy test 9. ANOVA-Pair wise comparison and Tukey's and Fishers LSD test 10. Two way ANOVA 11. Multi way ANOVA 12. Determination of Sample Size for ANOVA	
3	**Regression** 1. Introduction to Multiple Linear Regression(MLR) 2. Sampling distribution of Regression coefficients 3. MLR: Hypothesis testing and Model Adequacy Test 4. MLR:Diagnostic and Testing for Lack of Fit 5. Regression approach to ANOVA	07
4	**Experimental Designs** 1. Randomized Complete block design (RCBD) 2. RCBD-Estimation of Parameters 3. RCBD-Balanced Incomplete block design(BIBD) 4. RCBD-Latin square design 5. Introduction to Factorial Design 6. Statistical Analysis of Factorial Design 7. Estimation of parameters and Model Adequacy test 8. Full factorial design 9. Two level factorial design 10. Statistical Analysis of the 2^k Design 11. Blocking and Confounding in the 2^k Design 12. Fractional Factorial Design	08
5	**Response Surface Methods and Designs** 1. Introduction to Response Surface Methodology 2. RSM-First order model 3. Experimental design for fitting Response Surfaces 4. RSM-Fitting Second order model 5. Analysis of Second order RSM	06
6	**Taguchi Approach** 1. Crossed Array Designs and Signal-to-Noise Ratios 2. Analysis Methods 3. Robust design examples	04

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statistics for Experimenters: Design, Innovation and Discovery, 2 nd Ed. Wiley
4. W J Diamond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 365	Design for Sustainability	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 365	Design for Sustainability	40	40	40	60	-	-	--	100

Course Objectives:

1. Understand the complex environmental, economic, and social issues related to sustainable engineering
2. Become aware of concepts, analytical methods/models, and resources for evaluating and comparing sustainability implications of engineering activities
3. Critically evaluate existing and new methods
4. Develop sustainable engineering solutions by applying methods and tools to research a specific system design
5. Clearly communicate results related to their research on sustainable engineering

Course Outcomes: Learner will be able to

1. Account for different theoretical and applied design principles and models for sustainable design
2. Account for and critically relate to sustainable design from an ethical, cultural and historical perspective
3. Critically review different design solutions ecological, social and economical consequences, risks, possible uses and functions in the work for a sustainable development
4. Independently apply a specific design theory on a specific challenge within the sustainability field.

Module	Detailed Contents	Hrs
1	Introduction - Need, Evolution of sustainability within Design, environmental - economic sustainability concept, Challenges for sustainable development, Environmental agreement & protocols	6
2	Product Life Cycle Design – Life Cycle Assessment, Methods & Strategies, Software Tools	6
3	Sustainable Product - Service System Design, Definition, Types & Examples ,Transition Path and Challenges, Methods and Tools, Design thinking and design process for sustainable development	8
4	Design for Sustainability – Engineering Design Criteria and Guidelines	6
5	Design for Sustainability – Architecture, Agriculture, Cities & Communities, Carbon Footprint	6
6	Green Building Technologies - Necessity, Principles, low energy materials, effective systems	6

Assessment:

Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. C. Vezzoli, System Design for sustainability. Theory, methods and tools for a sustainable / satisfaction system/design, Rimini, Maggioli Edition, 2007.
2. C. Vezzoli and E. Manzini, Design for Environmental Sustainability, Springer – Verlag, London, 2008.
3. L. Nin and C. Vezzoli, Designing Sustainable Product-Service Systems for all. Milan: Libreria, CLUP, 2005
4. A. Tukker and U. Tischner (eds.), New Business for Old Europe, Product Services, Sustainability and Competitiveness, Greenleaf Publishing, Shefield, 2008.
5. A. Tukker, M. Charter, C. Vezzoli, E. Sto and M.M. Andersen (eds.), System innovation for Sustainability Perspective on Radical Changes to sustainable consumption and production, Greenleaf Publishing, Shefield, 2008
6. UNEP, Product-Service Systems and Sustainability. Opportunities for sustainable solutions, CEDEX, Paris, 2002, at http://www.uneptie.org/pc/sustain/reports/pss/pss-imp-7.pdf

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 366	Political Science	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 366	Political Science	40	40	40	60	-	-	--	100

Course Objectives:

1. Provide a good grounding in the basic concepts of Political Theory.
2. Familiarize learners with fundamental rights and duties.
3. Teach students the structure and process of the electoral system, the features and trends of the party system and create an awareness of the social movements in India.
4. To inculcate the values of renowned thinkers on law, freedom of thought and social justice.
5. To prepare the learners for understanding the importance of Comparative Government and Politics.
6. To train learners in understanding International Relations.

Course Outcomes: Learner will be able to

1. Acquire conceptual and theoretical knowledge in the basic concepts of political theory.
2. Demonstrate understanding of fundamental rights and duties and directive principles.
3. Perform successfully in expressing the process of the electoral system, the features and trends of the party system and the importance of the social movements in India.
4. Illustrate the contribution of renowned thinkers and relate it to the current scenario.
5. Compare and contrast Indian Government and Politics with European countries.
6. Develop an understanding of International Relations with respect to Indian foreign policy.

Module	Detail Content	Hrs.
1	Understanding Political Theory- Evolution of State, Nation, Sovereignty, Types and Linkages between Power and Authority; Interrelationships between Law. Liberty, Equality, Rights; Justice and Freedom, Democracy vs Authoritarianism	4
2	Constitutional Government in India - Evolution of the Indian Constitution, Fundamental Rights and Duties. Directive Principles. Union-State Relations, Union Legislature: Rajya Sabha, Lok Sabha: Organisation, Functions – Law making procedure, Parliamentary procedure, Government in states: Governor, Chief Minister and Council of Ministers: position and functions – State Legislature: composition and functions. Judiciary: Supreme Court and the High Courts: composition and functions – Judicial activism. Constitutional amendment. Major recommendations of National Commission to Review the Working of the Constitution.	6

3	Politics in India: Structures and Processes- Party system: features and trends – major national political parties in India: ideologies and programmes. Coalition politics in India: nature and trends. Electoral process: Election Commission: composition, functions, role. Electoral reforms. Role of business groups, working class, peasants in Indian politics, Role of (a) religion (b) language (c) caste (d) tribe. Regionalism in Indian politics. New Social Movements since the 1970s: (a) environmental movements (b) women's movements (c) human rights movements.	6
4	Indian Political Thought- Ancient Indian Political ideas: overview. Kautilya: Saptanga theory, Dandaniti, Diplomacy. Medieval political thought in India: overview (with reference to Barani and Abul Fazal). Legitimacy of kingship. Principle of Syncretism, Modern Indian thought: Rammohun Roy as pioneer of Indian liberalism – his views on rule of law, freedom of thought and social justice. Bankim Chandra Chattopadhyay, Vivekananda and Rabindranath Tagore: views on nationalism. M.K. Gandhi: views on State, Swaraj, Satyagraha.	7
5	Comparative Government and Politics- Evolution of Comparative Politics. Scope, purposes and methods of comparison. Distinction between Comparative Government and Comparative Politics.	6
6	Perspectives on International Relations- Understanding International Relations: outline of its evolution as academic discipline. Major theories: (a) Classical Realism and Neo-Realism (b) Dependency (c) World Systems theory. Emergent issues: (a) Development (b) Environment (c) Terrorism (d) Migration. Making of foreign policy. Indian foreign policy: major phases: 1947-1962; 1962-1991; 1991-till date. Sino-Indian relations; Indo-US relations.	7

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. O.P. Gauba. (2021). *An Introduction to Political Theory*. Mayur books
2. Vibhuti Bhushan Mishra. (1987). *Evolution of the Constitutional History of India (1773-1947 : With Special Reference to the Role of the Indian National Congress and the Minorities).* South Asia Books
3. Chetna Sharma Pushpa Singh. (2019). *Comparative Government and Politics.* SAGE Publications India Pvt Ltd.
4. Henry R. Nau. (1900). *Perspectives on International Relations: Power, Institutions and Ideas*. CQ Press

Back To Scheme

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 367	Visual Arts	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 367	Visual Arts	40	40	40	60	-	-	--	100

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

Assessments:
Internal Assessment: 40 marks
End Semester Examination: 60 marks
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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	Scheme	Theory	Practical	Tutorial	Total
IL 368	Modern Day Sensor Physics	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 368	Modern Day Sensor Physics	40	40	40	60	-	-	--	100

Course Objectives:

1. Acquire knowledge about the principles and analysis of sensors.
2. Emphasis on characteristics and response of micro sensors.
3. Acquire adequate knowledge of different transducers and Actuators.
4. Learn about the Micro sensors and Micro actuators.
5. Selection of sensor materials for fabrication for different applications

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

1. Analyze the basics and design the resistive sensors.
2. Identify the materials and designing of inductive and Capacitive Sensors.
3. Analyze various types of Actuators.
4. Design Micro sensors and Micro Actuators for various applications.
5. Implement fabrication process and technologies and compare various Micro machining processes

Module	Detail Content	Hrs.
1	**Fundamentals of Sensors :** Difference Between Sensor, Transducer And Actuators- Classification Of Sensors: Proprioceptive And Exteroceptive – Active And Passive– Contact And Non-Contact, Selection And Characteristics: Range; Resolution, Sensitivity, Error, Repeatability, Linearity And Accuracy, Primary Sensing Elements.	6
2	**Temperature sensors:** Principle of operation, construction details, characteristics and applications of Bimetallic thermometer, Resistance thermometer, Thermistor, Thermocouples and Total radiation Pyrometers	8
3	**Strain, Force, Torque and Pressure Sensors** Strain gauges, strain gauge beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo- resistive and capacitive pressure sensor, Manometer, vacuum sensors, Pirani gauge.	6
4	**Displacement, Level and Flow Sensors**	8

	Displacement Sensors: LVDT, RVDT, eddy current, transverse inductive, Hall Effect, magneto resistive, magnetostrictive sensors. **Liquid level sensor**: Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor. **Flow sensors**: pressure gradient technique, ultrasonic, electromagnetic sensors and Hot wire anemometer. Micro flow sensor, Coriolis mass flow and drag flow sensor.	
5	**Micro Machining Technologies** Overview of silicon processes techniques, Photolithography, Ion Implantation, and Diffusion, Chemical Vapor Deposition, Physical vapor Deposition, Epitaxy, Etching, Bulk micromachining, Surface Micromachining, LIGA and other techniques.	6
6	**Actuators** Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator, Hydraulic actuator - Control valves and cylinders Electrical actuating systems: Solenoids, Electric Motors- D.C motors - AC motors - Three Phase Induction Motor, Stepper motors -Piezoelectric Actuator.	5

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/Reference:

1. Robert H Bishop, “The Mechatronics Hand Book”, CRC Press, 2002.
2. Thomas. G. Bekwith and Lewis Buck.N, “Mechanical Measurements”, Oxford and IBH publishing Co. Pvt. Ltd.,
3. Massood Tabib and Azar, “Microactuators Electrical, Magnetic, thermal, optical, mechanical, chemical and smart structures”, First edition, Kluwer academic publishers, Springer, 1999.
4. Manfred Kohl, Shape Memory Actuators, first edition, Springer.
5. Patranabis.D, Sensors and Transducers, Wheeler publisher, 1994.

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 369	Energy Audit and Management	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 369	Energy Audit and Management	40	40	40	60	-	-	--	100

Course Objectives:

1. To impart basic knowledge to the students about current energy scenario, energy conservation, audit and management.
2. To inculcate among the students systematic knowledge and skill about assessing the energy efficiency, energy auditing and energy management.
3. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
4. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

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

1. To identify and describe the present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities.
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detail Content	Hrs.
1	**Energy Scenario:** Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy and environment: Air pollution, Climate change, Energy security, Energy conservation and its importance, Energy strategy for the future, Energy conservation Act2001 and its features.	4
2	**Energy Management and Audit:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.	10

	Material and Energy balance: Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams. **Financial Management:** Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracts and role of ESCOs	
3	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
4	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
5	**Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on:** Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	3
6	**Energy conservation in Buildings: Energy Conservation Building Codes (ECBC):** Green Build Building, LEED rating, Application of NonConventional and Renewable Energy Sources	3

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 370	Maintenance of Electronics Equipment	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 370	Maintenance of Electronics Equipment	40	40	40	60	-	-	--	100

Course Objectives:

1. To demonstrate use of different instruments used in electronics lab.
2. To understand testing of different active and passive components.
3. To understand functionality of digital ICs.
4. To understand software required for simulation of electronic circuit.
5. To understand fault finding.
6. To understand concept of designing, manufacturing electronic circuit

Course Outcomes:

1. Able to use different types of instruments used in electronics lab.
2. Able to test different active and passive components manually.
3. Able to understand functionality of digital logics.
4. Able to simulate and test electronic circuits with multimeter, CRO, DSO, etc.
5. Able to identify faults in circuits.
6. Able to design, manufacture and troubleshoot electronic circuit.

Detailed Lab/Tutorial Description: Students will have to perform five to six experiments / tutorials based on the syllabus and design, assemble electronic circuit in lab and write journal and project report as a term work.

SN	Detailed Lab/Tutorial Description	Hrs.
1	Demonstrate working and use of two instruments in electronics laboratory.	6
2	Fundamental troubleshooting procedures inside an electronic equipment.	7
3	Parametric testing of Active and Passive Components with multimeter, CRO, DSO, etc.	6
4	Testing of Integrated Circuits (ICs) and design of electronic circuit using ICs and various active and passive components.	6
5	Repairing and fault finding in circuits and surface mounted assemblies.	6

6	Fabrication of designed circuit and troubleshooting, checking output on CRO and report submission.	8

The students will have to submit project report in prescribed format and give presentation at the end of semester.

Assessments:
Internal Assessment: 40 marks (IA-I, IA-II Based on practical and project work)
End Semester Examination: 60 marks (Based on practical, project work, report and presentation, question- answer session)

Books/References:

1. Troubleshooting and Maintenance of Electronics Equipment, Singh K. Sudeep, Katson Book, New Delhi, II edition, Reprint 2014
2. Troubleshooting Electronic Equipment: Includes Repair and Maintenance, Second Edition, Khandpur R. S., Tata McGraw-Hill Education, New Delhi, India, latest edition.
3. Data Books, National Semiconductor.
4. Modern Digital Electronics, Fourth edition, R. P. Jain, Tata McGraw-Hill Education, New Delhi, India.
5. Manuals of instruments in electronics laboratories.

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 371	Cooking and Nutrition	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 371	Cooking and Nutrition	40	40	40	60	-	-	--	100

Course Objectives: The course is aimed to

1. To understand nutrition and of health problems related to diet and various factors affect diet
2. To various statistical tools required to analyze the experimental data in nutrition and community research
3. Gain information about various food constituents, and changes that occur in them during food processing.
4. To gain food-related knowledge and skills so that they can organise and manage family resources effectively according to the needs and lifestyles of family members
5. To be able to make informed judgements and choices about the use of food available.
6. To create interest in the creative side and enjoyment of food and the skills necessary for food preparation and food preservation. And to be aware of relevant mandatory and other necessary safety and hygiene requirements

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

1. To understand the importance and mechanisms of the food components taking place during food processing,
2. To understand nutrition and of health problems related to diet and various factors affect diet
3. To aware how eating patterns and dietary needs depend on age and social group
4. Ability to assess the effectiveness and validity of claims made by advertisers
5. To enhance aesthetic and social sensitivity to dietary patterns and to develop an interest in the creative aspect and enjoyment of food
6. To develop skills necessary for food preparation and food preservation and knowledge of safety and hygiene requirements

Module	Detail Content	Hrs.
1	**Nutritional terms**: proteins (high biological and low biological value), carbohydrates (monosaccharide, disaccharide and polysaccharide), fats, vitamins (A, C, D, E, K, B group – thiamin, riboflavin, nicotinic acid and cobalamin), mineral elements (calcium, iron, phosphorous, potassium, sodium, iodide) water Sources and uses of food energy. Sources and functions of dietary fibre.	3
2	**Kitchen equipment & Kitchen planning:** Selection, Use and care of: modern cookers, thermostatic control and automatic time-controlled ovens, microwave ovens, slow electric cook pots, refrigerators and freezers, small kitchen equipment, e.g. knives, pans, small electrical	4

	kitchen equipment, e.g. food processors, electric kettles, Advantages and disadvantages of microwave ovens, Organisation of cooking area and equipment for efficient work., Selection, Use and care of: work surfaces, flooring, walls and wall coverings, lighting, ventilation	
3	**Meal planning and guidelines:** Factors affecting food requirements, Planning and serving of family meals, Meals for different ages, occupations, cultures and religions, Special needs of: people with food allergies and intolerances, people with medical conditions linked to diet, such as diabetes, convalescents, vegetarians, including vegans and lacto-vegetarians, Meals for special occasions, festivals, packed meals, snacks, beverages, Use of herbs, spices and garnishes, Attractive presentation of food, Terminology describing recommended dietary intakes, e.g. Dietary Reference Value (DRV) and Reference Daily Intake (RDI).	6
4	**Strategic cooking**: Transfer of heat by conduction, convection and radiation. Principles involved in the different methods of cooking, baking, boiling, braising, cooking in a microwave oven, frying, grilling, poaching, pressure cooking, roasting, simmering, steaming, stewing, use of a slow cooker. Reasons for cooking food, Sensory properties of food (flavour, taste, texture), Effect of dry and moist heat on proteins, fats and oils, sugars and starches, and vitamins to include: caramelisation, coagulation dextrinization, enzymic and non-enzymic browning, gelatinisation, rancidity, smoking point, Preparation and cooking of food to preserve nutritive value, Economical use of food, equipment, fuel and labour.	6
5	**Convenience foods and Basic proportions:** Foods partly or totally prepared by a food manufacturer – dehydrated, tinned, frozen, ready-to-eat, Intelligent use of these foods, Advantages and disadvantages, Food additives – types and function, Packaging – types, materials used, Labelling – information found on labels, Importance of maintaining proportions, maintaining proportions for : Bakery products, melting, rubbing-in and whisking methods, Pastries – shortcrust, flaky and rough puff, Sauces – pouring and coating, roux and blended methods, Batters – thin (pouring) and coating, Sweet and savoury yeast products	5
6	**Food preservation & Kitchen safety and first aid**: Food preservation & Kitchen safety and first aid: Reasons for preserving food, Methods of preservation and an understanding of the principles involved: heating – canning, bottling; removal of moisture – dehydrating; reduction in temperature – freezing; chemical preservation – sugar, salt, vinegar; modified atmosphere packaging; irradiation; Awareness of potential danger areas in the kitchen. Safety precautions. First aid for burns and scalds, cuts, electric shock, fainting, shock.	5

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Fundamentals of Food and Nutrition by Tejmeet Rekhi, Heena Yadav
2. Food Process Engineering And Technology by Akash Pare, B L Mandhyan

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 372	Environmental Management	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 372	Environmental Management	40	40	40	60	-	-	--	100

Course Objectives:

1. To promote the safety, health, and welfare of people and the environment through engineering professionals.
2. To encourage students to be productive and contributing members of the environmental profession as practitioners, entrepreneurs, researchers, or teachers.
3. To develop environmental awareness among students that meet specified engineering needs with consideration of public health, safety, and welfare, as well as global, environmental, and legal factors.

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

1. Understand core concepts and methods from ecological sciences and their application in environmental problem-solving.
2. Recognize different types of toxic substances and analyze toxicological information
3. Acquire and apply environmental knowledge to the engineering field as needed.
4. 4. Assist industries and projects in obtaining environmental clearance and compliance with other environmental laws.
5. Interpret appropriate environment-related legislation.
6. Develop a thorough understanding of practice and procedure followed by various enforcing agencies/bodies/countries.

Module	Detail Contents	Hrs.
1	**Fundamentals of Environmental Sciences** Definition, Principles, and Scope of Environmental Science. Structure and composition of the atmosphere, hydrosphere, lithosphere, and biosphere. Concept of Ecology- Ecosystem, Food chain, Food web, Ecological pyramid, Ecological succession, limiting factor, and carrying capacity. Global Environmental Concerns (Global warming, Loss in Bio-diversity, Ozone depletion, E-waste management) and Renewable Energy Resources (Solar Energy, Wind Energy, Hydrothermal Energy, etc.)	8
2	**Environmental Chemistry Toxic chemicals:** Pesticides and their classification and effects. Biochemical aspects of	8

	heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se), Sewage treatment, Concept of DO, BOD, and COD. Composition of air-chemical processes in the formation of inorganic and organic particulate matter, Thermochemical and photochemical reactions in the atmosphere, Oxygen and Ozone chemistry. Photochemical smog, Air Quality Index	
3	**Fundamentals of Environmental Management** Concept of Environmental Management, Need & Objective of Environmental Management, Role of Engineers in Environmental Management, Career Opportunities. The need for sustainable development, Sustainable Development Goals	5
4	**Scope of Environmental Management** Role and functions of Government as a planning and regulatory agency. Environment Quality Management and Corporate Environmental Responsibility. Total quality Environmental management: ISO 14000, EMS Certification. Environmental Management System Standards (ISO-14000 series). Environment and Social Management Plan	7
5	**Overview of Environmental Laws in India** Constitutional provisions in India (Articles 48A and 51A). Wildlife Protection Act, 1972 Indian Forest Act, Water (Prevention and Control of Pollution) Act, Air (Prevention and Control of Pollution) Act, Environmental (Protection) Act, 1986, The e-waste (Management) Rules 2016	5
6	**Environmental Conventions and Agreements** Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Earth Summit at Rio de Janeiro, 1992, Agenda-21, Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Copenhagen Summit, Paris Agreement, CITES.	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G.Oakwell, Edward Elgar Publishing
3. Environmental Management, V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 373	Vehicle Safety	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 373	Vehicle Safety	40	40	40	60	-	-	--	100

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 built 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	8
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	6

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	Antilock braking system Electronic Stability Program Low tire pressure warning system Collision avoidance systems	5
6	Basic Vehicle Operations and Road/Helmet Safety Activity	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

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	Scheme	Theory	Practical	Tutorial	Total
IL 388	Quantum Computing and Quantum Technologies – Part 1	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 388	Quantum Computing and Quantum Technologies – Part 1	40	40	40	60	-	-	--	100

Course Objectives:

1. To provide an overview of the emerging field of Quantum Computing and Technology and make the students familiar with the four verticals of Quantum Technology.
2. To review theoretical core principles of linear algebra and other tools required to understand quantum states, probability and statistics.
3. To understand the basics of computer architecture and digital circuits required for quantum systems.
4. To familiarize students with the concept of qubits and their physical realization.
5. To review basic concepts of quantum mechanics with specific reference to quantum entanglement, superposition and evolution of quantum states with time.
6. To introduce the concept of error correction with reference to quantum systems.

Course Outcomes: Students will be able to learn:

1. The basic concept of Quantum Technology and its four verticals.
2. Necessary mathematical tools of linear algebra.
3. Basics of computer architecture and von Neumann architecture, digital circuits.
4. About physical principles of qubits and how they are important for quantum computation.
5. Basic postulates of quantum mechanics, quantum entanglement, time evolution of quantum states.

Module	Detail Content	Hrs.
1	**Introduction:** National Quantum Mission; Four verticals of Quantum Technologies: Quantum Computing, Quantum Communication, Quantum Sensing and Quantum Materials	1
2	**Review of mathematical tools**: Linear algebra, Probability and Statistics	5
3	**Review of Computer Architecture Basics:** Principles of Computer Design, Basic computer organization and microprocessor, memory management, Relevance to quantum computer architecture	5
4	**Digital Logic and Circuits:** Introduction to digital logic gates, Boolean algebra, Combinational circuits	5
5	**Introduction to Quantum Computing:** Qubits vs classical bits, different types of qubits, Basics of Quantum Algorithms	10
6	**Basics of Quantum Mechanics:** General concepts of superposition, entanglement, and tunneling, Schrödinger equation and Uncertainty Principle, quantum states and time evolution	13

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023).
2. Elementary Linear Algebra with Applications, Bernard Kolman, David A Hill, Pearson New International Edition, (2013).
3. Elementary Statistics: Picturing the World, Ron Larson, 8th edition, Pearson (2023).
4. Computer system architecture, M. Morris Mano, (3rd ed.). Prentice Hall, Inc. USA.
5. Digital Fundamentals, 11th Edition, Thomas L. Floyd, Pearson Publication.
6. Digital Logic and Computer Design, M. Morris Mano, by Pearson Publication.
7. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010).
8. Quantum computing explained, David McMahon, Wiley (2008).
9. Introduction to Quantum Mechanics, Griffiths D. J., 3rd Edition, Cambridge University Press (2024).
10. Principles of Quantum Mechanics, Shankar, R., 2nd edition, Springer (2014).

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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 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. Apply various mechanical design considerations.
2. Develop Design procedure for designing any machine Component
3. Apply strength and rigidity for basic design of machine components.
4. Use Design data books for various component designs.
5. Acquire production drawing skills using CAD software.
6. 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.	5

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.	8
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.	5

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 311	**Power Engineering**	**3+1**

Course Objectives:

1. To study boilers, boiler mountings and accessories
2. To study the utilization of thermal energy in Steam turbine and gas turbine
3. To familiarize with the working of S.I. and C.I. engines and its important systems

Course Outcomes: The learner will be able to

1. Differentiate boilers, boiler mountings, and accessories and calculate boiler efficiency
2. Draw velocity triangles of impulse/reaction turbines and calculate performance parameters/efficiency.
3. Evaluate different systems of gas turbines to improve their efficiency and demonstrate the working of jet propulsion engines.
4. Signify the basics of I C Engine and differentiate between S I and C I Engine.
5. Illustrate the working of S. I. Engine and calculate the performance parameters
6. Demonstrate the working of C. I. Engine and calculate the performance parameters

Theory Syllabus:

Module	Detail Content	Hrs.
1	**Steam Generators** Fire tube and Water tube boilers, Low pressure and high-pressure boilers, once through boiler, examples, and important features of HP Boilers Mountings and accessories, Equivalent evaporation of boilers, Boiler performance, Boiler efficiency.	08
2	**Steam Turbine** Basic of steam turbine, Classification, compounding of turbine, Impulse turbine – velocity diagram, Condition for max efficiency, Reaction turbine - velocity diagram, degree of reaction, Parson's turbine, Condition for maximum efficiency	08
3	**Gas Turbines** Applications of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output, open cycle with intercooling, reheat, and regeneration, Effect of operating variable on thermal efficiency and work ratio **Introduction to Jet Propulsion Engine**	07
4	**I C Engine:** Cycle of operation in Four-stroke and Two-stroke I C engines and their comparative study; Actual working cycle, Valve Timing Diagram.	04
5	**S. I Engine:** Mixture requirements, Fuel-Air ratio, Fuel supply system: Simple carburetor, Injection systems: single point and multi-point, Introduction to Ignition Systems, Combustion phenomenon in SI Engines, Ignition delay, Flame propagation, Pressure-Crank angle diagram, Abnormal combustion, Detonation and Knocking, Factors affecting combustion and detonation, performance analysis, heat balance sheet.	06

6	**C. I. Engines:** Fuel Injection Systems, Combustion phenomenon in C I engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, performance analysis, heat balance sheet.	**06**

Laboratory Syllabus

List of Experiments

1. Demonstration of Boilers
2. Demonstration of Boiler mountings and accessories
3. Study of Steam turbines
4. Study of Gas turbine
5. Study of jet propulsion engine
6. Load Test on diesel engine (Rope brake dynamometer)
7. Load Test on diesel engine (Electrical dynamometer)
8. Morse Test on petrol engine
9. Compulsory visit to Thermal Power Plant/Hydroelectric Power Plant/Gas Turbine Power Plant

Theory Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Tests/Quizzes/Case studies/Seminar presentation of 40 Mark**s**

End Semester Examination: 60 Marks

The 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 Marks: 25 Marks

Laboratory Work	: 15 Marks
Attendance	: 05 Marks
Industrial Visit report	: 05 Marks

End Semester Practical/Oral Examination:

Pair of Examiners should conduct practical/viva based on the contents.

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

Practical Examination: 15 Marks

Oral Examination : 10 Marks

Reference Books:

1. Thermal Engineering, R K. Rajput, Laxmi Publication
2. Thermal Engineering, Kothandraman, Domkundwar, Arora, Dhanpatrai & Sons
3. Steam and gas turbine, R Yadav
4. Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics, and Heat Transfer, Michael J. Moran
5. Internal Combustion Engine, Mathur and Sharma
6. Internal Combustion Engine, V Ganesan, TMH
7. Internal Combustion Engines, Willard W.Pulkrabek, Pearson Education
8. Internal Combustion Engine, Gills and Smith
9. Internal Combustion Engines Fundamentals, John B. Heywood , TMH

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Course Code	Course Name	Credits
ME 312	**Design of Heat Exchangers**	**3**

Course Objectives:

1. To learn the sizing of heat exchangers, thermal and mechanical stress analysis for various heat exchange applications.
2. Learn performance analysis and maintenance aspects of heat-exchanging equipment

Course Outcomes: The learner will be able to

1. Gain insight into the concepts and working principles of heat exchangers.
2. Customize sizing and/or designing of shell and tube heat exchangers.
3. Do thermal analysis of double pipe heat exchangers.
4. Grasp the concept of the condenser and the evaporator.
5. Acquire knowledge about the cooling tower and evaluate its performance.
6. Identify the efficacy of conventional or compact heat exchangers for a specific purpose.

Theory Syllabus:

Module	Detail Content	Hrs.
1	**Basic Design Methods of Heat Exchangers:** Introduction, Recuperators and regenerators, arrangement of flow path in heat exchanger, selection of heat exchangers, design methodology, application. Overall heat transfer coefficient, LMTD and NTU method for heat exchanger analysis.	06
2	**Shell and Tube Heat Exchangers:** TEMA standards, Basic components – shell – tube bundles, tube layout – baffles, preliminary estimation of size, pressure drop and Heat transfer calculations	08
3	**Double pipe heat exchangers:** Thermal And Hydraulic design – Inner pipe – Annulus, Hairpin heat exchanger – Basic inner tube – Finned multi tubes – Parallel and series arrangements, thermal analysis	07
4	**Condensers and Evaporators:** Shell and tube condensers – Horizontal and vertical types – Design and operational consideration, Plate condensers, Air cooled and direct contact type, condenser for refrigeration, Evaporators for refrigeration and air conditioning – Chillers – air coolers	07
5	**Cooling Towers**: Types- Spray Design - Selection of Pumps and Fans- Testing and Maintenance of cooling towers, cooling tower performance variable.	06
6	**Compact Heat Exchangers:** – types – constructional features, Finned plate and tube heat exchanger, special purpose heat exchangers, Gasketed plate heat exchangers, Introduction, advantages, passes and flow arrangements, application	05

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. Sadik Kakal & Homgton Lin – Heat Exchangers – CRC Press, London, 1998.
2. A. Kakac, H Liu, Heat Exchangers, CRC Press, 2002
3. Arthur.P.Fraas, - Heat exchanger Design, John Willey & Sons, 1997.
4. Kenn.D, - Process heat transfer – Tata McGraw Hill, 1980.
5. Holger Martin - Heat exchangers – Hemi sphere Publishing Corporation, London.
6. Yonous A. Cengel, Heat transfer: A Practical Approach, McGraw Hill, 2002
7. R. K. Shah and D P Sekulic, Fundamentals of Heat Exchanger Design, John Wiley & Sons., 2003
8. W. M. Kays, A. L. London, Compact Heat Exchangers, Krieger Pub Co, 1998
9. Tubular Exchanger Manufacturers Association, Inc, Standards of Tubular Exchanger Manufacturers Association, 1968
10. G. F. Hewitt, G L Shires and T R Bott, Process Heat Transfer, CRC Press, 1994

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Course Code	Course Name	Credits
ME 313	**Computational Fluid Dynamics**	**3**

Course Objectives:

1. Understand the laws of fluid flow for ideal and viscous fluids.
2. Develop finite difference and finite volume discredited forms of the CFD equations.
3. Formulate explicit & implicit algorithms for solving the Euler Equation & Navier Stokes Equation.

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

1. Explain the fundamental principles of fluid motion and their application to the analysis and solution of problems in fluid flow engineering.
2. Solve Fluid dynamic & Heat transfer problem using computational fluid dynamics.

Detailed Theory Syllabus:

Module	Details Content	Hrs
01	**Introduction:** Definition and overview of CFD, Advantages and disadvantages, applications, CFD methodology, Working of Commercial CFD Softwares	05
02	**Governing Differential Equations**: Governing equations for mass, momentum and energy; Navier-Stokes equations; Mathematical behavior of PDE's viz. parabolic, elliptic and hyperbolic, Initial and boundary conditions, Initial and Boundary value problems. Selection criteria for BC	08
03	**Grid Generation:** Structured and unstructured Grids: O-type, H-type, C-type of Structured Grid Generation,General transformations of the equations; body fitted coordinate systems; Algebraic and Elliptic Methods; adaptive grids	05
04	**Discretization Techniques:** Introduction to Finite difference Method, Finite Volume method and Finite Element method Finite difference methods; Finite difference representation of PDE's; Solutions to Finite Difference Equations; Implicit, semi-implicit and explicit methods; Errors and stability criteria	08
05	**Turbulence Modeling:** Introduction to Turbulence, Modeling Effect of turbulence on governing equations; RANS, LES and DNS Models	06
06	**Finite Difference & Finite Volume Methods:** FDM & FVM solutions to steady and unsteady one-, two- and three-dimensional problems and, FVM solution to steady & unsteady one- and two-dimensional diffusion, convection-diffusion (no numerical); Advection schemes; Pressure velocity coupling; SIMPLE family of algorithms.	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 end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum

Text/Reference Books:

1. Modern Compressible Flow with Historical Perspective, John D. Anderson, McGraw Hill.
2. Fundamentals of Aerodynamics, J. D. Anderson, 2nd Ed, McGraw Hill.
3. An introduction to computational fluid dynamics-The finite volume method, Versteeg.H.K. ,Malalasekera.W., Prentice Hall
4. Computational Fluid Mechanics and Heat Transfer, Anderson, D.A., Tannehill, I.I., and Pletcher, R.H., Hemishphere Publishing Corporation, New York, USA, 1984.
5. Introduction to Computational Fluid Dynamics, Niyogi P. ,Laha M.K., Chakrabarty S.K., Pearson Education, India.
6. Computational Fluid Flow and Heat Transfer, Muralidhar, K., and Sundararajan,T., Narosa Publishing House ,New Delhi1995.
7. Computer Simulation of flow and heat transfer, Ghoshdasdidar, P. S., Tata McGrawHill Publishing Company Ltd., 1998.
8. Finite Element Programming of the Navier Stock Equation, Taylor, C and Hughes J.B., Pineridge Press Ltd.U.K.1981.
9. Computational Techniques for Fluid Dynamics: Fundamental and General Techniques, Fletcher, C.A.J., Springer-Verlag, 1987.
10. Numerical Fluid Dynamics, Bose, T. K., Narosa Publishing House, 1997
11. Turbulent Flow, R. J. Garde, 2ndEd., New Age International Publishers.

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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. Apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Analysing various Hazard Models to calculate Failure rates correctly
4. Evaluate System Configurations to estimate the system reliability of simple and complex systems
5. Analysing and applying various techniques to improve the Reliability of the system
6. Design for Maintainability of the equipment and the system

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.

Back To Scheme

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	**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 318	**Non Destructive Testing Techniques**	**3**

Will be added soon.

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 374	Digital Business Management and Digital Marketing	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 374	Digital Business Management and Digital Marketing	40	40	40	60	-	-	--	100

Course Objectives:

1. To familiarize with digital business concepts.
2. To acquaint oneself with E-commerce.
3. To give insights into E-business and its strategies.
4. To understand digital marketing plans.

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

1. Identify drivers of digital business.
2. Illustrate various approaches and techniques for E-business and management.
3. Prepare an E-business plan.
4. Develop a digital marketing plan.

Module	Detail Content	Hrs.
1	Introduction to E-Business, Making Functional Areas E-Business Enabled : Value chain and supply chain, inter and intra organizational business processes, ERP	6
2	Making Functional Areas E-Business Enabled : E-marketing, E-Selling, E-Supply Chain Management, E-Procurement.	6
3	Technologies for E-Business: Internet and Web based system,Security and payment systems,Supply chain integration technologies: EDI, RFID, Sensors, IoT, GPS, GIS; Supply chain integration technologies: Web services and cloud.	8
4	Marketing concept, Coordinated marketing, Meta marketing, Holistic marketing dimensions, : Case Analysis, Case Discussion; Marketing Environment.	6
5	Marketing decisions, Customer delivered value, Buyer Behaviour, Input - output map, Case Discussion, Marketing Planning, Price, Distribution, Advertising and Promotion, Case Discussion.	8
6	Marketing mix, Product policy, New products, PLC, Marketing organization, Product Management.	5

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014.
2. Management Information Systems: Managing the Digital Firm, Laudon and Laudon, Pearson
3. Marketing Management- Analysis, Planning and Control, Prentice Hall,14th Edition, 2015
4. NPTEL Course on E-business; https://onlinecourses.nptel.ac.in/noc24_mg16/preview; Refer Week 1 and Week 2 for Module 1; Week 3 and Week 4 for Module 2; and Week 5, Week 6 and Week 7 for Module 3.
5. NPTEL Course on Integrated Marketing Management; https://onlinecourses.nptel.ac.in/noc24_mg27/preview
   Refer Week 1 and Week 2 for Module 4; Week 3 and Week 4 for Module 5; and Week 5, Week 6 and Week 7 for Module 6.

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 375	Business Analytics	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 375	Business Analytics	40	40	40	60	-	-	--	100

Course Objectives: The course is aimed to

1. To understand the importance of business analytics .
2. To learn how to explore and summarize the data with statistical methods.
3. To study how to represent and process the data.
4. To provide hands-on experience with data visualization techniques and hypothesis testing.
5. Discuss the ethical implications of data privacy and security in business analytics.
6. Encourage critical thinking and problem-solving skills through practical applications.

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

1. Understand the fundamentals of business analytics.
2. Students will be able to evaluate the quality of data and its impact on analytical outcomes.
3. Apply statistical techniques to analyze data
4. Creation of informative data visualizations and draw meaningful conclusions from testing.
5. Demonstrate ethical decision-making skills when faced with ethical dilemmas in business
   analytics.
6. Apply analytical techniques learned throughout the course to solve real-world business
   problems.

Module	Detail Content	Hrs.
1	**Introduction to Business Analytics** : Definition, scope and importance of business analytics, introduction to business planning, types of plans, levels of planning, overview of analytical tools and techniques.	3
2	**Exploring Data:** Introduction to different types of data (structured, semi-structured, and unstructured data). Extract, transform and load (ETL) data - ETL fundamentals, data extraction, data transformation, data mapping and Conversion. descriptive statistics measure of central tendency (mean, median, mode) and dispersion (variance, standard deviation), probability theory, conditional probability and bayes' theorem, random variables and probability distributions: discrete (binomial, poisson) and continuous (normal, exponential) distributions.	7

3	**Statistical Analysis:** Business analytics with excel: importance of excel functionalities, analysis with pivot tables, dashboard creation. Statistical analysis with Python, correlation and regression analysis, time series analysis.	6
4	**Data visualization and Hypothesis testing:** Principles of effective data visualization, tableau for business Intelligence- tableau workspace and types of charts, data preparation and chart creation, filters and analytics in Tableau, tableau dashboards. Understanding UML diagrams, UMLtools for Business process analysis BPMN (Business Process Model and Notation) in business process Analysis, BPMN diagrams. Null and alternative hypotheses: Formulating hypotheses for testing (anova, chi-square tests, t-tests).	10
5	**Ethical considerations in Business Analytics:** Privacy, security and confidentiality of data, bias and fairness of data, Types of biases (sampling bias, selection bias, algorithmic bias) and their impact on analytics, strategies for detecting and mitigating biases in data, transparency and Accountability of data.	5
6	**Application and case studies:** Real-world case studies in various industries (e.g., Customer segmentation and targeting, Market forecasting, Social media analytics, Fraud detection, Demand forecasting, Customer churn analysis etc.) Application of analytics techniques to solve business problems	8

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books and References:

1. Business Analytics: A Practitioner's Guide" by Sandhya Kuruganti and Ram Ramesh
2. "Business Analytics: Data Analysis and Decision Making" by S. Christian Albright and
   Wayne L. Winston
3. "Business Analytics: The Science of Data-Driven Decision Making" by U Dinesh Kumar
4. Ethical Data and Information Management: Concepts, Tools, and Methods" by Katherine
   O'Keefe
5. “Princip and Practice of Management”, by J.S. Chandan, SK Mandal, Vikas Publishing
   House.
6. “Business Analytics”, by Dr. Mohd Imran Khan, Published By : Lovely Professional University.

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 376	Biomechanics	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 376	Biomechanics	40	40	40	60	-	-	--	100

Course Objectives:

1. Introduce basic biomechanical terminologies and principles relevant to the human body.
2. Analyze the kinematics and forces acting on muscles and joints using free-body diagrams.
3. Perform biomechanical assessments of the upper and lower limb joints to understand movement mechanics.
4. Examine the mechanical properties of hard and soft tissues and their implications for human movement.

Course Outcome: Students will be able to

1. Accurately define key biomechanical terms.
2. Effectively create and interpret free-body diagrams for joint analysis.
3. Analyze joint mechanics in the upper limb and lower limb, identifying critical forces.
4. Apply gait analysis principles to differentiate between healthy and pathological movement patterns.
5. Explain the mechanical properties of hard tissues and their relevance to biomechanics.
6. Examine biofluid mechanics and blood flow dynamics in the cardiovascular system.

Module	Detail Content	Hrs.
1	**Introduction:** Introductory Mechanics – Statics and Dynamics – Basic Principles. The human body as a biomechanical system – basic terminologies	6
2	**Joint Mechanics:** Kinematics of muscles and joints - free-body diagrams and equilibrium, forces and stresses in joints Biomechanical analysis of joints of upper limb - Shoulder, Elbow, wrist, hand and fingers	7
3	**Analysis of Joints:** Upper limb as a mechanical system – analysis of reaching as movement of a multi-link serial chain – forward kinematics, analysis of fingertip forces as a parallel manipulator Biomechanical analysis of joints – Spine, Hip, Knee, Ankle.	7
4	**Gait Analysis:** Introduction to Postural stability and Gait analysis.	6

	Gait analysis in health and disease - basics.	
5	**Tissue Mechanics:** Mechanics of Hard Tissues - Definition of Stress and Strain, Deformation Mechanics, structure and mechanical properties of bone - cortical and cancellous bones, Wolff's law of bone remodeling; Soft Tissues - Structure, functions, material properties – tendon function, elasticity in a tendon, models of non-linear elasticity in a tendon – physiological and non-physiological regimes, Davis' law of soft tissue remodeling.	7
6	**Biofluid mechanics:** Visco-elastic properties of soft tissues, Models of visco-elasticity: Maxwell & Voight models. Basic Biofluid mechanics - Flow properties of blood in the intact human cardiovascular system.	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. David A. Winter, Biomechanics and Motor Control of Human Movement .
2. Margareta Nordin and Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System.
3. Francisco Valero-Cuevas, Fundamentals of Neuromechanics.
4. Susan Hall, Basic Biomechanics.
5. Irving Hermann, Physics of Human Body.

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 377	Medical Image Processing	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 377	Medical Image Processing	40	40	40	60	-	-	--	100

Course Objectives:

1. To introduce the learners to the basic theory of digital image processing.
2. To expose learners to various available techniques and possibilities of this field.
3. To prepare learners to formulate solutions to general image processing problems.

Course Outcomes: Learner will be able to

1. Record, extract and analyse key information about teeth, muscles, bones etc
2. Acquire the fundamental concepts of a digital image processing
3. Analyze images in the spatial and frequency domain.

Module	Detail Content	Hrs.
1	**Medical Imaging Systems:** Properties, advantages and disadvantages of X-rays based imaging systems, Magnetic Resonance Imaging (MRI) imaging, Gamma-rays based imaging systems, Positron emission tomography (PET), Single-photon emission computerized tomography (SPECT) scan, Computed Tomography (CT) scan, Ultrasound (sonography), Endoscopy, and Thermography based imaging systems. Difference between different medical imaging systems. Nature of Biomedical images, Objectives of biomedical image analysis, Difficulties in biomedical image acquisition and analysis.	7
2	**Medical Imaging Toolkits:** ImageJ (and/or FIJI), ITK-Snap, SimpleITK, MITK, FreeSurfer, SLICER, OsiriX. Image Formats: dicom (.dcm), Nifti (.nii), Minc (.mnc), Analyze (img/hdr), Raw (.raw), MHD (.mhd) and MHA (.mha)	5
3	**Medical Image Detection and Recognition:** Medical image parsing, Deep Learning for Medical Image Recognition, Automatic Interpretation of Carotid Intima–Media Using Convolutional Neural Networks, Deep Cascaded Networks for Sparsely Distributed Object Detection, Deep Voting and Structured Regression for Microscopy Image Analysis.	6
4	**Medical Image Registration:** Intensity-based methods, Cost functions - correlation, least squares, mutual information, robust estimators. Optimization techniques - fixed-point iteration, gradient descent, Nelder-Mead simplex method. MRI motion compensation, Convolutional Neural Network for Robust and Real-Time 2-D Registration.	6
5	**Medical Image Segmentation Networks:** Comparative study and analysis of U-Net family of segmentation: U-Net, V-Net, 3D U-Net, H-DenseUNet, GP-Unet, UNet++, MDU-Net, DUNet, RA-UNet, nnU-Net, SUNet, IVD-Net, LADDERNET, Attention U-Net,	9

	R2U-Net, MultiResUNet, U-NetPlus, CE-Net, CIA-Net, U2-Net, ScleraSegNet, AHCNet, MFP-Unet, ResUNet-a, RAUNet, 3D U2-Net, SegNAS3D, U^2-Net, UNET 3+.	
6	**Deep Learning for Healthcare:** Deep learning for different healthcare applications: Diabetic Retinopathy, Knee Osteoarthritis, Histological and Microscopic Elements Detection, Gastrointestinal Diseases Detection, Cardiac Imaging. Lesion detection: Brain tumor detection, prostate lesion detection, Lung nodule detection.	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. W. Birkfellner, Applied Medical Image Processing: A Basic Course, CRC Press , Second Edition, 2014
2. I. Bankman, Handbook of Medical Image Processing and Analysis, Academic Press , Second Edition, 2008
3. Rangaraj M. Rangayyan, “Biomedical Image Analysis”, CRC Press, 2000.
4. Zhou et al “Deep learning for Medical image analysis” Elsevier 2018.
5. R. C. Gonzalez, Digital Image Processing, Pearson Education India , Third Edition, 2013
6. S. Jayaraman, T. Veerakumar, S. Esakkirajan, Digital Image Processing, McGraw Hill Education , 2017
7. A K Jain, “Fundamental of Digital Image Processing”, Prentice Hall, 2002.

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 378	Product Design	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 378	Product Design	40	40	40	60	-	-	--	100

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.	6
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.	6
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).	8

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.	8
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	6
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.	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

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	Scheme	Theory	Practical	Tutorial	Total
IL 379	Technologies for Rural Development	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 379	Technologies for Rural Development	40	40	40	60	-	-	--	100

Course Objectives:

1. To understand the concept of rural technology
2. To understand the characteristics of rural resources and its importance in Rural Development.
3. To understand various technologies required for Rural Development
4. Rural planning and implementation of rural development projects
5. To generate awareness regarding government policies (monitoring and documentation).

Course Outcomes: Learner will be able to

1. Understand various natural resources and their importance in rural development.
2. Get exposure to various challenges and problems with regard to availability and use of natural resources.
3. Develop and implement various technologies for rural development
4. Explore various schemes for rural development

Module	Detail Content	Hrs.
1	**Rural Resources-** Understanding the Characteristics and nature of Rural Recourses Importance of different resources in Rural Development. Natural resource management(NRM)	3
2	**Concept of Information and Communication Technologies (ICT's) in Rural Development-** Evolution of ICT's, Communication Functions of ICT's, Nature and Scope of ICT's, Information Haves and Information Have Nots in the Rural Areas, Strengths and Weaknesses of ICT's in Rural India, Application of ICT's for Rural Development in India, Satellite Communication support for Rural Development, Telecommunication support for Rural Development, Computer Communication support for Rural Development	6
3	**Management Information System for Rural Development in India** Basic concepts Role of MIS in the management of agricultural extension programmes Design of a MIS in an agricultural extension organization Need for automation ,Organization of a database Networking and	8

	interactive processing , End-user computing Illustrative computer-based MIS , Rural Energy system	
4	**The Role of Rural Technology** – Global approach in Innovative Rural technology Innovative technologies in Production and Postharvest management, Innovation in productivity and Sustainable management(Bio fertilizer) Innovation Commercial Production Technologies Technology for Rural Women, difficulties in adoption of rural technology.	6
5	**Globalisation of Rural Economy-** Globalisation and aims and objectives; Impact of Globalisation on rural economy, Design and Innovation in Integrated Rural Health Management, SEZ's and Agriculture. Agricultural value chain	4
6	**Government Schemes and initiatives-** Various government schemes**,** participation of various Stake holders for development and Protection of Rural resources	3

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Rural Resource Management: A Geographical Perspective by Paul Cloke (Author), C. Park
2. Rural Development: Principles, Policies and Management, Katar Singh, Sage Publications India Pvt. Ltd., 2009
3. Mosse, D., & Cooke, B. (2001). People's knowledge, participation and patronage: Operations and Representations in Rural Development.
4. ICTs: Digital Opportunities in Agricultural Extension, Dipaj De Basavaprabhu Jirli Shaik N. Meer
5. S.S. Singh., Principles and Practices of Agronomy. 1985. Kalyani Publishers, Ludhiana
6. Indian Economy by Datt, Rudra & Sundharam, New Delhi: S. Chand, 2008.
7. W.T.O and Indian Economy by Deogirikar, A. B. Jaipur: Shri Niwas Publications, 2004
8. S.S. Singh., Principles and Practices of Agronomy. 1985. Kalyani Publishers, Ludhiana
9. Indian Economy by Datt, Rudra & Sundharam, New Delhi: S. Chand, 2008.
10. W.T.O and Indian Economy by Deogirikar, A. B. Jaipur: Shri Niwas Publications, 2004
11. Maheshwari, S. (1985). Rural development in India: A Public Policy Approach. SAGE Publications Pvt. Limited.
12. Indian Economy by Datt, Rudra & Sundharam, New Delhi: S. Chand, 2008.
13. Government of India, "Various Five-Year Plans (1st to 12th)" Planning Commission, New Delhi

Back To Scheme

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 380	Economics	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 380	Economics	40	40	40	60	-	-	--	100

Course Objectives:

1. Provide a good grounding in the basic concept of Economics and Economic Planning in India.
2. Familiarize the learner the causes of Poverty and Unemployment in India.
3. Familiarize the learner the concept of Rural and Urban Development.
4. To provide the information on reforms in agriculture in India
5. To create an awareness on the new industrial policy 1991 and contribution of different industry in economy
6. To prepare the learners in understanding the concept of Liberalization, Privatization and Globalization (LPG) also the outcomes of LPG reforms

Course Outcomes: Learner will be able to

1. Acquire conceptual and theoretical knowledge of the types of Indian Economy and the Economic Planning in India.
2. Exhibit the causes of Poverty and Unemployment in India and ways to overcome.
3. Exemplify the various schemes propounded by the Government for Rural and Urban Development.
4. Determine the significance of agriculture in India and the various reforms and initiatives on agriculture by the Government.
5. Exemplify the various Industrial policies post-Independence and Government schemes for Industrial development.
6. Epitomize the Economic Reform of 1991 and Outcomes of LPG Reform.

Module	Detail Content	Hrs.
1	**Economy – An Introduction & Economic Planning in India** Introduction – Types of Economy – Features of Indian Economy – Economic Development – Human Capital and Human Development Planning in Indian Economy – Objectives of Planning in India – History of Planning in India – Types of Planning – Planning Commission – National Development Council (NDC) – NITI Aayog – Five Year Plans in India and Abolition	**7**
2	**Poverty and Unemployment** Introduction – Categories of Poor in India – Types of Poverty – Poverty Line – Poverty Estimation in India – Causes of Poverty in India – Measures to Eradicate Poverty Introduction – Types of Unemployment – Causes of Unemployment – Measurement of Unemployment in India – Impact of Unemployment in	**5**

	India – Government Programmes and Scheme Related to Poverty and Unemployment	
3	**Rural and Urban Development (Basic Infrastructure)** Concept of Rural Development – Ministry of Rural Development – Issues in Rural Development – Rural Development Schemes *(SVAMITVA, Jal Jeevan Mission, Gram Swaraj Abhiyan, Pradhan Mantri Awaas Yojana – Gramin, Shyama Prasad Mukherjee Rurban Mission, Saansad Adarsh Gram Yojana (SAGY) Deen Dayal Antyodaya Yojana – National Rural Livelihoods Mission (DAY – NRLM), Deen Dayal Upadhyaya Grameen Kaushalya Yojana, Providing Urban Amenities in Rural Area (PURA), National Rural Drinking Water Programme (NRDWP), Pradhan Mantri Adarsh Gram Yojana (PMAGY), Mahatma Gandhi National Rural Employment Guarantee Act, 2005 (MGNREGA), Pradhan Mantri Gram Sadak Yojana, National Social Assistance Programme)* Urban Development – Challenges Associated with Urbanisation in India, Urban Development Schemes *(Smart Cities Mission, Atal Mission for Rejuvenation and Urban Transformation (AMRUT), National Heritage City Development and Augmentation Yojana (HRIDAY), Pradhan Mantri Awaas Yojana (PMAY) – Housing for all (Urban), Swachh Bharat Mission – Urban, National Urban Livelihoods Mission (NULM)* – Other Schemes of Rural and Urban Development *(Ayushman Bharat Yojana, Pradhan Mantri Suraksha Bima Yojana, Mission Indradhanush)*	**8**
4	**Agriculture** Introduction to Indian Agriculture – Reforms in Indian Agriculture – Significance of Agriculture in Indian Economy – Salient Features of Indian Agriculture – Challenges Associated with India's Agriculture Sector – Agriculture Marketing – Introduction to Organic Farming – Indian Scenario regarding Organic Farming – Government initiatives in the field of Organic Farming – Minimum Support Price (MSP) – Crop Insurance – Food Security – Agriculture Allied Sector – Agriculture Revolutions	**6**
5	**Industry and Industrial Policies** Introduction to Industries – Industrial Development in India – Industrial Sectors in India – Industrial Policies in India since Independence – New Industrial Policy 1991 – Contribution of different Industries in Economy – Micro Small and Medium Enterprises (MSME) – Central Government Schemes related to Industrialization	**5**
6	**Liberalization, Privatization and Globalization (LPG)** Economic Reforms 1991 – Liberalization – Objectives of Liberalization – Liberalization Measures in India – Privatization – Privatization and Disinvestment – Globalization – Effects of Globalization in India – Outcomes of LPG Reforms	**5**

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Reference Books:

1. Indian Economy 39th Revised Edition (Paperback, S. K. Misra, V.K. Puri)
2. Imagining India by Shri Nandan Nilekani
3. Backstage: The story behind India's high growth years by Montek Singh Ahluwalia

Back To Scheme

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 381	Journalism, Media and Communication studies	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 381	Journalism, Media and Communication studies	40	40	40	60	-	-	--	100

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

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

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

Back To Scheme

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 382	Operation Research	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 382	Operation Research	40	40	40	60	-	-	--	100

Course Objectives: The course is aimed

1. To acquaint the students with basics of Operation Research.
2. To learn the different Linear Programming methods.
3. To make the students aware of the topic "sensitivity Analysis"
4. To learn the different methods of solving Transportation & Assignment Problems.
5. To Understand sequencing Models & related Problems.
6. To explore the different methods used in Game Theory.

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

1. The basic concepts of Operation Research to solve optimization problems..
2. The different Linear Programming methods to solve Problems.
3. The understanding of Linear Programming to sensitivity analysis.
4. The different methods to solve Transportation & assignment Problems.
5. The concept of sequencing models to related problems.
6. The understanding of Game Theory and solve related Problems.

Detailed Theory Syllabus:

Module	Detailed Contents	Hrs.
1	**Introduction to Operation Research:** Canonical & standard form of a Linear Programming Problem, Simplex method , multiple solutions of L.P.P, Infeasible solution & unbounded solution	6
2	**Linear Programming Model:** Artificial variables , Big M-penalty method , Duality in Linear Programing, dual simplex method, revised simplex method.	8
3	**Sensitivity Analysis:** Changes in the right handside of the constraint equations ' b_i' changes in the cost coefficients 'c_j' changes in the coefficients of the constraints 'a_{ij}'.	6
4	**Transportation & Assignment Problems:** NorthWest Corner method , Vogel's approximation method, Hungarian method, maximization problem, unbalanced transportation problem	8
5	**Sequencing models & related Problems:** Processing n-jobs on two machines , processing n-jobs on m-machines	6

6	**Game Theory :** Two – person zero sum game with & without saddle points, solution of mixed strategy ganmes , Matrix reduction by dominance.	5

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books and References:

1. Operations Research : Prem Kumar Gupta , D.S.Hira ; S. Chand & company Ltd.
2. Operations Research ; An Introduction : Hamdy .A.Taha ; Prentice Hall of India
3. Introduction to Operation Research : Frederick.S.Hillier,Gerald.J.Lieberman McGraw Hill Education (India) Private Ltd.
4. Operation Research : R. Paneerselvan, PHI Learning Private Ltd.

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 383	Climate Informatics	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 383	Climate Informatics	40	40	40	60	-	-	--	100

Course Objectives:

1. To promote the safety, health, and welfare of people and the environment through engineering professionals.
2. To encourage students to be productive and contributing members of the environmental profession as practitioners, entrepreneurs, researchers, or teachers.
3. To develop environmental awareness among students that meet specified engineering needs with consideration of public health, safety, and welfare, as well as global, environmental, and legal factors.

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

1. Present the international climate change legal and policy framework and explain key issues under negotiation.
2. Describe the expected consequences of climate change and the role of adaptation.
3. Provide a rationale for climate change mitigation and propose actions in key sectors.
4. Identify main streams of climate change finance.
5. Outline basic elements of planning processes to deliver climate change action.
6. Analyse principal challenges and opportunities for climate change action.

Module	Detailed Contents	Hrs
1	**Introduction to Climate Change Science:** An overview of key concepts such as climate, weather and the greenhouse gas effect. Human contribution to climate change and provides an overview of important greenhouse gases and their main sources. The main observed changes in the climate since the industrial revolution. Future trends and impacts of climate change on surface temperature, ocean pH, and sea-level.	5
2	**Introduction to the International Legal and Policy Framework to address Climate Change:** An overview of the international legal and policy framework to address climate change. Brief history of international climate change negotiations and introduces the United Nations Framework Convention on Climate Change	6

	(UNFCCC). Key provisions of the UNFCCC, its organisational structure, and different Party groups under the Convention. The Kyoto Protocol and its associated bodies.	
3	**ICT Trends and their Implications for Tackling Climate Change:** Information Needs in Adaptation and Mitigation, Communication on Climate Change, Scope and Definition of ICTs, ICT Trends and their Implications for Tackling Climate Change, e-Waste and Recycling ,Green Computing	6
4	**Weather and Climate Informatics:** **Climate Change and Climate Modelling:** Global environmental issues in climate change due to human activities or natural climate variations. Understanding and Using Climate Data, The Climate data analysis, Seasonal Climate Forecasting, Climate Extremes, Uncertainty, and Impacts	5
5	**Data Challenges and Opportunities in Climate Informatics**: Issues with Cross-Class Comparisons, Climate System Complexity. Challenge: Cloud-Computing-Based Reproducible Climate Data Analysis	4
6	LAB WORK or Case Study Software Lab: Introduction to basic data analysis tools. Survey of numerical methods employed in atmospheric and related sciences: theory, application, and programming. OR Report on a Case study	4

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G.Oakwell, Edward Elgar Publishing
3. Environmental Management, V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 384	Maintenance of Mechanical Equipment	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 384	Maintenance of Mechanical Equipment	40	40	40	60	-	-	--	100

Lab Objectives:

1. To understand use of different types of hand tools, importance of right tool for right job.
2. To understand .importance of preventive and breakdown maintenance,industrial safety
3. Understand assembly of lathe cross slide, spindle.
4. Understand Plumbing tools and pipe fitting minor domestic jobs.
5. To make aware about Importance of work skill in maintenance, also about related electrical, chemical activities
6. Encourage & create start up in maintenance and reconditioning field

Outcomes: Learner will be able to…

1. Know the use of various tools and equipment used in maintenance
2. Know, how to apply particular strategy, scheduling, planning of maintenance
3. Develop student for a start-up activity.

Module	Detailed Contents	Hrs
1	Need and role of maintenance in industry. Preventive and breakdown/shut down maintenance. Planning maintenance schedule, records, Spare parts, procuring & inventory control. In house spares making. (indigenous and import substitutes) Need of plant & process knowledge	4
2	Tools and equipment used in mechanical maintenance, (Torque wrench, Jacks and pullers spanners…. etc) their classification. Importance Selection of right tool for right job. Types of fits. Ball Bearings' classification Study of Related electrical equipments, starter switch,, motor, contactors ...etc	6
3	Lathe machine functioning demonstration with, making a simple job.	8
4	Dismantling and assembly of cross slide, tool post. Lathe spindle study	12
5	Domestic plumbing and other Various domestic, "Do it yourself type jobs. Eg. : Window and split air conditioner periodic cleaning, ceiling fan fitting, mixer repairing,	6

	curtain rod fitting on wall..etc.	
6	Industrial safety. Rules and instructions for mechanical safety in industry and safety precautions related to domestic equipment. Risk assessment.	4

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 marks

Books/References:

1. Maintenance Engineering – 1 December 2010 , Sushil Kumar Srivastava
2. Handbook for Mechanical Maintenance Engineers – 30 May 2020 , Gyani Mahato
3. Maintenance Engineering Dr. G.K. Vijayaraghavan, Dr. L. Govindarajan

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 385	Physical Education	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 385	Physical Education	40	40	40	60	-	-	--	100

Course Objectives:

1. To understand the components of Physical Fitness.
2. To understand the modern development and social aspects of physical education
3. To understand general troop games, recreational games and the importance of playing to achieve health & wellness.
4. To acquaint students with principles of nutrition and the application of human energy.
5. To understand the role of food in physical performance.
6. To understand the need for wellness & weight management.
7. To understand common sports injuries, first aid & their treatment.
8. To understand the application of Yoga in physical education & sports.
9. To enable the student to understand the basic structure & function of the human body and the effect of exercise on the body as a whole.

Course Outcomes: Learner will be able to

1. Maintain a health-enhancing level of fitness throughout the program as well as be able to collect and analyse personal fitness data.
2. Gain knowledge regarding the application of yoga to Physical Education and Sports
3. Understand the anatomy and Physiology of Asanas and Pranayamas.
4. Acquire the knowledge regarding the effect of exercise on the body as a whole
5. Develop an understanding of the concept of personality, factors affecting personality development
6. To understand proportional body weights and their management
7. To understand nutrition and balance diet

Module	Detail Content	Hrs.
1	**Physical Fitness** 1.1 Concept, definition and meaning of Physical fitness, activity and exercise 1.2 Component of Physical fitness, Benefit of Physical fitness & exercise. 1.3 Principles of physical fitness 1.4 Definition and concept of wellness and factors affecting Physical fitness & wellness 1.5 Concept and importance of physical conditioning, warming up and cooling down of all age groups	8
2	**Nutrition and Dietary Requirement** 2.1 Nutrition components and balanced diet 2.2 Meaning and definition of doping and ergogenic aids 2.3 Prevention and first-aid of common injuries during Physical training 2.4 Need of Energy, Carbohydrate and Protein 2.5 Concept training nutrition and competition nutrition	6

3	**Wellness, Weight management and Holistic health** 3.1 Meaning, concept and components of Wellness 3.2 Manipulation of energy balance to induce weight loss and weight gain 3.3 Methods of weight management 3.4 Concept, types and cause of obesity and its management. 3.5 Waist hip ratio, larger heart, BMI, calculation of Training Heart Rate	6
4	**Human body system, function and effect of exercise** 4.1 Meaning and Importance of the study of Human anatomy in physical education & sports 4.2 Classification and functions of bones and joints 4.3 Movements of various joints 4.4 Structural classification of muscle, types of muscle and effect of exercise on the musculoskeletal system. 4.5 Structure and Effect of exercise on the cardiorespiratory system 4.6 Digestion and effect of exercise on the digestive system 4.7 Nervous system and effect of exercise on the nervous system.	6
5	**Yoga and meditation** 5.1 Concept of Yoga and misconception about Yoga 5.2 Comparison of Physical Education exercise and Yogic exercise. 5.3 Meaning, Types and principles of Meditation 5.4 Principles governing various exercises in Yoga(Asana, Pranayam, Bandha, Mudra, Kriya) 5.5 Yoga for stress management and emotional stability 5.6 Application of Yoga in sports & physical education and effect of Yogic exercise on different systems of the human body.	8
6	**General & recreational troop games and its method of skill training** 6.1 The game soccer and its rules and regulation 6.2 The game Volleyball, Basketball and its rules and regulations 6.3 The Indoor games and their rules and regulations 6.4 Method of sports skill developing training 6.5Recreational games and their importance in day to day life	6

Assessment:

1. Term Papers (40 Marks):

Two theory papers will be conducted for 40 marks each with average marks of both papers as the final score. One hour theory paper as per the pattern of the semester-end examination will be conducted.

2. Projects/Assignments(30 Marks):

Project on Nutrition (10 Marks): The learner will be given one project on the calculation of Basel metabolic rate. He /she will submit the report of the same in a prescribed format based on which the learner will be evaluated for 10 marks by the concerned teacher/s

Projects/Assignment on Yoga education (10 Marks): The learner will be given an assignment on yoga education such as gathering/compiling the information about the various aspects of asanas and asking to prepare and submit the report of the same based on which the concerned subject teacher will give marks out of 10.

Assignments on Sports Injuries (10 Marks): The learner will be given two assignments on the specific sports injuries and their remedial aspects based on the report submitted in the prescribed format by him/her as well as observations, the concerned teacher/s will give marks out of 10.

3. Physical Activities(25 Marks):

a. To perform 8 Asanas in a group (10)
b. To perform one Pranayama and one Kriyas(5)
c. To perform any five exercises of Motor Fitness. (5)

d. To perform any five exercises of HRPF(5)

4. Trekking/ Hiking (05 Marks)- The learner should be provided experience of participating in the organization and the actual conduct of the co-curricular activities viz. Hiking/Trekking and the assessment of 05 marks should be done based on learners actual participation and involvement in the same.

Reference Books:

1. Padmakshan Padmanabhan 'Handbook of Health & Fitness', Indus Source; First edition, Indus Source Books, Wadala Mumbai. 2014.
2. Adams, William.C. 'Foundation of Physical Education Exercises and Sports Sciences', Lea and Febigor, Philadelphia, 1991.
3. Dr. Kamlesh M.L. 'Principles and History of Physical Education and Sports', Friends Publication (India) New Delhi, 2004
4. Bates M.'Health Fitness Management (2nd Ed.) USA : Human Kinetics.2008
5. Fink, H.H., Burgoon,L.A., & Mikesky. Practical Applications in Sports Nutrition. Canada : Jones and Bartlett Publishers. 2006.
6. Worthington, Vivian. History of Yoga. London : Routledge and Kegan Paul Ltd. 1982.
7. Rajan, M. Yoga Stretching and Relaxation for Sportsman. Delhi : Allied publishers. 1985.
8. Crouch James E. – Essential Human Anatomy A Text – Lea & Febriger , Philladalphia
9. Murgesh N. – Anatomy, Physiology and Health Education, Sathya, Chinnalapatti, 1990
10. Giam, C.K. Sport Medicine Exercise and Fitness. Singapore : P.G. Medical Book. 1994.

Back To Scheme

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 386	Industrial Regulations and Laws	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 386	Industrial Regulations and Laws	40	40	40	60	-	-	--	100

Course Objectives:

1. To provide a foundation on Environmental Laws in relation to Industrial Regulations
2. To acquaint the learner about the Industrial Relations and the factors affecting it.
3. To acquaint the learner about the Trade Union system in India
4. To create an awareness on the New Industrial Policy 1991 and government schemes related to Industrialization.
5. To create awareness on the safety and welfare measures of the workmen.
6. To acquaint the learner about the social security benefits mandated by the government for workmen

Course Outcomes: Learner will be able to

1. Acquire conceptual and legitimate knowledge on the Environmental laws
2. Exhibit the causes of problems in Industrial Relations and the mean to resolve it.
3. Exhibit the need of Trade Union system and its challenges.
4. Exemplify the Industrial Policy 1991 and the Government schemes for Industrial development.
5. Determine the significance of the safety and welfare measures of the workmen.
6. Epitomize the various social security benefits related to the EPF and EPS, ESIC and Gratuity.

Module	Detail Content	Hrs.
	PART - I	
I	**Introduction to Environmental Laws and Industrial Regulations**	
a	**The Environment Protection Act, 1986** ● Introduction, Concept of Vasudhaiva Kutumbakam ● Stockholm Conference – 1972, Objectives of Act, ● Bhopal Gas Tragedy ● Needs of Environment Protection Rules ● Coastal Regulation Zone Notifications (CRZ Notifications)	7
b	The National Green Tribunal Act, 2010 ● Introduction to NGT ● Objective, Structure and Powers of NGT ● Rio De Janerio Summit (1992)	

	• Judicial Activism in Environmental Jurisprudence • Law Commission Recommendation – 2003	
II	Industrial Relations • Concept of Industrial Relations • Types of Industrial Relations • Characteristics, Nature and Objectives of Industrial Relations • Factors Affecting Industrial Relations	3
III	Trade Union • Trade Union Structure and Movement in India • Phases of Trade Union Movement in India • Features of Trade Union Movement • Changing Role of Trade Union in Context of Liberalization • Challenges faced by Trade Unions in India	4
IV	Industrial Policy • Industrial Polices in India • Objectives of Industrial Policies • New Industrial Policy 1991 • Government Schemes related to Industrialization	
	PART - II	
V	**Industrial Laws**	
a	Apprentice Act, 1961 • Object of the Act, • Meaning of – Apprenticeship Advisor, Industry • Qualification for being trained as an Apprentice • Contract of apprenticeship • Condition for Novation of Contract of Apprenticeship • Period of Apprenticeship • Payment & Termination of Apprenticeship • Number of apprentices in designated trade • Obligations of employers & apprentice • Offence and punishment	4
b	Employees' Provident Fund & Misc. Provisions Act, 1952 & the Schemes • Eligibility and Applicability of the Act • Payment of Contribution • Benefits and Rate of Contribution • Clarification about contribution • Damages • Penal Provision	3
c	Employees' State Insurance Act, 1948 & the Scheme • Applicability of the Act & Scheme • Coverage & Rate of Contribution of the wages • Manner and time limit for making payment of contribution and benefits • Wages for ESI Contributions and Contribution period • Penalties	4
d	The Factories Act, 1948	4

	• Applicability of the Act • Employer to ensure health of workers • Registration and Renewal of Factories • Safety measures • Welfare measures • Working hours, Spread Over and Overtime • Employment of Young Persons • Annual Leave with wages • Offences and Penalties	
e	The Payment of Gratuity Act, 1972 and the Rules • Applicability of the Act • Employee covered under the Act • Qualifying period • Calculation of gratuity • Display of Notice • Nomination • Recovery and Forfeiture of Gratuity • Protection of Gratuity • Penalties	4

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 marks

Reference Books:

1. P. L. Malik's - Handbook of Labour and Industrial Law
2. N. D. Kapoor's - Handbook of Industrial Law
3. Dr. V. G. Goswami's - Labour and Industrial Laws

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 387	Industrial and high voltage Safety	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 387	Industrial and high voltage Safety	40	40	40	60	-	-	--	100

Will be Available Soon

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Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 389	Quantum Computing and Quantum Technologies – Part 2	Contact Hours	3	0	-	3
		Credits	3	0	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 389	Quantum Computing and Quantum Technologies – Part 2	40	40	40	60	-		--	100

Course Objectives:

1. To give a good grounding in experimental techniques relevant to Quantum Computing
2. To update students with digital circuits, RLC circuits and Vector Network Analyzer
3. Review interfacing instruments with computer and data acquisition
4. Review basics of Quantum Communication, networks and Internet
5. Overview of Quantum Materials and their importance
6. Provide some basics of band theory, magnetism, superconductivity, low dimensional materials and topological materials

Course Outcomes: Student will be able to learn:

1. Basic experimental techniques of RLC circuits, digital circuits and calculate quality factors
2. Fundamental techniques in RF engineering
3. Interfacing instruments with computers and data acquisition
4. Some aspects Quantum Communication, Networks and Internet
5. About Quantum Materials and connection with magnetism, superconductivity, 2-D and topological materials

Module	Detail Content	Hrs
1	**Basics of Quantum Communications:** Basics of Digital communication, Shannon entropy, Basic ideas of quantum communications, Quantum memories, Quantum networks and Quantum Internet.	10
2	**Basic Lab course for Quantum Tech:** RLC circuits, Digital circuits, RF Technology, VNA, Interfacing instruments with computer, Data acquisition and signal conditioning.	13
3	**Quantum Materials:** Introduction to materials relevant to quantum technologies.	2
4	**Magnetism and Superconductivity:** Basics of Magnetism, Magnetic measurements, Magnetoresistance, Hall, Faraday and Kerr effects, BCS theory of Superconductivity, Josephson Effect, Superconducting devices for quantum technologies.	10
5	**2-Dimensional Materials:** Properties of 2-D and topological materials	5

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Art of Electronics, Paul Horowitz and Winfield Hill, 3rd edition, Cambridge University Press (2015)
2. Digital Design, Morris Mano, Michael D. Cilletti, 6th edition, Pearson Education (2018)
3. Microwave Engineering, David Pozar, 4th edition, Wiley (2013)
4. Discrete-time signal processing, Alan V. Oppenheim and Ronald W. Shaffer, 4th edition, Pearson (2009)
5. Quantum computation and quantum information – Nielsen and Chuang Cambridge University Press, Cambridge (2010)
6. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)
7. Condensed Matter Physics , M P Marder, 2nd Edition, John Wiley and Sons, 2010
8. Introduction to Superconductivity, Michael Tinkham, standard ed., Medtech (2017)

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Course Code	Course Name	Credits
ME 392	**Major Project I**	**3**

Course Objectives:

1. To acquaint with the process of undertaking literature survey or market survey or feasibility study /industrial visit and identifying the problem
2. To familiarize the process of problem solving in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research

Course Outcomes: Learner will be able to

1. Do literature surveys based on market or feasibility study/industrial visit and identify the problem.
2. Apply basic engineering fundamentals in the domain of practical applications
3. Cultivate the habit of working in a team
4. Attempt a problem solution in the right approach.
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare project reports as per guidelines and with proper references/citations.
7. Exhibit and explain project ideas/models at various platforms.

Guidelines for Project

- Students should do literature survey/Market survey/ feasibility study/visit industry/analyze current trends and identify the problem for Project and finalize the project title in consultation with Guide/Supervisor.
- Students should use multiple literatures and understand the problem.
- Students should attempt a solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and report to be compiled in standard format.

Assessment:

Project I should be assessed based on following points

1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope
5. Breadth and depth of literature survey
6. Societal importance
7. Presentation skill/ Question-answer session.

Project I should be assessed through a presentation by the student project group to a panel of Internal and External examiners appointed by the Head of the Department/Institute of respective Programme.

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Course Code	Course Name	Credits
ME 401	**Production Planning and Systems**	**3**

Course Objectives:

1. To provide an exposure to Production Planning & Systems and its significance in Manufacturing Industries
2. To give exposure to forecasting methods, aggregate planning and capacity planning techniques.
3. To give insights of various inventory control techniques and system approach of MRP
4. To give exposure to production scheduling and sequencing so as to optimize resources
5. To understand heuristics methods for design of manufacturing system.

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

1. Illustrate production planning functions and manage manufacturing functions in a effective way
2. Forecast the demand of the product and prepare an aggregate plan
3. Apply inventory management techniques to control inventory
4. Develop MRP systems for any manufacturing firm
5. Apply production planning techniques to optimize resources
6. Apply heuristic methods for design of manufacturing systems.

Module	Detail Content	Hrs.
1.	Production systems- components and types, need for PPC, functions of PPC, relationship of PPC with other functions Production planning techniques: Linear Programming Problems, Simplex, Big Methods, Sensitivity Analysis Various issues of interest: Assembly Line, Repetitive batch manufacturing, Cellular manufacturing, FMS, JIT, CIM	6
2.	**Forecasting, Aggregate planning, Capacity planning** Forecasting: Need for forecasting, role of forecasting in PPC, Qualitative and Quantitative methods of forecasting, Forecasting Errors and Forecasting Bias Aggregate planning: Concept of aggregate planning, decision rules, strategies and methods Capacity Planning: Measurement of capacity, Measures of capacity, Factors influencing effective capacity, short range, medium range and long range capacity planning, Rough cut capacity planning.	8
3.	**Inventory Control:** Basic concepts of inventory, Types of inventory, purpose of holding stock and influence of demand on inventory, Costs associated with Inventory management. Inventory Models: Deterministic models - instantaneous stock replenishment model, Production model, planned shortages and price discount model, Probabilistic models- fixed quantity system(Q-system) and Fixed period system (p-system) Selective Inventory Control techniques - ABC analysis, HML analysis and VED analysis	8
4.	MRP, MRP II, ERP Material Requirement planning(MRP) and Manufacturing Resource Planning (MRP-II) General concepts, types of demands, Inputs to MRP, MRP objectives, outputs of MRP, Estimation of planned order releases, Lot sizing	6

	decisions, Benefits and Limitations of MRP II Enterprise Resource Planning (ERP): Evolution, features, purpose of modeling an enterprise, information mapping, generic model of ERP, Modules in ERP, Methodology of implementation, critical success factors of ERP, Case studies of success and failure of ERP implementations, ERP packages	
5.	Production Scheduling and Sequencing Scheduling: Inputs for scheduling, loading and scheduling devices, factors influencing scheduling, scheduling techniques, use of Gantt Charts and basic scheduling problems. Project scheduling by using elements of network analysis PERT & CPM, cost analysis & crashing, resource leveling Sequencing: Product sequencing, dispatching, progress report & expediting and control, Johnson's sequencing algorithms	6
6.	Decision making in design of manufacturing systems: Various heuristics in Line Balancing, Group Technology and Plant layout and simulation of manufacturing systems.	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. D. Bedworth and J. E. Bailey (1983), Integrated Production Control System- Management, Analysis and Design, John Wiley.
2. E. A. Elsayed and T. O. Boucher (1985), Analysis and Control of Production Systems, Prentice Hall.
3. P. F. Bestwick and K. Lockyer (1982), Quantitative Production Management, Pitman Publications.
4. A. C. Hax and D. Candea (1984), Production and Inventory Management, Prentice Hall.
5. L. A. Johnson and D. C. Montgomery (1974), O.R. in Production Planning, Scheduling and Inventory Control, John Wiley and Sons.
6. H. Noori and R. Radford (1995), Production and Operations Management, McGraw Hill Inc.
7. S. Nahmias (1997), Production and Operations Analysis, R. Irwin.
8. R. B. Chase, N. J. Aanilano and F. R. Jacobs (1999), Production and Operations Management- Manufacturing and Services, Tata McGraw Hill, Second Edition.
9. K. Hitomi (1996), Manufacturing Systems Engineering, Viva Books Pvt. Ltd, India.
10. M. Pinedo and X. Chao (1999), Operations Scheduling, McGraw Hill.
11. Production Planning and Control Samuel Eilon.
12. Production Planning and Control, W. Boltan-Longman Scientific & Technical
13. Production Systems- Planning, Analysis & Control, James. L. Riggs-John Wiley &Sons
14. Manufacturing Planning and Control Systems, Thomas E. Vollman, William L.Berry& Others- Galgotia Publishers
15. Manufacturing Process Planning and Systems Engineering, Anand Bewoor-Dreamtech Press
16. Production and Operations Management, S.N.Chary- TMH publishing company
17. Automated Production System by M P Groover, PHI

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Course Code	Course Name	Credits
ME 402	**Refrigeration & Air Conditioning**	**3+1**

Course Objectives:

1. To study the fundamental and operating principles of Air Refrigeration, Vapour Compression and Vapour Absorption systems.
2. To study components of refrigeration and air conditioning systems.
3. To study applications of Refrigeration & Air Conditioning.

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

1. Apply knowledge of thermodynamic cycle/processes for refrigeration and air conditioning system
2. Analyze performance of vapour compression refrigeration system
3. Identify and locate various components of the refrigeration and air conditioning system
4. Estimate cooling load for design of air conditioning system
5. Able to design a duct system using different duct design methods.
6. Evaluate refrigeration and air conditioning systems in perspective of industrial application

Theory Syllabus

Module	Detail Content	Hrs.
1.	**1.1 Introduction to Refrigeration:** Introduction to refrigeration, coefficient of performance (COP), Energy Efficiency Ratio (EER), Tonnage of refrigeration, Bureau of Energy Efficiency (BEE) star rating. **1.2 Air refrigeration cycle:** Carnot cycle, Bell Coleman cycle **1.3 Air Refrigeration System:** Necessity of air cooling, Factors considered for the selection of air refrigeration system, Types of air refrigeration system with schematic and T-S Diagram, Numerical based on simple and bootstrap air refrigeration system.	7
2.	**2.1 Refrigerant:** Classification,Designation,Selection of refrigerant,Physical and chemical properties of refrigerants ,Secondary refrigerants **2.2 VapourCompression Refrigeration System:** Simple system on P-h and T-s diagrams, analysis of the simple cycle, factors affecting the performance of the cycle, actual cycle, Numerical based on using P-h chart only. **2.3 Vapour Absorption Refrigeration System:** Simple and practical vapour absorption system, Refrigerant-adsorbent properties, COP of ideal vapour absorption system, Domestic Electrolux refrigerator, Lithium Bromide Absorption system.	8
3.	**3.1 Components of VCRS system:** Types of Compressors, Condensers, Evaporators, Expansion devices. Cooling Towers, Types, Approach, Range, Efficiency, Components and maintenance **3.2: Non Conventional Refrigeration System:** Thermoelectric refrigeration system, Vortex tube refrigeration system, Mixed refrigeration system, Magnetic refrigeration system.	5

4.	**4.1 Human Comfort:** Thermodynamics of the human body, Factors affecting comfort, Effective temperature, Factor governing optimum effective temperature. **4.2 Psychrometry:** Psychrometric properties chart and processes. Bypass factor, ADP, Adiabatic mixing of two air streams, RSHF, GSHF, and ESHF., Numerical based on psychrometric chart and Apparatus dew point .Classification of air conditioning system **4.3 Cooling Load Estimation :** Introduction, Components of cooling load, Different heat sources ,Various load Estimation, Design of summer and winter air conditioning system	10
5.	**5.1 Air distribution system:** Pressure loss in duct, Friction chart for circular ducts. Equivalent diameter of a circular duct for rectangular ducts. **5.2 Methods of duct design:** Velocity reduction method, Static pressure regain and equal friction (or constant pressure loss) method	5
6.	**Applications of Refrigeration & Air Conditioning**: Food Preservation, Cold Storage, Domestic refrigerators, Water coolers, Desert coolers, Ice plant.	4

Laboratory Syllabus:

Part A: List of Experiments

S.No.	Details	Hrs.
1.	Trial Experiment on Simple VCR System.	2
2.	Performance evaluation of Water cooler trainer.	2
2.	Study and performance of cooling towers.	2
3.	Performance on Air conditioning test rig for cooling and dehumidification process	2
4.	Performance on Air conditioning test rig for Heating and humidification process.	2
5.	Performance evaluation of Ice plant.	2
6.	Performance evaluation of vapour absorption system.	2
7.	Simulation Experiment on VCR system using simulation software.	2
8.	Cooling load calculation for the various applications	2
9.	Performance evaluation of evaporative cooling system	2

Part -B / Presentation on Case studies through Seminar

1. Chiller unit
2. Building Management system(Introduction)
3. Effect on Ozone depletion andGlobal warming,
4. Alternative Refrigerants.
5. Refrigerant Different Protocols used in
6. Variable refrigerant flow technology & its smart control

Term Work

Term work shall consist of

1. Minimum Six experiments
2. Industrial visit on any RAC plant
3. Case study report

Distribution of Term work marks as follow

1. Experiments : 10 marks
2. Case study : 5 marks
3. Industrial Visit Report : 5 Marks
4. Attendance (Theory + Practical) : 5 marks

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.

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. Refrigeration & Air Conditioning by C. P. Arora, McGraw Hill Education (I) Pvt Limited, New Delhi
2. Refrigeration & Air Conditioning – W F Stoecker and J W Jones, Tata McGraw Hill
3. Principles of Refrigeration – R J Dossat, Wiley Eastern Publication
4. Refrigeration & Air Conditioning - R. S. Khurmi and J K Gupta, Eurasia Publishing House Pvt Ltd. New Delhi
5. Refrigeration and Air Conditioning – Manohar Prasad, New Age Int (P) Ltd.
6. Basic Refrigeration & Air Conditioning - P.N. Ananthanarayanan, Fourth Edition, Tata McGraw Hill
7. ASHRAE Handbook of Fundamentals
8. ASHRAE Handbook of Systems
9. ASHRAE Handbook of Equipment
10. ISHRAE Refrigeration Handbook
11. ISHRAE HVAC Databook

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Course Code	Course Name	Credits
ME 403	**Thermal Design of Electronic Equipment**	**3**

Course Objectives:

1. To teach students about modes of heat transfer in electronic devices.

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

1. Gain in depth knowledge of designing cooling systems for electronic equipment.
2. Design a system that withstands high pressure.
3. Understand fluid dynamics in electronic equipment design.
4. Understand the effect of various modes of heat transfer on designing a system.

Module	Detail Content	Hrs.
1.	Introduction: Introduction to modes of heat transfer in electronic equipments conduction, convection and radiation. Theoretical power dissipation in active devices like CMOS device, Junction FET, Power MOSFET. Theoretical power dissipation in passive devices like Interconnect , resistor, capacitor	08
2.	Conductive heat transfer: Introduction, Thermal conductivity, thermal resistance, conductivity in solids and fluids. Steady state conduction: Conduction in simple geometry like plain wall without heat generation, conduction through cylinder and spheres without heat generation. Conduction in complex geometries like multidimensional analytic method, multidimensional graphical method. Conduction: transient-lumped capacitance method. Thermal Contact Resistance in Electronic Equipment Interfaces: Simplified contact resistance model, geometry of contacting surface.	08
3.	Fluid dynamics for electronic equipments: Introduction. Hydrodynamics properties of fluid: compressibility, viscosity and surface tension. Fluid statistics: Relationship between pressure and density. Fluid dynamics: streamline & flow fields, One and two dimensional flow. Incompressible fluid flow: One dimensional flow-Euler and Bernoulli's equation. Incompressible fluid flow: laminar and turbulent flow. Electronic chassis flow:	08
4.	Convection heat transfer in electronic equipments: Introduction , properties of air, boundary layer theory, Forced convection laminar flow, forced convection in turbulent flow: circular and non circular tubes. Forced convection external flow: Laminar and forced convection flow over flat plate. Forced convection flow along populated circuit boards. Natural convection: flat plate, vertical fins, horizontal and vertical cylinder, spheres, cones.	08
5.	Radiation heat transfer in electronic equipments: Introduction, radiation equations, surface characteristics like absorptance, emittance and reflectance. Calculation of estimated diffuse view factors, Environmental effects:- solar radiation and atmospheric radiation.	08
6.	Heat transfer with phase change and combined mode of heat transfer: Introduction:-dimensionless parameters in boiling and condensation, modes of boiling liquids, evaporation.	08

	Conduction in series and parallel, conduction and convection in series, radiation and convection in parallel, Overall heat transfer coefficient. Selection of cooling technique: Ranges of cooling rates of different cooling methods, selection criteria; Experimental techniques used for thermal measurements; Reliability issues: importance, bathtub curve.	

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. Younes Shabany, Heat Transfer: Thermal Management of Electronics, CRC Press Inc, 2010.
2. Ravi Kandasamy and Arun S. Mujumdar, Thermal Management of Electronic Components, Lambert Academic Publishing, 2010.
3. Dave S. Steinberg, Cooling Techniques for Electronic Equipment, Wiley, 1991.
4. Sung Jin Kim, Sang Woo Lee, Air Cooling Technology for Electronic Equipment, Taylor & Francis, 1996.
5. Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw-Hill, 2001.
6. Yunus A. Cengel, Heat Transfer: A Practical Approach. McGraw-Hill, 2003.
7. Thermal Design of Electronic Equipment by Ralph Remsburg , CRC Press
8. Richard K. Ulrich & William D. Brown Advanced Electronic Packaging - 2nd Edition : IEEE Press, 1995.

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Course Code	Course Name	Credits
ME 404	**Computational Methods in Thermal Engineering**	**3**

Course Objectives:

1. To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in Thermal Engineering.
2. To study and apply numerical solution techniques for the partial differential equations governing the Thermal engineering problems.
3. To study the mathematical structure which could be used to describe the behaviour and results of most numerical methods commonly used in Thermal Engineering. Problems.
4. To write code for some real-life Thermal Engineering problems.

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

1. Solve mass, momentum, and energy governing equations in thermal Engg using numerical methods.
2. Identify live Initial value problems and boundary value problems arise in thermal engineering and use suitable numerical methods to solve them.
3. Write codes for thermal engineering problems in MATLAB, C, C++ and also to solve thermal engineering problems by using any commercial CFD package.

Module	Detail Content	Hrs.
1.	Root finding: Algebraic and transcendental equation: Bisection method, Fixed point, Regula-Falsi method, Newton-Raphson method, Rate of convergence, Merits, and demerits of methods	7
2.	Solution of simultaneous Linear Algebraic Equations: Motivation, Gauss elimination, Pitfalls of Gauss Elimination method, LU factorization, Iterative methods: Jacobi method, Gauss-Seidel method, Relaxation method	6
3.	Interpolation and Curve Fitting: Motivation, Polynomial forms, Linear interpolation, Lagrangian interpolation, Newton's divided difference interpolation, Finite difference operators, Newton's forward and Newton's backward difference interpolation, Regression analysis- linear regression, Least-square method, Fitting of non-linear curves, Polynomial functions, Multiple linear regression.	7
4.	Initial Value Problems: Modified Euler's Method, Runge-Kutta method of fourth order, Solution of simultaneous differential equations and higher order equations.	6
5.	Boundary-value Problems: Motivation, Shooting method, Finite difference method, Finite difference representation of differential equations, Elliptic, Parabolic and Hyperbolic Partial Differential Equations and their solutions using finite difference schemes, Explicit and Implicit schemes. Applications of finite difference methods to thermal engineering problems.	7
6.	Finite Volume Method, Finite element method, 1d, 2-d and 3-d steady and unsteady flow and thermal problem. The role of simulation in the design of thermal systems	6

Students must understand the practical applications of Computational methods by solving the following assignments.

1. Writing codes for 1-d and 2-d steady and unsteady thermal problem in MATLAB, C, C++
2. Solving 1d, 2-d and 3-d steady and unsteady flows and thermal problem using any commercial CFD package like Ansys-FLUENT, STAR CCM, FLUIDYNE, Ansys-CFX etc.

Note:

- Total six Assignments (One from each module).
- Out of this at least one assignment should be solved by coding in the prog language and/or on use of commercial packages as described above.

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous Evaluation : Assessment on the completion of assignments and Internal Oral based on assignments (at the time of assessment of assignments) : 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. Computer Based Numerical and Statistical Techniques, Manish Goyal, Laxmi Publications (P) Ltd, New Delhi
2. Numerical Methods in Engineering, Salvadori M G, Baron M L, Prentice-Hall
3. Numerical Methods for Engineers, Chapra S C, Candle R P, 2nd Ed, McGraw-Hill, New York
4. Applied Numerical Analysis, Gerald CF, Wheatley PO, 6thedition, Pearson Education, 1999
5. Numerical Mathematics and Computing, Cheney W., Kincaid D., 5thedition, Thomson / BrooksCole, 2004.
6. Numerical Methods for Partial Differential Equations, William F. Ames, 2nd Edition, Academic Press, 1977

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Course Code	Course Name	Credits
ME 405	**Design of Mechanical Systems**	**3**

Prerequisites:

1. Engineering Mechanics
2. Material Science
3. Strength of Materials
4. Machine Design-I
5. Machine Design-II

Course Objectives:

1. To learn and apply system design concepts.
2. To study the design of various mechanical systems.

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

1. Understand the difference between mechanical component design and mechanical system design.
2. Understand the concept of optimum design and its importance in system design.
3. Design a hoisting mechanism.
4. Design material handling system.
5. Design an internal combustion engine.
6. Design a machine tool gear box.

Module	Detail Content	Hrs.
1.	**Component Design and System Design:** Concept of a component design, concept of system design, how component design and system design are different, various phases of system design.	2
2.	**Optimum Design:** Objectives of Optimum design, Johnson's method of optimum design, primary design equations, subsidiary design equations and limit equations. Optimum design with normal specifications for simple machine elements like tension bar, transmission shaft, spring etc. Introduction to redundant specifications.	4
3.	**Design of EOT crane:** Calculation of safe stress, selection of wire rope and calculation of rope life, Selection of pulley, Design of pulley axel and selection of bearing for pulley. Selection of hook and check for safety at critical cross section, Selection of bearing for hook, design of hook shaft, Design of Shackle plate.	8
4.	**Design of Material handling systems (Conveyor Belts):** Calculation of belt width and Thickness , Driving force and power, selection of motor and pulleys, Design of idlers.	6
5.	**Design of an IC Engine:** Design of Cylinder, piston, connecting rod and crankshaft.	8
6.	**Design of Machine tool gear box:** Introduction to machine tool gearboxes, design and its applications, basic considerations in design of drives, determination of variable speed range, graphical representation of speed and structure diagram, ray diagram, selection of optimum ray diagram, gearing diagram.	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 syllabus.

Use of standard design data books like PSG Data Book, Machine Design Data Book by Mahadevan, Design of engine parts by Khandare S.S and Kale A.V., are permitted at the examination and shall be supplied by the college.

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Books/References:

1. Rudenko - 'Material Handling Equipment' M.I.R. publishers, Moscow.
2. Bhandari V.B., "Design of Machine Elements", Tata McGraw Hill
3. Design Data Book, P.S.G. College of Technology, Coimbatore
4. Design and analysis of new flexible and safe fork lifts https://repository.library.northeastern.edu
5. Optimum design of mechanical elements, Ray C Johanson
6. Design data book by Kale Khandare
7. Design data book by Mahadevan
8. N K Mehta- 'Machine Tool Design' Tata McGraw Hill
9. Shigley- 'Mechanical engineering Design', Tata McGraw Hill
10. IS 11592:2000, Indian Standard for selection and design of belt conveyors-Code of practice.
11. IS 3177:1999(reaffirmed 2004), code of practice for electric overhead travelling cranes and gantrycranes other than steel work cranes

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Course Code	Course Name	Credits
ME 406	**Engineering Vibrations**	**3**

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:**	6

	Viscous damping: Underdamped, critically-damped, overdamped systems, Logarithmic decrement for underdamped system. Dampers in series and parallel combination, inclined dampers. Coulomb damping.	
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.

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 407	**Robotics**	**3**

Course Objectives:

1. To study the basics of robotics and its control
2. To study various design principles of robotics through kinematic analysis, workspace analysis, and trajectory planning
3. To study applications of robots in industrial inspection and material handling
4. To study the role of a robot as a humanoid

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

1. Demonstrate the basic functioning of a robot
2. Identify various components of robots
3. Carryout kinematic analysis, workspace analysis, and trajectory planning for a robot
4. Identify suitable sensors/actuators for robot
5. Select an appropriate robot for given industrial inspection and material handling systems.
6. Illustrate various aspects of a robot as a humanoid

Module	Detail Content	Hrs.
1.	**Introduction** Definition of robot, Evolution of robots, Laws of robots, International Robotic Standards, Types of robots, Selection of robots, Robot Classifications, Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a robot, Robot feedback controls: Point to point control and Continuous path control, Control system for robot joint, Adaptive control, Drives and transmission systems, End effectors, Applications of robots, Social & Economical Benefits.	08
2.	**Kinematics of Robots** Direct: Link coordinates D-H Representation, The ARM equation, Direct kinematic analysis for Four axis, SCARA Robot and three, five, and six axis Articulated Robots. Inverse: The inverse kinematics problem, General properties of solutions, Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis Articulated robot. Mobile Robot Kinematics Introduction, Kinematic models and constraints, Representing robot position, Forward kinematic models, Wheel kinematic constraints, Robot kinematic constraints, Mobile robot maneuverability, Degree of mobility, Degree of steerability, Mobile robot workspace, Degree of freedom, Holonomic robots, Path and trajectory considerations, Motion control, Open loop control, Feedback control.	10
3.	**Workspace Analysis and Trajectory Planning** Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations, Joint space technique - Continuous path motion, Interpolated motion, Straight line motion and Cartesian space technique in trajectory planning.	08
4.	**Robotic vision systems -** Image representation, Object recognition and categorization, Depth measurement, Image data compression, Visual inspection, Segmentations, Software considerations	06
5.	**Robots for Inspection and Material Handling** Concepts of material handling, Principles and considerations in material handling systems design, Conventional material handling systems - Industrial trucks, Monorails, Rail guided vehicles, Conveyor systems, Cranes and Hoists, Advanced material handling systems, Automated guided vehicle	08

	systems, Automated storage and retrieval systems, Barcode technology, Radio frequency identification technology.	
6.	**Humanoids** Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, and sound, Vision, Tactile Sensing, Models of emotion and motivation, Performance, Interaction, Safety and robustness, Applications, Case studies.	08

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. Yoram Korean, “Robotics for engineers”, McGrew Hill Co.
2. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, “Industrial Robotics Technology programming and Applications”, McGraw-Hill,
3. Robotics: Fundamental Concepts and Analysis by Ashitava Ghosal, Oxford University Press
4. R.K. Mittal and I.J. Nagrath, “Robotics and Control”, TMH Publications
5. Robert J. Schilling, “Fundamentals of Robotics Analysis and Control”, PHI Learning
6. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robotics and Automation Sensor – Based integration, Academic Press

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Course Code	Course Name	Credits
ME 408	**Modelling and Simulation**	**3**

Course Objectives:

1. To understand the significance of modeling
2. To highlight the importance of simulation

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

1. Demonstrate a clear understanding of model for any system
2. Analyze any model for the given system.
3. Realize any system with the help of model and the tool for simulation
4. Demonstrate the simulation skill for any given system
5. Use modern Engineering tools to solve engineering problems.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	**System Modeling** 1.1 Types of model Static and dynamic physical and mathematical model 1.2 Step response method two ,three and four parametric model	05
2.	**Mathematical Model** 2.1 Necessity of mathematical modeling, principles of mathematical modeling 2.2 Dimensional analysis, scale	08
3.	**Approximating and validating models** 3.1 Taylor's formula, algebraic approximations, Numerical approximations 3.2 Validating models	08
4.	**Analysis and control of the systems** 4.1 Solution Techniques for Ordinary Differential Equations, Free Response and Eigenvalues 4.2 State-space Equations: Converting to state space, simulating the models using any simulation	05
5.	**Examples of System Models** 5.1 Exponential growth and decay – radioactive decay, capacitor charging discharging 5.2 Freely vibrating pendulum, spring-mass oscillator	08
6.	**System Simulation** 6.1 Techniques of simulations, The Monte-Carlo Method 6.2 Types of system Simulation 6.3 Continuous System Simulation: Analog and Hybrid method 6.4 Probability concepts in simulation	05

Laboratory Syllabus:

Sr. No.	Experiment Title
1	Circuit Design with Circuit simulation tools
2	Tools used in control system and instrumentation like Labview
3	Programming with Embedded tools
4	FPGA/CPLD programming tools
5	Modeling with autocad tools
6	Mathematical modeling tools like Scilab/Matlab
7	Tools for implementation of Real Time Operating System
8	Tools used for communication

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 syllabus.

Books/References:

1. Clive L. Dym, “Principles of Mathematical Modeling” Academic Press, Second Edition
2. Dean C. Karnopp, Donald L. Margolis, Ronald C. Rosenberg, “System Dynamics: Modeling, Simulation, and Control of Mechatronic Systems,” 5th Edition, Wiley
3. Geoffrey Gordon , “ System Simulation” Prentice Hall India
4. Karl J Astrom, Tore Huggland “ PID Controllers” 2nd Edition
5. Fundamentals of Process Control Theory, Paul Murrill, ISA

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Course Code	Course Name	Credits
ME 409	**Nanotechnology, Nanostructures and Nanomaterials**	**3**

Prerequisites:

1. XII Chemistry
2. Chemistry of Engg Materials
3. Materials And Metallurgy

Course Objectives:

1. To make the students understand the fabrication of nanostructures for advanced devices.
2. Provide and train the students about nanomaterial synthesis and thin film deposition techniques

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

1. Explain the strong dependence of the properties of materials on size.
2. Suggest various approaches to engineer nanomaterials and nanostructures
3. Develop applications of nanomaterials with a focus on fundamentals, fabrication, characterization, and applications.
4. Apply vacuum technology for nanomaterial synthesis.
5. List the various deposition techniques at the atomic and molecular level
6. Compile the structure and properties correlation of thin films.

Module	Detail Content	Hrs.
1.	Structure and property – 2D and 3D system. Specific surface to volume ratio and surface energy,Top-down approach: photolithography, e-beam lithography and soft lithography . Bottom-up approach: shape controlled synthesis of nanomaterials.	6
2.	Length of nanoscales: metal, semiconductor and magnetic nanoparticles. Light and electrons: optical and electron microscopy. Near field imaging: near field optical microscopy and scanning probe microscopy.	6
3.	Deposition techniques for nanocoatings and structure.Particularities and versatility of physical vapor deposition (PVD), chemical vapor deposition (CVD), laser-, electron- and ion-assisted technologies	6
4.	Fundamentals, Advantages and limitations of Chemical vapor deposition (CVD) techniques; Different kinds of CVD techniques- Metal Organic (MO) CVD, Photoassisted CVD, Thermally activated CVD, Plasma enhanced (RF, μ-Wave) CVD, Low pressure (LP) CVD, Atmospheric pressure (AP) CVD etc,.	8
5.	Definition of thin films- Environment (Gas phase and plasma) for thin film deposition, Deposition parameters and their effects on film growth; Physical parameters for evaluation of thin films. Surface roughness; Density; Stress in thin films; Adhesion; Stoichiometry.	7
6.	Recent development of nanomaterials and safe nanotechnology, hazards with handling and transportation of nano materials	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. T.Pradeep, Nano;The Essentials,Understanding Nanoscience and Nanotechnology,McGraw Hill Publication.
2. Richard Brooker,EarlBousen, Nanotechnology,Wiley India Publication.
3. No Small Matter: Science on the Nanoscale: Felice C. Frankel and George M. Whitesides, The Belknap Press of Harvard University Press, 2009 .
4. Introductory Nanoscience: Physical and Chemical Concepts: Masaru Kuno, Garland Science; 1 edition (August 19, 2011)
5. Hari Singh Nalwa, Handbook Of Nanostructured Biomaterials And Their Applications In Nanobiotechnology, Journal of Nanoscience and Nanotechnology, 2005.
6. J. George, Preparation of Thin Films, Marcel Dekker, Inc., New York. 2005.
7. G.A. Ozin and A.C. Arsenault, Nanochemistry: A chemical approach to nanomaterials, Royal Society of Chemistry, 2009.

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Course Code	Course Name	Credits
ME 410	**Electrical, Magnetic and Optoelectronic Materials**	**3**

Prerequisites:

1. XII Physics
2. Elementary knowledge of Solid State Physics

Course Objectives:

1. To introduce students to different classes of engineering materials
2. To introduce students to the basic principles that help in understanding why a material behaves in a certain fashion.
3. To introduce students about materials used as sensors and actuators.

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

1. Acquire knowledge of electrical, magnetic and optical properties of available materials.
2. Choose appropriate material in designing engineering components.
3. Understand the basic principles involved in working of various sensors and actuators.
4. Provide basic knowledge so that learners can appreciate the importance of discovery of new materials.
5. Use appropriate safety procedures in handling various materials, sensors and actuators.

Module	Detail Content	Hrs.
1.	**Electrical Materials: Part 1** Origin of electrical conductivity, Conductors, Insulators, Semiconductors, Electrical contact materials, Dielectrics, Polarizability, Permittivity, Behavior of dielectrics in DC and AC fields, Solid dielectrics (organic and inorganic), Liquid dielectrics (mineral and synthetic oils) and Gaseous dielectrics (Sulphur hexafluoride etc.)	7
2.	**Electrical Materials: Part 2** Ferroelectric materials, high dielectric materials, low dielectric materials, capacitors, super capacitors, Piezoelectric materials, Ferroelectric Materials, Multiferroics. Superconductors, Magnetic levitation, Electroactive polymers, Ionic conductors.	7
3.	**Magnetic Materials: Part 1** Atomic structure and origin of magnetism, Magnetization, Permeability, Susceptibility, Curie-Weis law, Classification of magnetic materials, Diamagnetic materials, Paramagnetic materials, Ferromagnetic materials, Anti-ferromagnetic materials, Magnetization curve, Hysteresis loop, Soft Magnets, Hard Magnets.	6
4.	**Magnetic Materials: Part 2** Methods of measuring magnetic field (Magnetic Resonance, Hall effect), Magnetocaloric Materials, Magnetic refrigeration, Magneto resistive materials, Magnetostrictive materials, Magnetic polymers, Soft magnetic composites, Ferrofluids.	6
5.	**Optoelectronic Materials: Part 1** Characteristics of optoelectronic devices, Direct and in-direct gap semiconductors, Semiconductors for LED, Photodetectors etc. Semiconductor Lasers, Laser Materials, Materials for optical fibers, Photonic materials, Semiconductor nano-structures.	7

6.	**Optoelectronic Materials: Part 2** Liquid crystals for display, Organic optoelectronic materials, Dye synthesized solar cells, Metal halide perovskite optoelectronic materials, Metamaterials, Negative refractive index materials.	6

Assessment:

Internal Assessment: 40 marks.

1. One compulsory in-semester class test of 40 marks. At least 40% of the syllabus shall be completed before conducting the test.
2. One assignment or mini-project 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. Engineering Materials by Kenneth G. Budinski (Prentice Hall of India)
2. Introduction to Material Science for Engineers by James F Shackelford
3. Introduction to magnetic materials, B. D. Cullity, C. D. Graham,(Wiley)
4. Fundamentals and applications of magnetic materials by Krishnan, Kannan M, (Oxford University Press)
5. Electrical Engineering Materials by A J Dekker
6. Dielectric Materials: Properties and Applications (Lecture Notes) http://tiiciiitm.com/profanurag/Physics-Class/Unit-2-DM.pdf
7. Electrical Engineering Materials: Lecture Notes by: Prof. Ramesh Chandra Prusty (https://www.vssut.ac.in/lecture_notes/lecture1426861925.pdf)
8. Optoelectronic Devices and Materials by Stephen J. Sweeney and Jayanta Mukherjee (in Springer Handbook of Electronic and Photonic Materials)
9. Basic Optoelectronics and LED—Lecture notes of Haldia Institute of Technology (hithaldia.in › sas_faculty › Lecture Note_EI_503A)
10. Contemporary Optoelectronics Materials, Metamaterials and Device Applications (Editors: Shulika, Oleksiy, Sukhoivanov)
11. Optoelectronics Materials and Techniques by P Predeep (Intech Publications)
12. Organic Optoelectronic Materials, (Ed) Yongfang Li

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Course Code	Course Name	Credits
ME 411	**Logistics & Supply Chain Management**	**3**

Course Objectives:

1. To understand the fundamentals of supply chain management and Logistics
2. To develop an understanding related to Supply Chain Performance and related aspects
3. To understand Inventory management in supply chain
4. To learn tools and techniques used in logistics, transportation, warehousing and outsourcing decisions.
5. To develop critical understanding towards digitization in supply chain management and sustainability
6. To develop analytical and critical understanding for planning and designing supply chain network.

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

1. Demonstrate a sound understanding of Logistics and Supply Chain Management concepts and their role in today's business environment.
2. Identify the drivers of supply chain performance and risks in supply chain management.
3. Apply various techniques of inventory management and rank the items using inventory management technique
4. Apply various strategies and techniques to minimize overall logistics cost
5. Understand the role of digitization in supply chain management leading to sustainability
6. Apply various mathematical models/tools to design the supply chain network

Module	Details	Hours
1.	**Introduction:** Objectives of a Supply Chain Management, Stages of Supply chain, Value Chain Process, Cycle view of Supply Chain Process, Key issues in SCM, logistics & SCM, Supply Chain Drivers /decisions and obstacles, Supply chain strategies, strategic fit, Best practices in SCM, Obstacles of streamlined SCM. Supplier Selection, Supplier quality audits, Contract management, Non-Disclosure Agreement (NDA), Make & Buy Decision while in-out sourcing	4
2.	**Supply Chain Performance:** Bullwhip effect and reduction, Performance measurement: Dimension, Tools of performance measurement, SCOR Model. Demand chain management, Global Supply chain- Challenges in establishing Global Supply Chain, Factors that influences designing Global Supply Chain Network. Supply Chain Risk Management **(**Risks involved in supply chain which includes – Supplier Financial Risk, Performance Risk, Compliance Risk, Country specific Risk, Cyber Security. Supplier performance measurement – (Delivery & Quality performance, schedule adherence, Goods receipt compliance etc), Supplier Capacity Analysis, Supplier Score card.	8
3.	**Inventory management:** Definition of Inventory, Inventory types & functions; EOQ Model and Buffer Stock, Assumptions, Instantaneous Replenishment case, Demand and production rate are different, when backorders are allowed, Buffer Stock and ROL.	6

	Replenishment systems (Q and P system) Inventory Control- ABC Analysis, Numerical problems on ABC analysis, VED Analysis	
4.	**Logistics Management and outsourcing:** Evolution, Objectives, Components and Functions of Logistics Management, Distribution related Issues and Challenges; Gaining competitive advantage through Logistics Management, Transportation- Functions, Costs, and Mode; Network and Decision, Containerization, Cross docking. Warehousing: Concept and types, Warehousing strategy, Warehouse facility location & network design Part Packaging, Use of Returnable pallets, ASN – Advance Shipment Notification. Reverse logistics: Outsourcing - Nature and concept, Strategic decision to Outsourcing, Third party logistics(3PL), Fourth party logistics(4PL), Cold chain operations in Supply chain.	8
5.	**Digitization in supply chain Management and Sustainability:** IT in supply chain - Role of IT in a supply chain, The supply chain IT framework, Application of Bar coding, Significance of SAP/RFID, The future of IT in the supply chain, Supply chain IT in practice, TMS (Transport Management System), WMS (Warehouse Management System) Green supply chain management, Supply Chain sustainability, Supply Chain sustainability index measurement with case studies. Social aspects of supply chain (CSR), Environment aspects of supply chain (CO2 emission), resource utilization, recycling.	4
6.	**Supply Chain Network Design:** Factors influencing distribution network design, Supply chain resilience, Design options for distribution network, Introduction to mathematical modelling, considerations in modelling SCM systems, Overview of the models, Models on transportation, Transportation problem, Vehicle routing problem, Travelling salesman problem, Capacitated transhipment problem, shortest path problem. Value Stream Mapping (VSM), Order Fulfillment Process Flow, understanding the terms related to Supply chain- Lead Time, Takt Time ,Minimum Order Quantity (MOQ), Manufacturing Critical Path Time (MCT)	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.

Text/Reference Books: -

1. R.P. Mohanty, S.G. Deshmukh, Essentials of Supply Chain management, Phoenix publishing House Pvt Ltd.
2. S.K. Bhattacharya, Logistics Management, Pearson Publication
3. Sunil Chopra, P. Meindl, Supply Chain Management, Pearson Education Asia.

4. Martin Christopher, Logistics and Supply Chain Management, Pitman Publishing.
5. Bowon Kim, Mastering Business in Asia. Supply Chain Management, John Wiley & sons (Asia) Pte Ltd.
6. Michael Hugos, Essentials of Supply Chain Management, John Wiley and Sons
7. Rahul V Altekar, Supply Chain Management: Concepts and cases, PHI
8. D. Simchi-Levi, P. Kaminsky, E. Simchi-Levi, and Ravi Shankar, Designing and Managing the Supply Chain concepts, Strategies and Case studies, Third Edition, Tata McGraw Hill, New Delhi, 2008.

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Course Code	Course Name	Credits
ME 412	**Quality Engineering**	**3**

Course Objectives:

1. To understand the concept of Quality.
2. Demonstrate the approaches and techniques to assess and improve process and/or product quality and reliability
3. Introduce the principles and techniques of Statistical Quality Control

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

1. To realize the importance and significance of quality
2. Illustrate basic concepts and statistical methods in quality control
3. Illustrate the different sampling techniques in quality control
4. Use control charts to analyze for improving the process quality
5. Acquire basic knowledge of total quality management

Module	Detail Content	Hrs.
1.	**Introduction** Different Definitions and Dimensions of Quality, Historical Perspective (From Evolution of Quality Control, Assurance and Management to Quality as Business Winning Strategy), Contribution of Renowned Quality Gurus (Their Philosophies and Impact on Quality).Introduction to Quality, Classification of Quality Tools, Quality of Design, Quality of Conformance, Compromise between Quality and Cost,	4
2.	**Quality Engineering and Management Tools, Techniques & Standards** 7 QC tools, 7 New Quality Management Tools, 5S Technique, Kaizen, Poka-Yoke, Quality Circle, Cost of Quality Technique, Introduction to Quality Management Standards – ISO : 9000, ISO:14000, QS:9000 (Concept, Scope, Implementation Requirements & Barriers, and Benefits), Introduction to National and International Quality Awards (Malcolm Baldrige National Quality Award – MBNQA, The Deming Prize Rajiv Gandhi National Quality Award)	8
3.	**Total Quality Management** Basic Philosophy, Approach, Implementation Requirements & Barriers. **Designing for Quality** Introduction to Concurrent Engineering, Quality Function Deployment (QFD) and Failure Mode and Effect Analysis (FMEA) – Concept, Methodology and Application (with case studies).	8
4.	**Introduction to Design of Experiments** Introduction , Methods, Taguchi approach, Achieving robust design, Steps in experimental design **SQC & SQC tools** Statistics in Quality control, Variables and Attributes data, Process Capability, Control charts for variables and for attribute data($\bar{X}$ and R-Chart, p-chart np-chart, c-chart, Uchart), Applications of SQC in engineering – case studies **Sampling Techniques** Advantages of Sampling Inspection, operating characteristic (OC) curve. Choosing OC curve for appropriate sampling plan, acceptance sampling	8

5.	**Contemporary Trends in Quality Engineering & Management** Just in time (JIT) Concept, Lean Manufacturing, Agile Manufacturing, World Class Manufacturing, Total Productive Maintenance (TPM), Bench 10 20 Marking, Business Process Re-engineering (BPR), Six Sigma - Basic Concept, Principle, Methodology, Implementation, Scope, Advantages and Limitation of all as applicable.	8
6.	**Quality in Service Sectors** Characteristics of Service Sectors, Quality Dimensions in Service Sectors, Measuring Quality in Different Service Sectors.	4

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. Quality Assurance and Total Quality Management (ISO 9000, QS 9000 ISO 14000) by K C Jain and A K Chitale, Khanna Publishers
2. Quality Control & Application by B. L. Hanson & P. M. Ghare, Prentice Hall of India
3. Total Quality Management by Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield and Mary Besterfield-Sacre, Pearson Educaiton
4. Quality Management by Kanishka Bedi
5. Total Quality Management – Dr. S. Kumar, Laxmi Publication Pvt. Ltd.
6. Total Quality Management by K C Arora, S K Kataria & Sons
7. Statistical Quality Control by M. Mahajan, Dhanpat Rai & Co. (P) Ltd.

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Course Code	Course Name	Credits
ME 413	**Sustainable/Zero Energy Buildings**	**3**

Course Objectives:

1. To study fundamental concepts of solar building design and energy systems.
2. To study the process involved in site selection of green buildings.
3. To study various energy efficient materials for green building construction.
4. To study various ASHRAE and IGBC standards.

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

1. Understand the benefits of green building.
2. Understand various heat transfer processes that increase cooling load in a building.
3. Understand various methods adopted for Occupant Comfort and Wellbeing.

Module	Detail Content	Hrs.
1.	Introduction to Green Buildings: Definition of green buildings and sustainable development, typical features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.	08
2.	Site selection and planning: Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect, maximizing comfort by proper orientation of building facades, day lighting, ventilation, etc. Water conservation and efficiency: Rainwater harvesting methods for roof & non-roof, reducing landscape, water demand by proper irrigation systems, water efficient plumbing systems, water metering, waste-water treatment, recycle and reuse systems.	08
3.	Energy Efficiency: Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy. Methods to reduce operational energy: Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.	08
4.	Heat transfer processes in buildings:- Thermal conductivity, resistance, transmittance, surface characteristics, surface coefficient, heat capacity, insulation. Calculation of principle building energy gains and losses. Estimation of building energy performance for heating and cooling for different climatic contexts. Importance of energy to human development, conventional and renewable energy sources – supply, uses and environmental impact. Assessment future growth in energy demand, availability, potential for sustainable development. Sustainable issues of planning, building design and development.	08
5.	Building materials: Methods to reduce embodied energy in building materials: (a) Use of local building materials (b) Use of natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks, (c) use of materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) reuse of waste and salvaged materials.	08

	Waste Management: Handling of construction waste materials, separation of household waste, on-site and off-site organic waste management.	
6.	Indoor Environmental Quality for Occupant Comfort and Wellbeing: Day-lighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics. Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc, Energy Conservation Act 2001	06

Assessment:

Internal Assessment for 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. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, 2013, Indian Green Building Council Publishers.
2. GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment.
3. Alternative building materials and technologies by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
4. Non-Conventional Energy Resources by G. D. Rai, Khanna Publishers.
5. Sustainable Building Design Manual, Vol.1 and 2, TERI, New Delhi 2004.
6. Mike Montoya, Green Building Fundamentals, Pearson, USA, 2010.
7. Charles J. Kibert, Sustainable Construction – Green Building Design and Delivery, John Wiley & Sons, New York, 2008.
8. Regina Leffers, Sustainable Construction and Design, Pearson / Prentice Hall, USA, 2009.
9. Faber, Oscar and Kell, J.R. Heating and air-conditioning of buildings. 2002.
10. Thomas, Randall & Fordham Max Sustainable urban design:an environmental approach" 2003.
11. Edwards, Brian and Hyett, Paul Rough guide to sustainability
12. Langston, Craig A. and Ding, Grace Sustainable practices in the built environment 2001.
13. Givoni Baruch,"Passive and Low Energy Cooling of Buildings",VNR, New YorK, 1994.
14. Martin J Gainsborough, Radford and Helen Bennets, T J Williamson, "Understanding Sustainable architecture", Spon Press, London, 2003.

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Course Code	Course Name	Credits
ME 414	**Energy Systems Modelling & Analysis**	**3**

Course Objectives:

1. To study and understand energy system models
2. To study and understand analysis parameters and trade-off

Course Outcomes: Learner will be able to

1. Develop the model for energy system
2. Evaluate the parameters for analysis
3. Build the complete model for local energy system

Theory Syllabus:

Module	Detail Content	Hrs.
1	Introduction to energy system modelling, usage, cost and efficiency, Classification of energy system models, Process system Engineering, Energy economics	10
2	Architecture of energy system, Taxonomy of energy system models,	07
3	Analytical approach to modelling, Top-down models, Bottom-up models, Hybrid models	07
4	Analysis of energy systems, integration of renewable sources with conventional energy systems	10
5	Energy infrastructure, planning, trade-off	07
6	Energy Internet: Overview, Concept, Model Structure, and Mechanism	07

Laboratory Syllabus:

Experiment	Name of Experiments	Hrs.
1	1. A case study on energy economics	4
2 and 3	Any two of the following 1. Development of Top-Down model for identified energy system 2. Development of Bottom-Up model for identified energy system 3. Development of Hybrid model for identified energy system	4
4 and 5	1. Identify the trade-off parameters 2. Make the necessary changes in the models developed in experiment 2	4

Assignments: At least 2 reports on

1. Local energy system
2. Local energy infrastructure
3. Energy planning for the municipal corporation
4. Cost analysis
5. Possibilities of adding renewable energy resources and its payback

Note: The reports may be prepared by a group of 4 to 5 students

Assessment:
Internal Assessment for 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. Modelling and Simulation of Energy Systems by Thomas A. Adams (MDPI)
2. Energy Systems Modelling Principles and Applications by Hooman Farzaneh (Springer)
3. Modelling, Analysis and Optimization of Process and Energy Systems by F. Carl Knopf (Wiley)
4. Modelling, Assessment and Optimization of Energy Systems by Hoseyn Sayyaadi (Academic Press)
5. Modern Power System Analysis by D P Kothari and I J Nagrath (McGraw Hill)

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Course Code	Course Name	Credits
ME 415	**Alternate Fuels and Emissions**	**3**

Course Objectives:

1. To provide in depth knowledge of Alternate fuel and energy systems.
2. To address the underlying concepts and methods behind alternate fuel and energy systems.
3. Study the effect of pollution on the environment and human health.
4. Study emission standards, methods of measurement and control techniques.

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

1. Identify different areas of alternate fuels and energy systems.
2. Describe various parameters that are used to characterize fuels.
3. Demonstrate the utilization of alternative fuels for Automotive applications..
4. Understand various sources of emission and harmful effects of pollution
5. Describe the importance of emission measurement and control and summarize pollution norms.
6. Assess need of eco-friendly fuel and vehicle

Module	Detail Content	Hrs.
1.	**Introduction**: Introduction to types of I.C engine, Conventional fuels for I C Engine, Properties of different types of fuels, Fossil fuels, availability and scope, Effect of different types of fuel on engine performance.	05
2.	**Alcohol :** Introduction to Alcohol fuel , Sources of various types and blends of alcohol fuel, Calorific value of different types of fuels, Application of fuel in I C Engine, Multiple fuel system, Improving performance of Engine with types of alcohol fuels. **Biodiesel** : Introduction to biodiesel, sources of biodiesel, Production of biodiesel, various blends of biodiesel, Effect of different types of blends on engine performance like exhaust.	06
3.	**Biogas**: Introduction to biogas, Biogas production methods, Various factors affecting generation of biogas, Application of ion. in Automotive industry. **LPG and CNG :** Introduction, Properties of LPG and CNG, Methods of LPG and CNG Transportation, Safety and regulation in storage and transport, Fuel flow metering system, Combustion, Cost. **Hydrogen and fuel Cell:** Hydrogen as alternative fuel, Sources and methods of hydrogen production, properties of hydrogen, Hydrogen storage and transportation, Application of hydrogen in Automobile, Layout of hydrogen powered Car. **Fuel Cell:** Concept of fuel cell, Types of fuel cell, Power rating and performance, Automobile layout of full cell powered Car.	07
4.	**Solar Energy:** Concept of solar cell, Types of solar cell, Energy production from solar cell, Types of batteries used in harvesting solar energy, Merits and limitations of solar energy, Automobile layout of solar powered car. **Hybrid and electric vehicle :** Introduction and components of electric vehicle high energy and power density batteries , – Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Technical	07

	characteristics, Motor rating, requirements, Types – series, parallel and series, parallel configuration	
5.	**Introduction**: Air pollution, Sources of air pollution, Engine exhaust and its constituents, Emission from petrol tank & carburetor, crankcase blow-by, Effect of valve timing, ignition timing, Combustion chamber design, Fuel injection, fuel composition, air fuel ratio, Catalytic converters , Effect of automobile exhaust on air quality and human beings. **Pollution Norms:** European pollution norms, Indian pollution norms as per Central Motor Vehicle Rules (C. M.V. R.), The Air (Prevention and Control of Pollution) Act, 1981 **Control Of Engine Emissions:** By injection parameters, Lubricating oil, Compression ratio, Crankcase ventilation, Fuel composition, Injection/ Ignition timing, Charcoal canister.	07
6.	Numerical calculations to determine constituents of exhaust gas by mass basis and by volume basis, EGR mass flow rate estimation, Flame Ionization Detector (FID). Non Dispersive infrared analyzer and NOx Measurement. **Electronic Engine Control Technologies** Electronic throttle control, Closed loop canister purge control system, **Recent Trends in automotive emission technology.**	06

Laboratory Syllabus:

List of Experiments

1. Exhaust gas analysis of 4 stroke diesel engine by using exhaust gas analyser
2. Exhaust gas analysis of 2 stroke petrol engine by using exhaust gas analyser
3. Exhaust gas analysis of 4 stroke petrol engine by using Orsat apparatus
4. Exhaust gas analysis of 4 stroke diesel engine by using Orsat apparatus
5. Exhaust gas analysis of 2 stroke petrol engine by using Orsat apparatus
6. Study of Catalytic converters
7. Study of Emission Norms
8. Study of Exhaust Gas Recirculation (EGR)
9. Study of LPG / CNG Kit

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. Internal combustion Engines by Mathur and P. L. Sharma
2. Air pollution By Rao & Rao
3. Electronic Engine Control Technologies by Ronald K. Jurgen
4. Internal combustion Engines & Air pollution by Edward F. Obert
5. Pollution control and conservation by Dr. m. Kovacs
6. Air pollution Volume I to Volume XII by Arthur C. Stern
7. Air pollution by Henry C. Perkins
8. Air pollution by Spedding
9. I.C.Engine fundamentals by J.B. Heywood

10. Alternate Fuels by Dr. S. Thipse, Jaico Publications
11. “Automotive Emission Control” by Crouse, AND Anglin – McGraw Hill.
12. “Alternative Fuels Guidebook” by Bechtold R.
13. “Internal Combustion Engines” by Ganeshan – Tata McGraw Hill

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Course Code	Course Name	Credits
ME 416	**Vehicle Dynamics**	**3**

Course Objectives:

1. To familiarize with basic concepts of vehicle dynamics.
2. To analyze the vehicle in context of ride, handling and longitudinal dynamics of vehicle.
3. To get acquainted with simulation process using software in the domain of vehicle dynamics.

Course Outcomes: Learner will be able to

1. Analyze the vehicle directional stability.
2. Enumerate the suspension systems, tire dynamics & directional stability of the vehicle.
3. Develop physical and mathematical models to predict the dynamic response of vehicles
4. Demonstrate the ride characteristic of the vehicle.
5. Analyze the vehicle roll behaviour
6. Comprehend the various trends in Vehicle Dynamics.

Module	Detail Content	Hrs.
1	**Introduction** History of Road and Off-Road Vehicle dynamics, Road Load, Aerodynamics-Drag, Side force, Lift force, Rolling Resistance Total Road Loads, Introduction about Longitudinal vehicle Dynamics, Introduction about control theory applied to Longitudinal dynamics	4
2	**Tyres** SAE Tyre axis system, Tyre forces, Moments, Lateral force V/S Slip Angle, Aligning Torque V/S Slip Angle, Tyre Construction, Tractive Properties, Cornering Properties, Camber Thrust, Aligning Moment, Combined braking and Cornering, Conicity and Ply Steer, Tire Vibration, Tyre Properties affecting Vehicle Roll over, Introduction to Magic Tyre Formula, Tyre testing on various road surfaces	6
3	**Suspension** Solid Axles, Independent suspensions, Variable Rate Leaf Spring., Anti Squat and Anti Pitch Suspension Geometry, Anti Dive Suspension Geometry, Equalizing Suspension, Roll Centre Analysis, Motion Analysis of Wheel Suspension, semi active and Active Suspensions, Introduction about control theory applied to Suspension systems	8
4	**Vertical Dynamics** Lumped mass, Equation of Simple Spring Mass System with to degrees of freedom system, pitch and bounce motion frequencies, Conjugate Points, Elastic, Dynamic, doubly Conjugate Points, Calculation of Conjugate Points Sources for vehicle vibration, vibration isolation, Effects of damping the vibration, vibration absorbers.	10
5	**Lateral Dynamics** Steering geometry, Front wheel geometry, Steering system forces and moments, Steering system effects, Influence of front wheel drive, four wheel steering, Suspension effect of cornering, High speed cornering, understeer, oversteer, Jack Knifing of articulated vehicles, Introduction about control theory applied to Lateral dynamics	6

6	**Recent Trends in Vehicle dynamics** Vehicle dynamic Control (ESP and active steering), Actuators, Sensors for Automobile Control, Sensors for Detecting Vehicle Environment, Central Tyre Inflation system.	4

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 syllabus.

Text Books:

1. Gillespie T.D, ―Fundamentals of Vehicle Dynamics‖, SAE USA 1992
2. Giri N.K – Automotive Mechanics, Khanna Publishers, 2007.
3. Colin Campbell - Automobile Suspension and Handling
4. William F Milliken and Douglas L Milliken - Race Car Vehicle Dynamics
5. Konrad Reif Ed. – Automotive Mechatronics Bosch Professional Automotive Information, Springer

Reference Books:

1. J. Y. Wong, ―Theory of Ground Vehicles‖, 3rd ed., John Willey & Sons, New York, 1997.
2. Hans B, Pacejka - Tyre and Vehicle Dynamics - SAE Publication – 2002
3. Vehicle Dynamics Theory and application – Reza Jazar, Springer
4. Heinz Heisler, ―Advanced Vehicle Technology ―, 2nd Edition, Butterworth-Heinemann, 2002
5. Rajesh Rajamani ―Vehicle Dynamics and Control
6. Road and Off-Road Vehicle system Dynamics. Hand Book
7. Mechanics of Road Vehicle, Steeds
8. Car Suspension: Bastow

Links for online NPTEL/ SWAYAM courses: https://nptel.ac.in/courses/107/106/107106080/

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Course Code	Course Name	Credits
IL 470	**Digital Business Management and Digital Marketing**	**3**

Course Objectives:

1. To familiarize with digital business concepts.
2. To acquaint oneself with E-commerce.
3. To give insights into E-business and its strategies.
4. To understand digital marketing plans.

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

1. Identify drivers of digital business.
2. Illustrate various approaches and techniques for E-business and management.
3. Prepare an E-business plan.
4. Develop a digital marketing plan.

Module	Detail Content	Hrs.
1	Introduction to E-Business, Making Functional Areas E-Business Enabled : Value chain and supply chain, inter and intra organizational business processes, ERP	6
2	Making Functional Areas E-Business Enabled : E-marketing, E-Selling, E-Supply Chain Management, E-Procurement.	6
3	Technologies for E-Business: Internet and Web based system,Security and payment systems,Supply chain integration technologies: EDI, RFID, Sensors, IoT, GPS, GIS; Supply chain integration technologies: Web services and cloud.	8
4	Marketing concept, Coordinated marketing, Meta marketing, Holistic marketing dimensions, : Case Analysis, Case Discussion; Marketing Environment.	6
5	Marketing decisions, Customer delivered value, Buyer Behaviour, Input - output map, Case Discussion, Marketing Planning, Price, Distribution, Advertising and Promotion, Case Discussion.	8
6	Marketing mix, Product policy, New products, PLC, Marketing organization, Product Management.	5

Assessment:

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

Books/References:

1. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014.
2. Management Information Systems: Managing the Digital Firm, Laudon and Laudon, Pearson
3. Marketing Management- Analysis, Planning and Control, Prentice Hall,14th Edition, 2015

4. NPTEL Course on E-business; https://onlinecourses.nptel.ac.in/noc24_mg16/preview; Refer Week 1 and Week 2 for Module 1; Week 3 and Week 4 for Module 2; and Week 5, Week 6 and Week 7 for Module 3.
5. NPTEL Course on Integrated Marketing Management; https://onlinecourses.nptel.ac.in/noc24_mg27/preview
   Refer Week 1 and Week 2 for Module 4; Week 3 and Week 4 for Module 5; and Week 5, Week 6 and Week 7 for Module 6.

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Course Code	Course Name	Credits
IL 471	**Business Analytics**	**3**

Course Objectives: The course is aimed to

1. To understand the importance of business analytics .
2. To learn how to explore and summarize the data with statistical methods.
3. To study how to represent and process the data.
4. To provide hands-on experience with data visualization techniques and hypothesis testing.
5. Discuss the ethical implications of data privacy and security in business analytics.
6. Encourage critical thinking and problem-solving skills through practical applications.

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

1. Understand the fundamentals of business analytics.
2. Students will be able to evaluate the quality of data and its impact on analytical outcomes.
3. Apply statistical techniques to analyze data
4. Creation of informative data visualizations and draw meaningful conclusions from testing.
5. Demonstrate ethical decision-making skills when faced with ethical dilemmas in business
   analytics.
6. Apply analytical techniques learned throughout the course to solve real-world business
   problems.

Module	Detail Content	Hrs.
1	**Introduction to Business Analytics** : Definition, scope and importance of business analytics, introduction to business planning, types of plans, levels of planning, overview of analytical tools and techniques.	3
2	**Exploring Data:** Introduction to different types of data (structured, semi-structured, and unstructured data). Extract, transform and load (ETL) data - ETL fundamentals, data extraction, data transformation, data mapping and Conversion. descriptive statistics measure of central tendency (mean, median, mode) and dispersion (variance, standard deviation), probability theory, conditional probability and bayes' theorem, random variables and probability distributions: discrete (binomial, poisson) and continuous (normal, exponential) distributions.	7
3	**Statistical Analysis:** Business analytics with excel: importance of excel functionalities, analysis with pivot tables, dashboard creation. Statistical analysis with Python, correlation and regression analysis, time series analysis.	6
4	**Data visualization and Hypothesis testing:** Principles of effective data visualization, tableau for business Intelligence- tableau workspace and types of charts, data preparation and chart creation, filters and analytics in Tableau, tableau dashboards.	10

	Understanding UML diagrams, UMLtools for Business process analysis BPMN (Business Process Model and Notation) in business process Analysis, BPMN diagrams. Null and alternative hypotheses: Formulating hypotheses for testing (anova, chi-square tests, t-tests).	
5	**Ethical considerations in Business Analytics:** Privacy, security and confidentiality of data, bias and fairness of data, Types of biases (sampling bias, selection bias, algorithmic bias) and their impact on analytics, strategies for detecting and mitigating biases in data, transparency and Accountability of data.	5
6	**Application and case studies:** Real-world case studies in various industries (e.g., Customer segmentation and targeting, Market forecasting, Social media analytics, Fraud detection, Demand forecasting, Customer churn analysis etc.) Application of analytics techniques to solve business problems	8

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books and References:

1. Business Analytics: A Practitioner's Guide" by Sandhya Kuruganti and Ram Ramesh
2. "Business Analytics: Data Analysis and Decision Making" by S. Christian Albright and
   Wayne L. Winston
3. "Business Analytics: The Science of Data-Driven Decision Making" by U Dinesh Kumar
4. Ethical Data and Information Management: Concepts, Tools, and Methods" by Katherine
   O'Keefe
5. “Princip and Practice of Management”, by J.S. Chandan, SK Mandal, Vikas Publishing
   House.
6. “Business Analytics”, by Dr. Mohd Imran Khan, Published By : Lovely Professional University.

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Course Code	Course Name	Credits
IL 472	**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 Cooperation 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 license, 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 license 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, Non-Patentable Subject Matters, Types of Applications, and Powers of Controllers. Section 25 - Section 66 of the Indian Patent Act, 1970 with	9

	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
End Semester Examination: 60 Marks

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 473	**Biomechanics**	**3**

Course Objectives:

1. Introduce basic biomechanical terminologies and principles relevant to the human body.
2. Analyze the kinematics and forces acting on muscles and joints using free-body diagrams.
3. Perform biomechanical assessments of the upper and lower limb joints to understand movement mechanics.
4. Examine the mechanical properties of hard and soft tissues and their implications for human movement.

Course Outcome: Students will be able to

1. Accurately define key biomechanical terms.
2. Effectively create and interpret free-body diagrams for joint analysis.
3. Analyze joint mechanics in the upper limb and lower limb, identifying critical forces.
4. Apply gait analysis principles to differentiate between healthy and pathological movement patterns.
5. Explain the mechanical properties of hard tissues and their relevance to biomechanics.
6. Examine biofluid mechanics and blood flow dynamics in the cardiovascular system.

Module	Detail Content	Hrs.
1	**Introduction:** Introductory Mechanics – Statics and Dynamics – Basic Principles. The human body as a biomechanical system – basic terminologies	6
2	**Joint Mechanics:** Kinematics of muscles and joints - free-body diagrams and equilibrium, forces and stresses in joints Biomechanical analysis of joints of upper limb - Shoulder, Elbow, wrist, hand and fingers	7
3	**Analysis of Joints:** Upper limb as a mechanical system – analysis of reaching as movement of a multi-link serial chain – forward kinematics, analysis of fingertip forces as a parallel manipulator Biomechanical analysis of joints – Spine, Hip, Knee, Ankle.	7
4	**Gait Analysis:** Introduction to Postural stability and Gait analysis. Gait analysis in health and disease - basics.	6
5	**Tissue Mechanics:** Mechanics of Hard Tissues - Definition of Stress and Strain, Deformation Mechanics, structure and mechanical properties of bone - cortical and cancellous bones, Wolff's law of bone remodeling; Soft Tissues - Structure, functions, material properties – tendon function, elasticity in a tendon, models of non-linear elasticity in a tendon – physiological and non-physiological regimes, Davis' law of soft tissue remodeling.	7

6	**Biofluid mechanics:** Visco-elastic properties of soft tissues, Models of visco-elasticity: Maxwell & Voight models. Basic Biofluid mechanics - Flow properties of blood in the intact human cardiovascular system.	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. David A. Winter, Biomechanics and Motor Control of Human Movement .
2. Margareta Nordin and Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System.
3. Francisco Valero-Cuevas, Fundamentals of Neuromechanics.
4. Susan Hall, Basic Biomechanics.
5. Irving Hermann, Physics of Human Body.

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Course Code	Course Name	Credits
IL 474	**Medical Image Processing**	**3**

Course Objectives:

1. To introduce the learners to the basic theory of digital image processing.
2. To expose learners to various available techniques and possibilities of this field.
3. To prepare learners to formulate solutions to general image processing problems.

Course Outcomes: Learner will be able to

1. Record, extract and analyse key information about teeth, muscles, bones etc
2. Acquire the fundamental concepts of a digital image processing
3. Analyze images in the spatial and frequency domain.

Module	Detail Content	Hrs.
1	**Medical Imaging Systems:** Properties, advantages and disadvantages of X-rays based imaging systems, Magnetic Resonance Imaging (MRI) imaging, Gamma-rays based imaging systems, Positron emission tomography (PET), Single-photon emission computerized tomography (SPECT) scan, Computed Tomography (CT) scan, Ultrasound (sonography), Endoscopy, and Thermography based imaging systems. Difference between different medical imaging systems. Nature of Biomedical images, Objectives of biomedical image analysis, Difficulties in biomedical image acquisition and analysis.	7
2	**Medical Imaging Toolkits:** ImageJ (and/or FIJI), ITK-Snap, SimpleITK, MITK, FreeSurfer, SLICER, OsiriX. Image Formats: dicom (.dcm), Nifti (.nii), Minc (.mnc), Analyze (img/hdr), Raw (.raw), MHD (.mhd) and MHA (.mha)	5
3	**Medical Image Detection and Recognition:** Medical image parsing, Deep Learning for Medical Image Recognition, Automatic Interpretation of Carotid Intima–Media Using Convolutional Neural Networks, Deep Cascaded Networks for Sparsely Distributed Object Detection, Deep Voting and Structured Regression for Microscopy Image Analysis.	6
4	**Medical Image Registration:** Intensity-based methods, Cost functions - correlation, least squares, mutual information, robust estimators. Optimization techniques - fixed-point iteration, gradient descent, Nelder-Mead simplex method. MRI motion compensation, Convolutional Neural Network for Robust and Real-Time 2-D Registration.	6
5	**Medical Image Segmentation Networks:** Comparative study and analysis of U-Net family of segmentation: U-Net, V-Net, 3D U-Net, H-DenseUNet, GP-Unet, UNet++, MDU-Net, DUNet, RA-UNet, nnU-Net, SUNet, IVD-Net, LADDERNET, Attention U-Net, R2U-Net, MultiResUNet, U-NetPlus, CE-Net, CIA-Net, U2-Net, ScleraSegNet, AHCNet, MFP-Unet, ResUNet-a, RAUNet, 3D U2-Net, SegNAS3D, U^2-Net, UNET 3+.	9
6	**Deep Learning for Healthcare:** Deep learning for different healthcare applications: Diabetic Retinopathy, Knee Osteoarthritis, Histological and Microscopic Elements Detection, Gastrointestinal Diseases Detection, Cardiac Imaging. Lesion detection: Brain tumor detection, prostate lesion detection, Lung nodule detection.	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. W. Birkfellner, Applied Medical Image Processing: A Basic Course, CRC Press , Second Edition, 2014
2. I. Bankman, Handbook of Medical Image Processing and Analysis, Academic Press , Second Edition, 2008
3. Rangaraj M. Rangayyan, “Biomedical Image Analysis”, CRC Press, 2000.
4. Zhou et al “Deep learning for Medical image analysis” Elsevier 2018.
5. R. C. Gonzalez, Digital Image Processing, Pearson Education India , Third Edition, 2013
6. S. Jayaraman, T. Veerakumar, S. Esakkirajan, Digital Image Processing, McGraw Hill Education , 2017
7. A K Jain, “Fundamental of Digital Image Processing”, Prentice Hall, 2002.

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Course Code	Course Name	Credits
IL 475	**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.	6
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.	6
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).	8
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.	8

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	6
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.	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

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 476	**Technologies for Rural Development**	**3**

Course Objectives:

1. To understand the concept of rural technology
2. To understand the characteristics of rural resources and its importance in Rural Development.
3. To understand various technologies required for Rural Development
4. Rural planning and implementation of rural development projects
5. To generate awareness regarding government policies (monitoring and documentation).

Course Outcomes: Learner will be able to

1. Understand various natural resources and their importance in rural development.
2. Get exposure to various challenges and problems with regard to availability and use of natural resources.
3. Develop and implement various technologies for rural development
4. Explore various schemes for rural development

Module	Detail Content	Hrs.
1	**Rural Resources-** Understanding the Characteristics and nature of Rural Recourses Importance of different resources in Rural Development. Natural resource management(NRM)	3
2	**Concept of Information and Communication Technologies (ICT's) in Rural Development-** Evolution of ICT's, Communication Functions of ICT's, Nature and Scope of ICT's, Information Haves and Information Have Nots in the Rural Areas, Strengths and Weaknesses of ICT's in Rural India, Application of ICT's for Rural Development in India, Satellite Communication support for Rural Development, Telecommunication support for Rural Development, Computer Communication support for Rural Development	6
3	**Management Information System for Rural Development in India** Basic concepts Role of MIS in the management of agricultural extension programmes Design of a MIS in an agricultural extension organization Need for automation ,Organization of a database Networking and interactive processing , End-user computing Illustrative computer-based MIS , Rural Energy system	8
4	**The Role of Rural Technology** – Global approach in Innovative Rural technology Innovative technologies in Production and Postharvest management, Innovation in productivity and Sustainable management(Bio fertilizer) Innovation Commercial Production Technologies Technology for Rural Women, difficulties in adoption of rural technology.	6

5	**Globalisation of Rural Economy-** Globalisation and aims and objectives; Impact of Globalisation on rural economy, Design and Innovation in Integrated Rural Health Management, SEZ's and Agriculture. Agricultural value chain	4
6	**Government Schemes and initiatives-** Various government schemes**,** participation of various Stake holders for development and Protection of Rural resources	3

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Rural Resource Management: A Geographical Perspective by Paul Cloke (Author), C. Park
2. Rural Development: Principles, Policies and Management, Katar Singh, Sage Publications India Pvt. Ltd., 2009
3. Mosse, D., & Cooke, B. (2001). People's knowledge, participation and patronage: Operations and Representations in Rural Development.
4. ICTs: Digital Opportunities in Agricultural Extension, Dipaj De Basavaprabhu Jirli Shaik N. Meer
5. S.S. Singh., Principles and Practices of Agronomy. 1985. Kalyani Publishers, Ludhiana
6. Indian Economy by Datt, Rudra & Sundharam, New Delhi: S. Chand, 2008.
7. W.T.O and Indian Economy by Deogirikar, A. B. Jaipur: Shri Niwas Publications, 2004
8. S.S. Singh., Principles and Practices of Agronomy. 1985. Kalyani Publishers, Ludhiana
9. Indian Economy by Datt, Rudra & Sundharam, New Delhi: S. Chand, 2008.
10. W.T.O and Indian Economy by Deogirikar, A. B. Jaipur: Shri Niwas Publications, 2004
11. Maheshwari, S. (1985). Rural development in India: A Public Policy Approach. SAGE Publications Pvt. Limited.
12. Indian Economy by Datt, Rudra & Sundharam, New Delhi: S. Chand, 2008.
13. Government of India, "Various Five-Year Plans (1st to 12th)" Planning Commission, New Delhi

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Course Code	Course Name	Credits
IL 477	**Economics**	**3**

Course Objectives:

1. Provide a good grounding in the basic concepts of Micro and Macroeconomics.
2. Familiarize learners with concept of demand, supply, price, income and equilibrium.
3. Teach students to represent Indifference curve in regular as well as in exceptional cases with respect to consumer behaviour, consumer preferences and Risk Aversion.
4. To inculcate the skills required to understand the concept of Production function with single and two variable inputs.
5. To create an awareness of the different market structures and its impact on the price and output of a product.
6. To prepare the learners in understanding the Keynesian System of Money, Interest and Income and its impact in society with respect to Inflation.

Course Outcomes: Learner will be able to

1. Acquire conceptual and theoretical knowledge of Micro and Macroeconomics and learn to think critically about issues and topics of the subject.
2. Demonstrate the understanding of the concepts of demand, supply, price, income and equilibrium and relate it to the existing scenario in the society.
3. Perform successfully in representing the Indifference curve in relation to the prevalent consumer behaviour and consumer preferences.
4. Illustrate the skills required for maximising output and minimising cost for effective production.
5. Determine the importance of the existence of different market structures and its impact in society.
6. Develop an understanding of the Keynesian System of Money, Interest and Income and formulate anti- inflationary policies.

Module	Detail Content	Hrs.
1	Introduction to Micro and Macro Economics	5
2	Demand & Supply: Concept of demand & supply functions, Price, Income & Cross elasticities of demand, Elasticity of Supply, Market demand functions, Concept of equilibrium, Impact of changes in demand & supply on equilibrium	7
3	Theory of Consumer Behaviour: Concept of cardinal and ordinal utility, consumer's equilibrium, Consumer's preferences, Risk Aversion and Indifference Curve Analysis, & its properties, Shapes of Indifference Curves in exceptional cases	7
4	The Theory of Production: Concept of Production function, Production with a single variable input, Production with two variable inputs, Optimal input combination, Constrained output maximization, Cost minimization, Elasticity of substitution	6
5	Theory of Cost: Different concept of cost, Short-run and Long- run cost analysis, modern concept. Market Structures a. Perfect Competition Short-run and long-run equilibrium of the firm and Industry, Stability of equilibrium, Concept of imperfect competition; short run and long run price and output decisions of a monopoly firm; concept of a supply curve under monopoly; comparison of perfect competition and monopoly,	4
6	The Keynesian System: Money, Interest and Income Money in the Keynesian theory, Interest Rate Determination (Liquidity Preference Theory), Money Market, Bond market and Commodity Market,	7

	Monetary policies and fiscal policies, Inflation and Unemployment Inflation, Role and Effects of inflation, Anti- inflationary policies	

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Reference Books:

1. Dr. Samwel Nyagucha Ores. (2019). *Micro and Macro Economics: Understanding the Basics of Economics*. New Generation Publishing.
2. Daron Acemoglu and James A. Robinson. (2013). *Why Nations Fail: The Origins of Power, Prosperity and Poverty*. Profile Books

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Course Code	Course Name	Credits
IL 478	**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

Assessment:

Internal Assessment: 40 marks
End Semester Examination: 60 Marks

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 479	**Operation Research for Management**	**3**

Course Objectives: The course is aimed

1. To acquaint the students with basics of Operation Research.
2. To learn the different Linear Programming methods.
3. To make the students aware of the topic "sensitivity Analysis"
4. To learn the different methods of solving Transportation & Assignment Problems.
5. To Understand sequencing Models & related Problems.
6. To explore the different methods used in Game Theory.

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

1. The basic concepts of Operation Research to solve optimization problems..
2. The different Linear Programming methods to solve Problems.
3. The understanding of Linear Programming to sensitivity analysis.
4. The different methods to solve Transportation & assignment Problems.
5. The concept of sequencing models to related problems.
6. The understanding of Game Theory and solve related Problems.

Detailed Theory Syllabus:

Module	Detailed Contents	Hrs.
1	**Introduction to Operation Research:** Canonical & standard form of a Linear Programming Problem, Simplex method , multiple solutions of L.P.P, Infeasible solution & unbounded solution	6
2	**Linear Programming Model:** Artificial variables , Big M-penalty method , Duality in Linear Programing, dual simplex method, revised simplex method.	8
3	**Sensitivity Analysis:** Changes in the right handside of the constraint equations ' b_i' changes in the cost coefficients 'c_j' changes in the coefficients of the constraints 'a_{ij}'.	6
4	**Transportation & Assignment Problems:** NorthWest Corner method , Vogel's approximation method, Hungarian method, maximization problem, unbalanced transportation problem	8
5	**Sequencing models & related Problems:** Processing n-jobs on two machines , processing n-jobs on m-machines	6
6	**Game Theory :** Two – person zero sum game with & without saddle points, solution of mixed strategy ganmes , Matrix reduction by dominance.	5

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books and References:

1. Operations Research : Prem Kumar Gupta , D.S.Hira ; S. Chand & company Ltd.
2. Operations Research ; An Introduction : Hamdy .A.Taha ; Prentice Hall of India
3. Introduction to Operation Research : Frederick.S.Hillier,Gerald.J.Lieberman McGraw Hill Education (India) Private Ltd.
4. Operation Research : R. Paneerselvan, PHI Learning Private Ltd.

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Course Code	Course Name	Credits
IL 480	**Weather and Climate Informatics**	**3**

Course Objectives:

1. To promote the safety, health, and welfare of people and the environment through engineering professionals.
2. To encourage students to be productive and contributing members of the environmental profession as practitioners, entrepreneurs, researchers, or teachers.
3. To develop environmental awareness among students that meet specified engineering needs with consideration of public health, safety, and welfare, as well as global, environmental, and legal factors.

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

1. Present the international climate change legal and policy framework and explain key issues under negotiation.
2. Describe the expected consequences of climate change and the role of adaptation.
3. Provide a rationale for climate change mitigation and propose actions in key sectors.
4. Identify main streams of climate change finance.
5. Outline basic elements of planning processes to deliver climate change action.
6. Analyse principal challenges and opportunities for climate change action.

Module	Detailed Contents	Hrs
1	**Introduction to Climate Change Science:** An overview of key concepts such as climate, weather and the greenhouse gas effect. Human contribution to climate change and provides an overview of important greenhouse gases and their main sources. The main observed changes in the climate since the industrial revolution. Future trends and impacts of climate change on surface temperature, ocean pH, and sea-level.	5
2	**Introduction to the International Legal and Policy Framework to address Climate Change:** An overview of the international legal and policy framework to address climate change. Brief history of international climate change negotiations and introduces the United Nations Framework Convention on Climate Change (UNFCCC). Key provisions of the UNFCCC, its organisational structure, and different Party groups under the Convention. The Kyoto Protocol and its associated bodies.	6
3	**ICT Trends and their Implications for Tackling Climate Change:** Information Needs in Adaptation and Mitigation, Communication on Climate Change, Scope and Definition of ICTs, ICT Trends and their Implications for Tackling Climate Change, e-Waste and Recycling ,Green Computing	6
4	**Weather and Climate Informatics:**	5

	Climate Change and Climate Modelling: Global environmental issues in climate change due to human activities or natural climate variations. Understanding and Using Climate Data, The Climate data analysis, Seasonal Climate Forecasting, Climate Extremes, Uncertainty, and Impacts	
5	**Data Challenges and Opportunities in Climate Informatics**: Issues with Cross-Class Comparisons, Climate System Complexity. Challenge: Cloud-Computing-Based Reproducible Climate Data Analysis	4
6	LAB WORK or Case Study Software Lab: Introduction to basic data analysis tools. Survey of numerical methods employed in atmospheric and related sciences: theory, application, and programming. OR Report on a Case study	4

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G.Oakwell, Edward Elgar Publishing
3. Environmental Management, V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000

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Course Code	Course Name	Credits
IL 481	**Maintenance of Mechanical Equipment**	**3**

Lab Objectives:

1. To understand use of different types of hand tools, importance of right tool for right job.
2. To understand .importance of preventive and breakdown maintenance,industrial safety
3. Understand assembly of lathe cross slide, spindle.
4. Understand Plumbing tools and pipe fitting minor domestic jobs.
5. To make aware about Importance of work skill in maintenance, also about related electrical, chemical activities
6. Encourage & create start up in maintenance and reconditioning field

Outcomes: Learner will be able to…

1. Know the use of various tools and equipment used in maintenance
2. Know, how to apply particular strategy, scheduling, planning of maintenance
3. Develop student for a start-up activity.

Module	Detailed Contents	Hrs
1	Need and role of maintenance in industry. Preventive and breakdown/shut down maintenance. Planning maintenance schedule, records, Spare parts, procuring & inventory control. In house spares making. (indigenous and import substitutes) Need of plant & process knowledge	4
2	Tools and equipment used in mechanical maintenance, (Torque wrench, Jacks and pullers spanners…. etc) their classification. Importance Selection of right tool for right job. Types of fits. Ball Bearings' classification Study of Related electrical equipments, starter switch,, motor, contactors ...etc	6
3	Lathe machine functioning demonstration with, making a simple job.	8
4	Dismantling and assembly of cross slide, tool post. Lathe spindle study	12
5	Domestic plumbing and other Various domestic, "Do it yourself type jobs. Eg. : Window and split air conditioner periodic cleaning, ceiling fan fitting, mixer repairing, curtain rod fitting on wall..etc.	6
6	Industrial safety. Rules and instructions for mechanical safety in industry and safety precautions related to domestic equipment. Risk assessment.	4

Assessment:

Internal Assessment: 40 marks

End Semester Examination: 60 marks

Books/References:

1. Maintenance Engineering – 1 December 2010 , Sushil Kumar Srivastava
2. Handbook for Mechanical Maintenance Engineers – 30 May 2020 , Gyani Mahato
3. Maintenance Engineering Dr. G.K. Vijayaraghavan, Dr. L. Govindarajan

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Course Code	Course Name	Credits
IL 482	**Physical Education**	**3**

Course Objectives:

1. To understand the components of Physical Fitness.
2. To understand the modern development and social aspects of physical education
3. To understand general troop games, recreational games and the importance of playing to achieve health & wellness.
4. To acquaint students with principles of nutrition and the application of human energy.
5. To understand the role of food in physical performance.
6. To understand the need for wellness & weight management.
7. To understand common sports injuries, first aid & their treatment.
8. To understand the application of Yoga in physical education & sports.
9. To enable the student to understand the basic structure & function of the human body and the effect of exercise on the body as a whole.

Course Outcomes: Learner will be able to

1. Maintain a health-enhancing level of fitness throughout the program as well as be able to collect and analyse personal fitness data.
2. Gain knowledge regarding the application of yoga to Physical Education and Sports
3. Understand the anatomy and Physiology of Asanas and Pranayamas.
4. Acquire the knowledge regarding the effect of exercise on the body as a whole
5. Develop an understanding of the concept of personality, factors affecting personality development
6. To understand proportional body weights and their management
7. To understand nutrition and balance diet

Module	Detail Content	Hrs.
1	**Physical Fitness** 1.1 Concept, definition and meaning of Physical fitness, activity and exercise 1.2 Component of Physical fitness, Benefit of Physical fitness & exercise. 1.3 Principles of physical fitness 1.4 Definition and concept of wellness and factors affecting Physical fitness & wellness 1.5 Concept and importance of physical conditioning, warming up and cooling down of all age groups	8
2	**Nutrition and Dietary Requirement** 2.1 Nutrition components and balanced diet 2.2 Meaning and definition of doping and ergogenic aids 2.3 Prevention and first-aid of common injuries during Physical training 2.4 Need of Energy, Carbohydrate and Protein 2.5 Concept training nutrition and competition nutrition	6
3	**Wellness, Weight management and Holistic health** 3.1 Meaning, concept and components of Wellness 3.2 Manipulation of energy balance to induce weight loss and weight gain 3.3 Methods of weight management 3.4 Concept, types and cause of obesity and its management. 3.5 Waist hip ratio, larger heart, BMI, calculation of Training Heart Rate	6
4	**Human body system, function and effect of exercise**	6

	4.1 Meaning and Importance of the study of Human anatomy in physical education & sports 4.2 Classification and functions of bones and joints 4.3 Movements of various joints 4.4 Structural classification of muscle, types of muscle and effect of exercise on the musculoskeletal system. 4.5 Structure and Effect of exercise on the cardiorespiratory system 4.6 Digestion and effect of exercise on the digestive system 4.7 Nervous system and effect of exercise on the nervous system.	
5	**Yoga and meditation** 5.1 Concept of Yoga and misconception about Yoga 5.2 Comparison of Physical Education exercise and Yogic exercise. 5.3 Meaning, Types and principles of Meditation 5.4 Principles governing various exercises in Yoga(Asana, Pranayam, Bandha, Mudra, Kriya) 5.5 Yoga for stress management and emotional stability 5.6 Application of Yoga in sports & physical education and effect of Yogic exercise on different systems of the human body.	8
6	**General & recreational troop games and its method of skill training** 6.1 The game soccer and its rules and regulation 6.2 The game Volleyball, Basketball and its rules and regulations 6.3 The Indoor games and their rules and regulations 6.4 Method of sports skill developing training 6.5Recreational games and their importance in day to day life	6

Assessment:

1. Term Papers (40 Marks):

Two theory papers will be conducted for 40 marks each with average marks of both papers as the final score. One hour theory paper as per the pattern of the semester-end examination will be conducted.

2. Projects/Assignments(30 Marks):

Project on Nutrition (10 Marks): The learner will be given one project on the calculation of Basel metabolic rate. He /she will submit the report of the same in a prescribed format based on which the learner will be evaluated for 10 marks by the concerned teacher/s

Projects/Assignment on Yoga education (10 Marks): The learner will be given an assignment on yoga education such as gathering/compiling the information about the various aspects of asanas and asking to prepare and submit the report of the same based on which the concerned subject teacher will give marks out of 10.

Assignments on Sports Injuries (10 Marks): The learner will be given two assignments on the specific sports injuries and their remedial aspects based on the report submitted in the prescribed format by him/her as well as observations, the concerned teacher/s will give marks out of 10.

3. Physical Activities(25 Marks):

a. To perform 8 Asanas in a group (10)
b. To perform one Pranayama and one Kriyas(5)
c. To perform any five exercises of Motor Fitness. (5)
d. To perform any five exercises of HRPF(5)

4. Trekking/ Hiking (05 Marks)- The learner should be provided experience of participating in the organization and the actual conduct of the co-curricular activities viz. Hiking/Trekking and the assessment of 05 marks should be done based on learners actual participation and involvement in the same.

Reference Books:

1. Padmakshan Padmanabhan 'Handbook of Health & Fitness', Indus Source; First edition, Indus Source Books, Wadala Mumbai. 2014.
2. Adams, William.C. 'Foundation of Physical Education Exercises and Sports Sciences', Lea and Febigor, Philadelphia, 1991.
3. Dr. Kamlesh M.L. 'Principles and History of Physical Education and Sports', Friends Publication (India) New Delhi, 2004
4. Bates M.'Health Fitness Management (2nd Ed.) USA : Human Kinetics.2008
5. Fink, H.H., Burgoon,L.A., & Mikesky. Practical Applications in Sports Nutrition. Canada : Jones and Bartlett Publishers. 2006.
6. Worthington, Vivian. History of Yoga. London : Routledge and Kegan Paul Ltd. 1982.
7. Rajan, M. Yoga Stretching and Relaxation for Sportsman. Delhi : Allied publishers. 1985.
8. Crouch James E. – Essential Human Anatomy A Text – Lea & Febriger , Philladalphia
9. Murgesh N. – Anatomy, Physiology and Health Education, Sathya, Chinnalapatti, 1990
10. Giam, C.K. Sport Medicine Exercise and Fitness. Singapore : P.G. Medical Book. 1994.

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Course Code	Course Name	Credits
IL 483	**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 built 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	8
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	6
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	Antilock braking system Electronic Stability Program Low tire pressure warning system Collision avoidance systems	5
6	Basic Vehicle Operations and Road/Helmet Safety Activity	6

Assessment:

Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

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
ME 491	**Major Project II**	**4**

Course Objectives:

1. To acquaint with the process of undertaking literature survey or market survey or feasibility study /industrial visit and identifying the problem
2. To familiarize the process of problem solving in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research

Course Outcomes: Learner will be able to

1. Do literature survey based on market or feasibility study/industrial visit and identify the problem.
2. Apply basic engineering fundamentals in the domain of practical applications
3. Cultivate the habit of working in a team
4. Attempt a problem solution in a right approach.
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare project report as per guidelines and with proper references/citations.
7. Exhibit and explain project ideas/models at various platforms

Guidelines for Project

- Students should do literature survey/Market survey/ feasibility study/visit industry/analyze current trends and identify the problem for Project and finalize the project title in consultation with Guide/Supervisor.
- Students should use multiple literatures and understand the problem.
- Students should attempt a solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and report to be compiled in standard format.

Assessment:

Project II should be assessed based on following points

1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization / Industrial trends
4. Clarity of objectives and scope
5. Quality of work attempted
6. Validation of results using numerical/experimental & simulation techniques
7. Quality of Written, Oral Presentation & Question answer session.

Project Report has to be prepared strictly as per report writing guidelines.

Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the BoS of the Department.

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Course Code	Course Name	Credits
ME 417	**Personal Financial Management**	**2**

C**ourse Objectives**: The course is aimed

1. To introduce the basic concepts of finance and their practical application.
2. To demonstrate the process of drafting a financial budget.
3. To explain investment avenues and planning of personal finance.
4. To develop portfolio strategies for individual and institutional investor
5. To discuss various components of insurance and tax management.
6. To introduce financial frauds, measures to avoid frauds and resources of frauds.

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

1. To know the basic concepts of finance and interpret current business positions by reading books of accounts.
2. To analyze investment avenues and plan personal finance to develop portfolio strategies for individuals.
3. To Develop skills to interpret current market position.
4. To Create analytical approach for financial decisions.
5. To learn and understand Tax and Insurance management.
6. To identify financial frauds and understand the level of financial aspects.

Detailed Theory Syllabus:

Module No	Module	Detailed Contents of Module	Hrs.
1	Introduction to Personal Financial Planning	Financial Planning Process: Goal, Vision and mission , Components of Personal Financial Plan, Advantages and developing personal financial plan	3
2	Financial Budget	Meaning and Process of Drafting Financial Budget,Components of Financial Budget,Drafting Financial Budget	3
3	Investment Management	Meaning of Investment,Concept of Risk and Return and Time Value of Money,Investment Avenues,Portfolio Creation and Management	6
4	Insurance and Spending Management	Components of Insurance: Life Insurance, Health Insurance, Property Insurance, Spending Management	3
5	Tax Management	Introduction to Tax Regime and Tax Returns,Introduction to Income Tax and its impact on Incomes ,Tax on property: Revenue and Capital Incomes,Tax Management, Tax Saving, Tax Avoidance	3
6	Financial Frauds	Meaning and Types of Fraud,Investment Frauds, Online Payment Frauds, Identity Theft, Mass Marketing Fraud ,Measures to avoid frauds,Recourse from frauds,Cases of Frauds	6

Theory Assessment:
Internal Assessment: 20 marks
Consisting of Two compulsory internal assessments 20 Marks each. The final marks will be the average score of both the assessments.
End Semester Examination: 40 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 and References:

1. Financial Management: I M Pandey, Vikas Publishing House.
2. Financial Management: M.Y. Khan, P.K. Jain, Tata McGraw Hill.
3. Financial Management: Prassana Chandra, Prentice Hall.
4. Investment Analysis & Portfolio Management- Prasanna Chandra, Tata McGrawHill
5. Wealth Management- Dun & Bradstreet, Tata McGrawHill
6. Wealth Management- S. K. Bagachi, Jaico publishing house

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Course Code	Course Name	Credits
ME 418	**Characterization Techniques**	**3**

Prerequisites:

1. Knowledge of Engineering Materials, Metallurgy and basic science skills

Course Objectives:

1. To introduce the students to the principles of optical and electron microscopy
2. To familiarize students with material characterization techniques and its importance.
3. To get exposure with various techniques of characterization and interpretation of results including standards etc

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

1. Explain importance & Classification of Characterization Techniques.
2. Describe use of Vacuum systems in Material Characterization techniques.
3. Explain working of Thermal Analysis techniques.
4. Describe the principal and methods of different optical microscopy techniques for observation of Microstructure.
5. Describe the principal and methods of different electron and atom microscopy techniques.
6. Explain Chemical & Elemental Analysis for a given engineering application.
7. Explain identification techniques of crystal structure, lattice parameter & crystallite size of different materials using X-ray diffraction.
8. Demonstrate the ability to use the core concepts of engineering application for Material characterization techniques

Module	Detail Content	Hrs.
1.	Importance and need of Material characterization, Classification of techniques for characterization and available techniques	2
2.	**Electron microscopy:** Electron beam. Principle, Construction and Working of TEM, SEM, STEM, with their merits, limitations and applications.	3
3.	**Atomic Microscopy and Surface Analysis**- Field Ion Microscope, Working of AFM and STM with their merits, limitations and applications.	3
4.	**Spectroscopic Techniques for chemical analysis:**, UV-Visual(UV-VIS), IR, FTIR, EDS & WDS, X-ray Fluoroscopy (XRF), Atomic absorption spectrometer(AAS), Atomic Emission spectroscopy (AES). Secondary Ion mass spectrometry (SIMS), Rutherford backscattering spectroscopy (RBS)	6
5.	**Diffraction method**: Fundamental crystallography, Bragg's Law, X-ray diffraction methods,Electron diffraction, determination of crystal structure, lattice parameter, crystallite size, merits and demerits Generation and detection of X-rays	5
6.	**Thermal Analysis**- Techniques, Principle, Working and application of DTA, TGA, TMA and DSC.	5

Laboratory Syllabus:

Module	Details	Hrs.
1.	To Study Differential scanning calorimetry technique.	1
2.	To study Thermogravimetric Analysis for oxidation rate measurement.	1
3.	To analyze the microstructure and measure the grain size using an image analyzer.	1
4.	To study the diffraction pattern using powder diffraction pattern and to predict the lattice parameter and structure of crystal.	1
5.	Analyzing AFM SEM and STM data	1
6.	Collection and Study of various samples of coated & surface treated-materials, new alloys etc.	1

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. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).
2. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction", Prentice-Hall, (2001)
3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009).
4. Encyclopedia of Materials Characterization, Surfaces, Interfaces, Thin Films. Editors C. Richard Brundle, Charles A. Evans, Jr., Shaun Wilson, Butterworth-Heinemann, Boston, USA
5. An Introduction to Materials Characterization by P. R. Khangaonkar, Penram International Publishing (India) Pvt. Ltd.
6. D. A. Skoog, F. James Leary and T. A. Nieman, Principles of Instrumental Analysis, Fifth Edition, Saunders Publishing Co., 1998
7. Y. Leng, "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods", Second Edition, Wiely-VCH, 2013
8. K.P. Menard, "Dynamic Mechanical Analysis; A Practical Introduction", CRC Press, Boca Raton, 1999. 4. S. Zhang, L. Li and A. Kumar, "Materials Characterization Techniques", CRC Press, Boca Raton, 2008
9. Whan R E (Ed), ASM Handbook, Volume 10, Materials Characterisation, Ninth Edition, ASM international, USA, 1986.

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Course Code	Course Name	Credits
ME 419	**Processing and Testing of Materials**	**3**

Prerequisites:

1. Engg Chemistry
2. Materials and Metallurgy

Course Objectives:

1. To make students aware of the shaping technologies for different classes of materials
2. To understand the mechanical testing requirements of materials
3. To make the students know the importance of various tests and interpretation of the results

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

1. To distinguish between the deforming abilities of metals, ceramics,composites and polymers
2. Differentiate between processing techniques and make good use of them
3. Test materials as per the specified standards having understanding of the requirements
4. Understand new techniques for testing of materials
5. Develop objects by processing of polymers/composites/ceramics
6. Synthesis nanomaterials and do their testing

Theory Syllabus:

Module	Detail Content	Hrs.
1.	Conventional Metal Forming Processes-Hot and Cold working operations-Forging,Casting, Rolling, Extrusion	4
2.	Processing of Polymers -Compression moulding, Injection moulding,rotational moulding,blow moulding,Recycling of polymer-recent trends	5
3.	Processing of Ceramics and Composites-powder metallurgy route, tape casting, slurry casting, layup method,Resin transfer moulding, Vacuum bagging ,pultrusion, tube rolling,Vacuum assisted Resin transfer moulding	7
4.	Nanoindentation technique to test and measure material properties,thickness measurements using interference,contact angles measurements from high resolution images	4
5.	Testing of Metals-ASTM standards for Tension, Compression, shear, Flexure testing.Hardness tests, impact tests, torsional, fatigue test,Testing procedures for ceramics and composites - ASTMD standard	7
6.	Nanomaterials synthesis and testing-sol gel process, inert gas condensation,plasma vapor deposition and chemical vapor deposition	6

Lab Syllabus:

Module	Details	Hrs.
1.	Processing of Polymers -Compression moulding/ Injection moulding/casting	2
2.	Processing of Ceramics and its testing	2
3.	Processing of Composites and its testing	2
4.	Non Destructive Testing of materials	2
5.	Solgel synthesis of nanomaterial	4
6.	Laser texturing of metals	2

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 Materials -Processing and Testing Technology (https://main.scientific.net/book/advanced-materials-processing-and-testing-technology/978-3-0357-3623-6/ebook)
2. Composite Materials Design and Testing, Stephen W. Tsai, Jose Daniel D. Melo
3. Advanced Materials Processing and Manufacturing,Yogesh Jaluria Springer)|2018|
4. Materials: Engineering, Science, Processing and Design, MF Ashby
5. Testing of Materials, John Vernon,Springer

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Course Code	Course Name	Credits
ME 420	**Tool Engineering**	**3**

Course Objectives:

1. To familiarize with the sheet metal working techniques for design of press tools.
2. To acquaint with the various press working operations for mass production of sheet metal components
3. To develop capability to design jigs and fixtures.
4. To familiarize with the capabilities of designing a simple productive and cost effective jigs and fixtures
5. To understand the design aspects of moulding dies and cutting tools.

Course Outcome: Learner will be able to.

1. Understand the basic concepts and principles of press tools.
2. Design the press tools for the various sheet metal operations
3. Design and develop simple productive and cost effective jigs and fixtures
4. Understand the moulding process and be able to design injection moulds for plastic components.
5. Design single and multipoint cutting tools

Module	Detail Content	Hrs.
1	**Sheet Metal Processing:** Basic Types of Press Working Operations and Equipment: General classification and components of Press Tools. Dies and Punches: Elements of Dies and Punch set. Types of dies – simple, compound, combination and progressive dies and punches of various press working operations such as punching, blanking, drawing, bending, forming, coining, Fine Blanking Burr free blanking etc. Design of Blanking die, Progressive die, Calculations of clearances, center of pressure, different forces, press tonnage, strip layout, sheet utilization ratio, methods of reducing forces.	08
2	**Drawing and Bending dies:** Design of Shallow & Deep drawing die, Calculation of blank size, number of draws, drawing force, press capacity, ironing & ironing force, Types of Bending dies, various methods used to overcome spring back, Calculation of total bend length and calculation of various forces.	06
3	**Design of Jigs and Fixtures**: Need for jigs and fixtures, elements of Jigs and fixtures, principles of location, design of locating elements, locating pins support pins spring back, vee blocks, etc. principles of clamping simple hand operated clamps, like screw clamp, lever clamps and other types of clamps. Drill bushes-their types and applications indexing devices, auxiliary elements. Design of drill jigs like plate, leaf solid and box types for drilling combined with reaming, spot facing etc. Design of milling fixtures such as plain, string, gang and indexing types. Design of turning fixtures.	10
4	**Plastics Injection Mold Design:** Introduction of compression and transfer moulding process, Study of Injection and blow moulding process; - machine specifications, moulding cycle. Mould Design – Design of simple two plate injection moulds. Design of simple blow moulds for articles like bottles, cans, etc. Study of types of ejectors, gates, runner's, Study of cooling systems and heat transfer consideration. Calculation of no. of cavities, Mould opening force, ejection force etc. Basic concepts of mold standardization and innovative mold	08

	components.	
5	**Design of single point cutting tools:** Different systems of tool nomenclature like MRS, ORS and NRS. Interrelationship among different systems of nomenclature for tool angles. Constructional features of solid tool, tipped tools, mechanically held regrind able insert type tools and throw away tip type tools. Design of shanks, cutting tip and chip breakers for HSS and Carbide tools. ISO coding system for tipped tools and tool holders.	06
6	**Design of Multi point cutting tools:** Various types such as flat form tool, tangential form tool, circular form tool, constructional details and fields of application. Profile design of flat and circular form tools. Broach nomenclature, design steps for circular pull type, key way and spline broaches. Design of face and peripheral milling cutters.	06

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.

Reference Books:

1. Cyrll Donaldson, George H.LeCain, V.C. Goold, “Tool Design”, Tata McGraw Hill Publishing Company Ltd., 2000, 3rdEdition.
2. *Jigs and Fixtures,* P H Joshi, McGraw Hill.
3. *Production Technology,* R C Patel & C G Gupte.
4. *Production Technology*, HMT, Tata Mc Graw Hill.
5. Vukota Boljanovic, “Sheet Metal Forming Processes And Die Design”, Industrial Press, New York, 2004.
6. *Introduction to Jigs and Tool design*, HA Kempster, Butterworth Heinemann Ltd.
7. *Manufacturing Process*, R A Lindberg, PHI India.
8. *Fundamentals of modern Manufacturing*, Fourth Edition, Mikell P Groover, John Wiley & Sons.
9. *Metals handbook*, Forming and Forging, Vol. 14, ASM.

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Course Code	Course Name	Credits
ME 421	**Additive Manufacturing**	**3**

Course Objectives:

1. To acquaint students with the fundamentals of Additive Manufacturing Technologies for various applications
2. To understand the process of conversion of part file into STL format.
3. To acquaint students with various Additive manufacturing processes of liquid based, powder based and solid based techniques.
4. To familiarize with the manufacturing procedure of a prototype using FDM technique.
5. To introduce the students to the mathematical models for AM

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

1. Illustrate the fundamentals of Additive Manufacturing Technologies for various applications.
2. Apply the methodology to produce the parts using SLA and SGC technologies
3. Select the appropriate material for AM processes
4. Understand the methodology to manufacture the products using LOM and FDM technologies and study their applications, advantages and case studies
5. Understand the methodology to manufacture the products using SLS and 3D Printing technologies and study their applications, advantages and case studies
6. Understand the modelling of AM processes

Module	Detail Content	Hrs.
1.	Introduction to prototyping fundamentals, historical development, advantages of AMT, AM process chain, 3D modelling, Data Conversion, and transmission, Checking and preparing, Building, Post processing, RP data formats, classification of AMT process, applications in various fields	06
2.	Materials used in AM, use of multiple materials, multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, structure property relationship, Grain structure and microstructure	06
3.	Liquid based systems: Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies.	08
4.	Solid based systems: Laminated object manufacturing(LOM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies, practical demonstration	08
5.	Powder Based Systems: Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Three dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, case studies.	08

6.	Mathematical models for AM, Selection of AM technologies using decision methods, AM process plan, Monitoring and control of defects, transformation.	06

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 syllabus.

Books/References:-

1. Ian Gibson, David W. Rosen and Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing, Springer, 2010.
2. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: Principles and applications, 3rd Edition, World Scientific, 2010.
3. D.T. Pham and S.S. Dimov, “Rapid Manufacturing”, Springer, 2001
4. Terry Wohlers, “ Wholers Report 2000”, Wohlers Associates, 2000
5. Paul F. Jacobs, “ Rapid Prototyping and Manufacturing”–, ASME Press, 1996
6. Ian Gibson, Davin Rosen, Brent Stucker “Additive Manufacturing Technologies, Springer, 2nd Ed, 2014.
7. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.
8. J.D. Majumdar and I. Manna, Laser-assisted fabrication of materials, Springer Series in Material Science, e-ISBN: 978-3-642- 28359-8.
9. L. Lu, J. Fuh and Y.-S. Wong, Laser-induced materials and processes for rapid prototyping, Kluwer Academic Press, 2001.
10. Zhiqiang Fan and Frank Liou, Numerical modeling of the additive manufacturing (AM)
processes of titanium alloy, lnTech, 2012.

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Course Code	Course Name	Credits
ME 422	**Energy Audit and Management**	**3**

Course Objectives:

1. To impart basic knowledge to the students about current energy scenario, energy conservation, audit and management.
2. To inculcate among the students systematic knowledge and skill about assessing the energy efficiency, energy auditing and energy management.
3. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
4. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

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

1. To identify and describe the present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities.
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detail Content	Hrs.
1.	**Energy Scenario**: Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy and environment: Air pollution, Climate change, Energy security, Energy conservation and its importance, Energy strategy for the future, Energy conservation Act-2001 and its features.	04
2.	**Energy Management and Audit:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments. **Material and Energy balance:** Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams. **Financial Management:** Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracts and role of ESCOs.	10
3.	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10

4.	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
5.	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	3
6.	**Energy conservation in Buildings**: Energy Conservation Building Codes (ECBC): Green Build Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	3

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 syllabus

Books/References:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press

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Course Code	Course Name	Credits
ME 423	**Solar Energy Engineering**	**3**

Course Objectives:

1. To learn the basics of the solar energy spectrum.
2. To learn about types of Solar cells and their ratings.
3. To learn the solar thermal system; an energy efficient approach.
4. To learn about solar power plants.

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

1. Get knowledge of the competing demands and requirements of the various solar operated electrical power networks.
2. Understand how renewable generation and distributed storage interacts with and is integrated into the power network.
3. Solar energy measurement techniques.
4. Need of solar cooling system to reduce dependency on mains grid.

Theory Syllabus:

Module	Detail Content	Hrs.
1.	Introduction to solar energy , World and Indian energy scenario, Types of energy resources and its importance, need of energy conservation, Solar spectrum, Solar constant , Solar Energy & Environment , green house effect, Physics of the Sun - Energy balance of the earth, Energy scenario and sustainable development through solar energy.	06
2.	Solar energy measurement:- Estimation of solar energy on earth's surface, characteristics of solar radiation, Sun –earth geometry and its effect on solar energy reaching on earth's surface, Depletion of solar radiation - Absorption, scattering, Solar day length – Sun path diagram – Shadow determination. Estimation of Sunshine hours, Calculation of total solar radiation on horizontal and tilted surfaces.	08
3.	**Solar Photovoltaic system :** Solar Cell, PV Module and Solar arrays:- 1. Introduction and types of solar cell 1.1. Parameters of solar cell 2. Factors affecting electricity generation by solar cell 2.1. Effect of conversion efficiency 2.2. Change in amount of input light 2.3. Change in solar cell area 2.4. Change in angle of light falling on PV Panel 2.5. Change in solar cell operating temperature 2.6. I-V characteristics of solar cell 3. PV Module and its ratings 3.1. PV Module parameters 3.2. Measuring PV Module parameters 4. Types of PV Module connections 4.1. Series connection of PV Modules 4.2. Parallel connection of PV Modules 4.3. Mixed Combination of connections	08
4.	**Solar thermal system:** Flat Plate Collector, Hot Air Collector, Evacuated Tube Collector, Parabolic , Compound Parabolic and Fresnel Solar Concentrators, Central Receiver System, Thermal Analysis of Solar Collectors Performance of Solar Collectors, Solar Water Heating	08

	Systems(Active & Passive), Solar Space Heating & Cooling Systems, Solar Industrial Process Heating Systems, Solar Dryers & Desalination Systems, Solar Thermal Power Systems.	
5.	**Electrical energy conversion from solar energy:** Solar Power plant, Estimating power and energy demand, site selection, land requirements, choice of modules, economic comparison, balance of systems, off grid systems, grid interface, Supporting structures, mounting and installation, junction boxes, battery storage, power condition unit, selection of cables and balance of systems, economic analysis.	08
6.	**Solar Cooling:** Potential and scope of solar cooling. Types of solar cooling systems, solar collectors and storage systems for solar refrigeration and air conditioning. Solar operation of vapour absorption and compression refrigeration cycles and their assessment. Solar dessicant cooling system. Open cycle absorption/desorption solar cooling alternatives. Advanced solar cooling systems. Refrigerant storage for solar absorption cooling systems. Solar thermoelectric refrigeration and air conditioning. Economics of solar cooling	10

Laboratory Syllabus

Sr. No.	Details	Hrs.
1	Investigating the thermal performance of solar collector.	1
2	Study of solar hot water systems (FPC and ETC)	1
3	Characteristics of SPV system.	1
4	Determination of efficiency of DC/AC inverter.	1
5	Study of Lead Acid Battery as a energy storage.	1
6	Solar PV Simulator.	1
7	Developing Solar PV Grid-tied Training kit.	1
8	Developing Solar Thermal Training kit.	1
9	Developing Solar Concentrator Training kit.	1
10	Determination of I-V& P-V Characteristics of a Solar PV Panel.	1
11	Power Flow calculation of Stand-Alone PV System of DC Load with Battery.	1
12	To study Charging and Discharging Characteristics of Battery	1
13	Industrial Visit	1

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. Foster .R, Ghassemi M., Cota A., “Solar Energy”, CRC Press, 2010.
2. Duffie .J.A, Beckman W.A. “Solar Engineering of Thermal Processes”, 3rd ed., Wiley, 2006.
3. De Vos .A, “Thermodynamics of Solar Energy Conversion”, Wiley-VCH, 2008.

4. Garg .H.P, Prakash .J, “Solar Energy Fundamentals and Applications”, Tata McGraw-Hill, 2005.
5. Kalogirou .S, “Solar Energy Engineering”, Processes and Systems, Elsevier, 2009.
6. Petela .R, “Engineering Thermodynamics of Thermal Radiation for Solar Power”, McGraw-Hill Co., 2010.
7. Yogi Goswami .D, Frank Kreith, Jan F. Kreider, “Principles of Solar Engineering”, Second Edition, Taylor & Francis, 2003.
8. Andrews .J, Jelley .N, “Energy Science”, Oxford University Press, 2010.
9. Renewable Energy: Power for a Sustainable Future, Edited by Godfrey Boyle, 3rd Edition, Oxford University Press
10. Solar Energy: Principles of Thermal Collection and Storage by SP Sukhatme and J K Nayak, TMH
11. Solar Energy: Fundamentals and Applications by H.P. Garg& Jai Prakash, Tata McGraw Hill.
12. Solar Photovoltaic’s: Fundamentals, Technologies and Applications, C S Solanki, 2ndEdition, PHI Learning
13. Renewable Energy Technologies: A Practical Guide For Beginners, PHI Learning
14. Solar Energy: The Physics and Engineering of Photovoltaic Conversion, Technologies by Arno Smets, Klaus Jäger Olindo Isabella René van Swaaij , UIT Cambridge LTD
15. Solar Photovoltaic Technology And Systems - A Manual For Technicians,Trainers And Engineers, PHI Learning

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Course Code	Course Name	Credits
ME 424	**Hybrid & Electric Vehicles**	**3**

Course Objectives:

1. To appreciate the need of Sustainable transportation options available.
2. To familiarize with basic Concepts of Hybrid, Electric and Fuel Cell vehicles.
3. To acquaint with various aspects of hybrid and electric drive train and Battery Management Systems.
4. To study various challenges involved with Fuel cell technology.

Course Outcomes: Learner will be able to

1. Identify and describe the history and evolution of electric & hybrid electric vehicles.
2. Identify and describe the working principle of different EV/HEV's configurations.
3. Compare various energy sources and storages for EV and HEV's
4. Design drivetrain parameters for HEV's
5. Elaborate use of fuel cells in vehicular applications
6. Appreciate the need of BMS and chargers in EV's and perform sizing calculations for Batteries and Electric Motors.

Module	Detail Content	Hrs.
1	**Introduction** Environmental Impact: Air pollution, Global Warming, Petroleum Resources, Importance of Different transportation development, History of Electric Vehicles, History of Hybrid Vehicles and History of Fuel Cell Vehicles, Well to Wheel Analysis, GoI Initiatives, Conventional Drivetrain. State of the art and Indian and global scenario in EV/HEV	05
2	**Electric Vehicles** 1. Configurations 2. Traction Motor characteristics, Tractive effort , transmission requirement and Vehicle Performance 3. EV Parameters-Weight,Size,Force,Energy and Performance	07
3	**Hybrid Electric Vehicles** 1. Configurations-Series,Parallel,Series-Parallel and Complex 2. Torque Coupling, Speed coupling and combined Torque and speed coupling Hybrid electric drivetrain. 3. Power flow control for above configurations Design of Series and Parallel Hybrid drivetrain 1. Control strategies for Series and Parallel hybrid drivetrain 2. Sizing of drivetrain parameters	07
4	**Energy Storages and Drives and Regeneration** 1. Specific Energy ,Specific power, Energy Efficiency, Electrochemical reactions and voltages 2. Batteries for EV's and HEV's-Lead Acid, Nickel Based and Lithium Ion Battery Chemistries 3. Ultra capacitors 4. Ultra High speed flywheels 5. Hybridization of Energy storages 6. Motors for Electric Vehicles-DC Motors, Induction Motors and Switched Reluctance Motors(SRM) 7. Energy consumption in braking, Brake systems for EV's and HEV's	07

5	**Fuel Cell Electric Vehicles** 1. Operating Principles of fuel cell 2. Electrode potential and current voltage curve 3. Fuel Cell Technologies-PEMFC,AFC,PAFC,MCFC,SOFC,DMFC 4. Hydrogen storage and Production 5. Fuel cell hybrid electric drive train-Configuration, control strategy	07
6	**BMS,Chargers for EV'S and Case Study** 1. Need of Battery management systems(BMS) for Electric Vehicles 2. Basics of Electric Vehicles Chargers-AC and DC Chargers 3. V2G and G2V concept. 4. Calculation for Battery Sizing, Motor Sizing for any 2Wheeler/4 Wheeler	06

Laboratory Syllabus:
List of Experiments (any 6 of the following)

1. Battery Sizing calculations for 2W/3W/4W Electric Vehicles.
2. Motor Selection and Sizing Calculations for 2W/3W/4W Electric Vehicles.
3. Vehicle Performance Calculations for HEV and EV's.
4. Simulating Vehicle Performance Calculations in Matlab/Scilab.
5. Modeling Li-Ion Battery in Matlab/Simulink.
6. Modeling BMS in Matlab/Simulink.
7. Case Study on Hybrid Electric Vehicle Model.
8. Case Study on Electric Vehicle Model.

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.

Text Books:

1. Robin Hardy, Iqbal. Hussein, Electric and Hybrid Vehicles, CRC Press,ISBN-0-8493-1466-6.
2. J. Larminie and J. Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. C. MI, M. Abul and D. W. Gao, Hybrid Electrical Vehicle Principles and Application with Practical Perspectives, Wiley 2011

Books/References:

1. Sandeep Dhameja,"Electric Vehicle Battery Systems",Newnes,Massachusetts,2002
2. C.C.Chan and K.T.Chau,"Modern Electric Vehicle Technology", Oxford University Press, 2001
3. I. Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003

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Course Code	Course Name	Credits
ME 425	**Vehicle Dynamics and Control**	**3**

Course Objectives:

1. To familiarize with basic concepts of vehicle dynamics.
2. To analyze the vehicle in context of ride, handling and longitudinal dynamics of the vehicle.
3. To get acquainted with simulation processes using software in the domain of vehicle dynamics.

Course Outcomes: After completion of this course, Learner will be able to

1. Analyze the vehicle directional stability.
2. Enumerate the suspension systems, tire dynamics & directional stability of the vehicle.
3. Develop physical and mathematical models to predict the dynamic response of vehicles
4. Demonstrate the ride characteristic of the vehicle.
5. Analyze the vehicle roll behaviour
6. Comprehend the various trends in Vehicle Dynamics.

Theory Syllabus:

Module	Detail Content	Hrs.
1	**Introduction** History of Road and Off-Road Vehicle dynamics, Road Load, Aerodynamics-Drag, Side force, Lift force, Rolling Resistance Total Road Loads, Introduction about Longitudinal vehicle Dynamics, Introduction about control theory applied to Longitudinal dynamics	4
2	**Tyres** SAE Tyre axis system, Tyre forces, Moments, Lateral force V/S Slip Angle, Aligning Torque V/S Slip Angle, Tyre Construction, Tractive Properties, Cornering Properties, Camber Thrust, Aligning Moment, Combined braking and Cornering, Conicity and Ply Steer, Tire Vibration, Tyre Properties affecting Vehicle Roll over, Introduction to Magic Tyre Formula , Tyre testing on various road surfaces	6
3	**Suspension** Solid Axles, Independent suspensions, Variable Rate Leaf Spring., Anti Squat and Anti Pitch Suspension Geometry, Anti Dive Suspension Geometry, Equalizing Suspension, Roll Centre Analysis, Motion Analysis of Wheel Suspension, semi active and Active Suspensions, Introduction about control theory applied to Suspension systems	8
4	**Vertical Dynamics** Lumped mass, Equation of Simple Spring Mass System with to degrees of freedom system, pitch and bounce motion frequencies, Conjugate Points, Elastic, Dynamic, doubly Conjugate Points, Calculation of Conjugate Points Sources for vehicle vibration, vibration isolation, Effects of damping the vibration, vibration absorbers.	10

5	**Lateral Dynamics** Steering geometry, Front wheel geometry, Steering system forces and moments, Steering system effects, Influence of front wheel drive, four wheel steering, Suspension effect of cornering, High speed cornering, understeer, oversteer, Jack Knifing of articulated vehicles , Introduction about control theory applied to Lateral dynamics	6
6	**Recent Trends in Vehicle dynamics** Vehicle dynamic Control (ESP and active steering), Actuators, Sensors for Automobile Control, Sensors for Detecting Vehicle Environment, Central Tyre Inflation system.	4

Laboratory Syllabus:

List of Experiments :

1. To plot characteristic curves for shock absorbers.
2. Simulation of Quarter car model for pitch and bounce.
3. Simulation of Quarter car model for different road profiles
4. Simulation of Half car model for pitch and bounce.
5. Simulation of Half car model for different road profiles.
6. Experimental studies of measurements of drag and lift coefficient for different geometry vehicle using wind tunnel apparatus.
7. To perform test on chassis dynamometer

Term work :

Term work shall consist of minimum 5 exercises, from the list, 6 assignments covering maximum portion of the syllabus (one on each module) or case study or mini project based on topics related to vehicle Dynamics. The case study or mini project is assigned for a group of students and the number of students in a group should not be more than two. The introduction of vehicle dynamics systems using any of the Dynamics software (like CARSIM etc) can be given to the students as a part of term work.

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.

Text Books:

1. Gillespie T.D, ―Fundamentals of Vehicle Dynamics‖, SAE USA 1992
2. Giri N.K – Automotive Mechanics, Khanna Publishers, 2007.
3. Colin Campbell - Automobile Suspension and Handling
4. William F Milliken and Douglas L Milliken - Race Car Vehicle Dynamics
5. Konrad Reif Ed. – Automotive Mechatronics Bosch Professional Automotive Information , Springer

Reference Books:

1. J. Y. Wong, “Theory of Ground Vehicles”, 3rd ed., John Willey & Sons, New York, 1997.
2. Hans B, Pacejka - Tyre and Vehicle Dynamics - SAE Publication – 2002

3. Vehicle Dynamics Theory and application – Reza Jazar, Springer
4. Heinz Heisler, “Advanced Vehicle Technology “, 2nd Edition, Butterworth-Heinemann, 2002
5. Rajesh Rajamani “ Vehicle Dynamics and Control “
6. Road and Off Road Vehicle system Dynamics. Hand Book
7. Mechanics of Road Vehicle, Steeds
8. Car Suspension : Bastow

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Course Code	Course Name	Credits
ME 492	**Major Project III**	**2**

Course Objectives:

1. To acquaint with the process of undertaking literature survey or market survey or feasibility study /industrial visit and identifying the problem
2. To familiarize the process of problem solving in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research

Course Outcomes: Learner will be able to

1. Do literature survey based on market or feasibility study/industrial visit and identify the problem.
2. Apply basic engineering fundamentals in the domain of practical applications
3. Cultivate the habit of working in a team
4. Attempt a problem solution in a right approach.
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare project report as per guidelines and with proper references/citations.
7. Exhibit and explain project ideas/models at various platforms

Guidelines for Project

Students are expected to have one of the following outcome of the project work done

1. Filing of patent on the innovating work done
2. Presentation of the work done in National/International Conference
3. Publishing the work done in National/International Journal
4. Participation in Project competition at State/National level

Assessment:

Project III should be assessed based on following points

1. Continuous assessment on the progress
2. Quality of platform used to present the project work done

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