

INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)
(Deemed to be University Estd. u/s 3 of the UGC Act, 1956)
PALLAVARAM - CHENNAI
ACCREDITED BY NAAC WITH 'A' GRADE
Marching Beyond 30 Years Successfully
INSTITUTION WITH UGC 12B STATUS

B.Tech.
Mechanical Engineering
(Working Professionals)

Curriculum and Syllabus

Regulation 2024

(Based on Choice Based Credit System (CBCS)

and

Outcome Based Education (OBE)

Effective from the Academic year

2024-2025

Department of Mechanical Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

Vision of the Department

The Department of Mechanical Engineering envisages to be recognized as a role model in advanced fields of Mechanical Engineering Education and Research and to cater the ever changing industrial demands and social needs.

Mission of the Department

M1: Educate, motivate and prepare the students to know the fundamental and technical skills in Mechanical Engineering through effective teaching learning Methodologies.

M2: To imbibe professional and ethical standards in the minds of the young engineers by continuous learning and professional activities.

M3: To impart the employability skills to the students as industry ready by implant training and industrial visits.

M4: To create entrepreneurship skills by industrial collaborations and mentoring.

M5: To encourage students to undertake R&D activities for the societal needs with high ethical standards.

PROGRAMME OUTCOMES:

PO 1: Engineering knowledge

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

PO 2: Problem analyses

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

PO 3: Design/development of solutions

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

PO 4: Conduct investigations of complex problems

Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5 Modern tool usage

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

PO 6: The engineer and society

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

PO 7: Environment and sustainability

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

PO 8: Ethics

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

PO 9: Individual and team work

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

PO 10: Communication

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

PO 11: Project management and finance

Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning

Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Educational Objectives (PEO's)

The Graduates will be Mechanical Engineering related technical and aptitude skills to offer best solution to industrial and societal problems.

PEO 1: To impart fundamentals of Engineering and Technology and applied Mathematics to transform the students as Mechanical Engineers.

PEO 2: To nurture design, analysis and implementation skills to innovate the process or system in Mechanical Engineering with global context.

PEO 3: To imbibe Mechanical Engineering related technical and aptitude skills to offer best solution to industrial and societal problems.

PEO 4: To initiate the entrepreneurial activities and leadership qualities of the students through the effective communication skills.

PEO 5: To develop the awareness among the students about the various social responsibilities related to Engineering ethics and human values with ecological.

Program Specific Outcomes (PSOs)

PSO 1	Graduate will be able to acquire core Mechanical Engineering knowledge and able to solve industrial as well as societal problems with ethical and environmental consciousness.
PSO 2	Graduate will be able to build the nation, by imparting technological concepts and tools on emerging fields through the Managerial and entrepreneurs skills.

Department of Mechanical Engineering

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.			
1.1	Demonstrate competence in mathematical modelling	1.1.1	1.1.1 Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems
		1.1.2	Apply advanced mathematical techniques to model and solve mechanical engineering problems.
1.2	Demonstrate competence in basic sciences	1.2.1	Apply laws of natural science to an engineering problem.
1.3	Demonstrate competence in engineering fundamentals	1.3.1	Apply fundamental engineering concepts to solve engineering problems
1.4	Demonstrate competence in specialized engineering knowledge to the program	1.4.1	Apply mechanical engineering concepts to solve engineering problems.
PO 2: Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.			
2.1	Demonstrate an ability to identify and formulate complex engineering problem	2.1.1	2.1.1 Articulate problem statements and identify objectives
		2.1.2	2.1.2 Identify engineering systems, variables, and parameters to solve the problems
		2.1.3	2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2	Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.1	Reframe complex problems into interconnected sub-problems
		2.2.2	Identify, assemble and evaluate information and resources.
		2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions
		2.2.4	Compare and contrast alternative solution processes to select the best process.
2.3	Demonstrate an ability to formulate and interpret a model	2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate interms of applicability and required accuracy.
		2.3.2	Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required.
2.4	Demonstrate an ability to execute a solution process and analyze results	2.4.1	Apply engineering mathematics and computations to solve mathematical models
		2.4.2	Produce and validate results through skillful use of contemporary engineering tools and models
		2.4.3	Identify sources of error in the solution process, and limitations of the solution.
		2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
PO 3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations			
3.1	Demonstrate an ability to define a complex/ open-ended problem in engineering terms	3.1.1	Recognize that need analysis is key to good problem definition
		3.1.2	Elicit and document, engineering requirements from stakeholders
		3.1.3	Synthesize engineering requirements from a review of the state-of-the-art
		3.1.4	Extract engineering requirements from relevant engineering Codes and Standards such as IEEE, ISO, ITU-R, ITU-T etc.
		3.1.5	Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural and societal issues
		3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2		3.2.1	Apply formal idea generation tools to develop multiple engineering design solutions

	Demonstrate an ability to generate a diverse set of alternative design solutions	3.2.2	Build models/prototypes to develop a diverse set of design solutions
		3.2.3	Identify suitable criteria for the evaluation of alternate design solutions
3.3	Demonstrate an ability to select an optimal design scheme for further development	3.3.1	Apply formal decision-making tools to select optimal engineering design solutions for further development
		3.3.2	Consult with domain experts and stakeholders to select candidate engineering design solution for further development
3.4	Demonstrate an ability to advance an engineering design to defined end state	3.4.1	Refine a conceptual design into a detailed design within the existing constraints (of the resources)
		3.4.2	Generate information through appropriate tests to improve or revise the design
PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.			
4.1	Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding	4.1.1	Define a problem, its scope and importance for purposes of investigation
		4.1.2	Examine the relevant methods, tools and techniques of experiment design, system calibration, data acquisition, analysis and presentation
		4.1.3	Apply appropriate instrumentation and/or software tools to make measurements of physical quantities
		4.1.4	Establish a relationship between measured data and underlying physical principles.
4.2	Demonstrate an ability to design experiments to solve open-ended problems	4.2.1	Design and develop an experimental approach, specify appropriate equipment and procedures
		4.2.2	Understand the importance of the statistical design of experiments and choose an appropriate experimental design plan based on the study objectives
4.3	Demonstrate an ability to analyze data and reach a valid conclusion	4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data
		4.3.2	Analyze data for trends and correlations, stating possible errors and limitations
		4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions
		4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions
PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.			
5.1	Demonstrate an ability to identify/ create modern engineering tools, techniques and resources	5.1.1	Identify modern engineering tools and techniques and resources for engineering activities.
		5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
5.2	Demonstrate an ability to select and apply discipline-specific tools, techniques and resources	5.2.1	Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.
		5.2.2	Demonstrate proficiency in using discipline-specific tools
5.3	Demonstrate an ability to evaluate the suitability and limitations of tools used to solve an engineering problem	5.3.1	Discuss limitations and validate tools, techniques and resources
		5.3.2	Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.
PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.			
6.1	Demonstrate an ability to describe engineering roles in a broader context, e.g. pertaining to the	6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level

	environment, health, safety, legal and public welfare		
6.2	Demonstrate an understanding of professional engineering regulations, legislation and standards	6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public
PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.			
7.1	Demonstrate an understanding of the impact of engineering and industrial practices on social, environmental and in economic contexts	7.1.1	Identify risks/impacts in the life-cycle of an engineering product or activity
		7.1.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability
7.2	Demonstrate an ability to apply principles of sustainable design and development	7.2.1	Describe management techniques for sustainable development
		7.2.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline
PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.			
8.1	Demonstrate an ability to recognize ethical dilemmas	8.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
8.2	Demonstrate an ability to apply the Code of Ethics	8.2.1	Identify tenets of the Mechanical professional code of ethics.
		8.2.2	Examine and apply moral & ethical principles to known case studies
PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.			
9.1	Demonstrate an ability to form a team and define a role for each member	9.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
		9.1.2	Implement the norms of practice (e.g., rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
9.2	Demonstrate effective individual and team operations--communication, problem-solving, conflict resolution and leadership skills	9.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
		9.2.2	Treat other team members respectfully
		9.2.3	Listen to other members
		9.2.4	Maintain composure in difficult situations
9.3	Demonstrate success in a team-based project	9.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions			
10.1	Demonstrate an ability to comprehend technical literature and document project work	10.1.1	Read, understand and interpret technical and non-technical information.
		10.1.2	Produce clear, well-constructed, and well-supported written engineering documents.
		10.1.3	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear.
10.2	Demonstrate competence in listening, speaking, and presentation	10.2.1	Listen to and comprehend information, instructions, and viewpoints of others
		10.2.2	Deliver effective oral presentations to technical and non-technical audiences
10.3	Demonstrate the ability to integrate different modes of communication	10.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations
		10.3.2	Use a variety of media effectively to convey a message in a document or a presentation

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.			
11.1	Demonstrate an ability to evaluate the economic and financial performance of an engineering activity	11.1.1	Describe various economic and financial costs/benefits of an engineering activity
		11.1.2	Analyze different forms of financial statements to evaluate the financial status of an engineering project
11.2	Demonstrate an ability to compare and contrast the costs/benefits of alternate proposals for an engineering activity	11.2.1	Analyzeandselectthemostappropriateproposalbasedoneconomicandfinancial considerations.
11.3	Demonstrate an ability to plan/manage an engineering activity within time and budget constraints	11.3.1	Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.
		11.3.2	Use project management tools to schedule an engineering project, so it is completed on time and on budget.
PO 12: Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.			
12.1	Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps	12.1.1	Describe the rationale for the requirement for continuing professional development
		12.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
12.2	Demonstrate an ability to identify changing trends in engineering knowledge and practice	12.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current
		12.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.
12.3	Demonstrate an ability to identify and access sources for new information	12.3.1	Source and comprehend technical literature and other credible sources of information
		12.3.2	Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.
PSO 1:Graduate will be able to acquire core Mechanical Engineering knowledge and able to solve industrial as well as societal problems with ethical and environmental consciousness.			
13.1	Demonstrate and understanding of the impact of engineering and industrial practices on social, environmental and in economic contexts	13.1.1	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability
		13.1.2	Identify risks/impacts in the life-cycle of an engineering product or activity
13.2	Demonstrate an ability to apply the Code of Ethics	13.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public
		13.2.2	Examine and apply moral & ethical principles to known case studies
PSO 2: Graduate will be able to build the nation, by imparting technological concepts and tools on emerging fields through the Managerial and entrepreneurs skills.			
14.1	Demonstrate an ability to identify/ create modern engineering tools, techniques and resources	14.1.1	Identify modern engineering tools and techniques and resources for engineering activities.
		14.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
14.2	Demonstrate an ability to form a team and define a role for each member	14.2.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
		14.2.2	Implement the norms of practice (e.g., rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
14.3	Demonstrate an ability to identify changing trends in engineering knowledge and practice	14.3.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current
		14.3.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.

School of Engineering

DEPARTMENT OF MECHANICAL ENGINEERING

CURRICULUM 2024 – 2025 (REGULATION – 2022)

Course Code	Category	Course Title	Credits	CA	SEE	Total
SEMESTER I						
	BSC	Numerical Methods	4	40	60	100
	ESC	Electrical Drives and Control	3	40	60	100
	PCC	Engineering Thermodynamics	3	40	60	100
	PCC	Manufacturing Technology – I	3	40	60	100
	PCC	Engineering Material Science	3	40	60	100
	PCC	Electrical Engineering Laboratory	1	40	60	100
	PCC	Manufacturing Technology – I Laboratory	1	40	60	100
			18			
SEMESTER II						
	ESC	Strength of Materials	4	40	60	100
	PCC	Kinematics of Machinery	3	40	60	100
	PCC	Fluid Mechanics and Machinery	3	40	60	100
	PCC	Manufacturing Technology –II	3	40	60	100
	BSC	Environmental Science and Engineering	3	40	60	100
	PCC	Fluid Mechanics and Strength of Materials Laboratory	1	40	60	100
	PCC	Manufacturing Technology – II Laboratory	1	40	60	100
			18			

SEMESTER III						
	PCC	Design of Machine Elements	4	40	60	100
	PCC	Dynamics of Machinery	3	40	60	100
	PEC	Applied Hydraulics and Pneumatics	3	40	60	100
	OEC	Open Elective Course Technical -I	3	40	60	100
	PCC	Engineering Metrology and Measurements	3	40	60	100
	PCC	Engineering Metrology and Measurements laboratory	1	40	60	100
	PCC	Computer Aided Machine Design Laboratory	1	40	60	100
			18			

SEMESTER IV						
	PCC	Thermal Engineering	4	40	60	100
	PEC	Professional Elective courses I	3	40	60	100
	PEC	Professional Elective courses II	3	40	60	100
	OEC	Open Elective Course Technical - II	3	40	60	100
	PCC	Design of Transmission Systems	3	40	60	100
	PCC	Thermal Engineering Laboratory	1	40	60	100
	PCC	Advanced Machining Laboratory	1	40	60	100
			18			

Course Code	Category	Course Title	Credits	CA	SEE	Total
SEMESTER V						
	OEC	Open Elective Course Technical -III	3	40	60	100
	OEC	Open Elective Course Management - I	3	40	60	100
	PEC	Professional Elective courses - III	3	40	60	100
	PEC	Professional Elective courses - IV	3	40	60	100
	PCC	Mechatronics	4	40	60	100
	PCC	Mechatronics Laboratory	1	40	60	100
	PCC	Simulation and Analysis Laboratory	1	40	60	100
			18			

SEMESTER VI						
	PEC	Professional Elective courses - V	3	40	60	100
	PEC	Professional Elective courses - VI	3	40	60	100
	OEC	Open Elective Course Technical -IV	3	40	60	100
	OEC	Open Elective Course Technical - V	3	40	60	100
	OEC	Open Elective Course Management -II	3	40	60	100
	Project	Project Phase - I	5	40	60	100
			20			

SEMESTER VII						
	PEC	Professional Elective courses - VII	3	40	60	100
	OEC	Open Elective Course Technical - VI	3	40	60	100
	Project	Project Phase - II	12	40	60	100
			18			

B.Tech. - MECHANICAL ENGINEERING

CURRICULUM

LIST OF PROFESSIONAL ELECTIVE COURSES

Code No.	Course	Hours / Week			Credits
		Lecture	**T**utorial	**P**ractical	**C**redits
	Special Casting Techniques	3	0	0	3
	Failure Analysis and Design	3	0	0	3
	Manufacture and Inspection of Gears	3	0	0	3
	Refrigeration and Air Conditioning	3	0	0	3
	Welding Technology	3	0	0	3
	Heat and Mass Transfer	3	0	0	3
	Cryogenic Engineering	3	0	0	3
	Renewable Energy Sources	3	0	0	3
	Composite Materials and Mechanics	3	0	0	3
	Automobile Engineering	3	0	0	3
	Design of Pressure Vessels and Piping	3	0	0	3
	Vibration and Noise Engineering	3	0	0	3
	Gas Dynamics and Jet Propulsion	3	0	0	3
	Design of Jigs, Fixtures and Press Tools	3	0	0	3
	Industrial Automation, CNC and Robotics	3	0	0	3
	Unconventional Machining Processes	3	0	0	3
	Manufacture of Automotive Components	3	0	0	3
	Design of Heat Exchangers	3	0	0	3
	Additive Manufacturing	3	0	0	3
	Rapid Prototyping, Tooling and Manufacture	3	0	0	3
	Computer Integrated Manufacturing	3	0	0	3
	Power Plant Engineering	3	0	0	3
	Computational Fluid Dynamics	3	0	0	3
	Advanced I.C. Engines	3	0	0	3
	Fundamentals of Nanoscience	3	0	0	3
	Product Development and Manufacture	3	0	0	3
	Non Destructive Testing and Materials	3	0	0	3
	Advanced Computer Integrated Manufacturing Systems	3	0	0	3
	Robotics and Automation	3	0	0	3
	Bio Materials	3	0	0	3
	Micro Electro Mechanical Systems	3	0	0	3
	Flexible Manufacturing System	3	0	0	3

B.Tech - Mechanical Engineering

CURRICULUM

LIST OF OPEN ELECTIVE COURSES

Code No.	Course	Hours / Week			Credits
		Lecture	**T**utorial	**P**ractical	**C**redits
	Principles of Management	3	0	0	3
	Operations Research	3	0	0	3
	Human Rights	3	0	0	3
	Professional Ethics in Engineering	3	0	0	3
	Quality Control and Reliability Engineering	3	0	0	3
	Value Analysis and Value Engineering	3	0	0	3
	Total Quality Management	3	0	0	3
	Production Planning and Control	3	0	0	3
	Energy Audit and Energy Conservation Methods	3	0	0	3
	Quality Control and Reliability Engineering	3	0	0	3
	Process Planning and Cost Estimation	3	0	0	3
	Supply Chain Management	3	0	0	3
	Industrial Marketing and Market Research	3	0	0	3
	Intellectual Property Rights	3	0	0	3
	Disaster Management	3	0	0	3
	Engineering Economics	3	0	0	3
	Entrepreneurship Development	3	0	0	3

Course Code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses
LC	Laboratory course
MC	Mandatory courses
PROJ	Project
CA	Continuous Assessment
SEE	Semester End Examination

	Numerical Methods	L	T	P	C
		3	1	0	4

Course Objective:

- Using appropriate numerical methods determine approximate solutions to ordinary differential equations.
- Analyze the errors obtained in the numerical solution of problems.

UNIT I Solution of Equations 12

Solution of algebraic and transcendental equations – Newton Raphson method –Regulafalsi method – Solution of linear system of equations- Gauss elimination method – Gauss-Jordon method–Gauss Seidel Method–Gauss Jacobi Method–Matrix Inversion by Gauss Jordon method.

UNIT II Interpolation and Approximation 12

Interpolation with unequal intervals-Lagrange's interpolation–Inverse Lagrange's interpolation– Newton's divided difference interpolation– Interpolation with equal intervals– Newton's forward and backward difference formulae

UNIT III Numerical Differentiation and Integration 12

Numerical Differentiation: Approximation of derivatives using interpolation polynomials-Numerical integration: Trapezoidal–Simpson's 1/3 and 3/8 rule – Romberg's method – Double integral of Trapezoidal –Simpson's Rule

UNIT IV Initial Value Problems for Ordinary Differential Equations 12

Single step methods: Taylor series method – Euler's method–Modified Euler's method– Second order Runge –Kutta method and Fourth order Runge–Kutta method for solving first order equations.

UNIT V Boundary Value Problems in Ordinary and Partial Differential Equations 12

Finite difference methods for solving two-point linear boundary value problems– Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain

Total: 60 Hours

Text Books:

1. Grewal,B.S. and Grewal,J.S., "Numerical methods in Engineering and Science", 9th Edition, Khanna Publishers, New Delhi, 2012.
2. Gerald,C.F. and Wheatley,P.O., "Applied Numerical Analysis",6th Edition, Pearson Education, Asia, New Delhi, 2006.
3. Sivaramakrishna Das.P and Vijayakumari.C, Numerical Analysis, Pearson Education Limited in South Asia, First edition 2014.

Reference Books:

1. Chapra, S. C and Canale, R. P., "Numerical Methods for Engineers", Tata McGraw-Hill, New Delhi, 5th Edition, 2007.
2. Sankara Rao K, "Numerical Methods for Scientists and Engineers", Prentice Hall of India, New Delhi, 3rd Edition, 2007.

Course Outcome

CO1:	Apply numerical methods to obtain approximate solutions to mathematical problems.	**K3**
CO2:	Understand numerical methods for various mathematical interpolation problems.	**K2**
CO3:	Evaluated if fermentation and integration solutions using numerical methods.	**K3**
CO4:	Understand the initial value problem for ordinary differential equations.	**K4**
CO5:	Understand the boundary value problem for Ordinary differential equations and Partial	**K4**

Mapping of Program Outcomes with Course Outcomes

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

Assessment Methods:

CAT1	CAT2	Model Exam	End Semester Exams	Assignments
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/Presentatio**
			✓	

	ELECTRICAL DRIVES AND CONTROL	L	T	P	C
		3	0	0	3

Course Objective: (Employability)

- To understand the basic concepts of different types of electrical machines and their performance.
- To study the different methods of starting D.C motors and induction motors.
- To study the conventional and solid-state drives.

UNIT I INTRODUCTION 9

Fundamentals of electric drives – advances of electric drive-characteristics of loads – different types of mechanical loads – choice of an electric drive – control circuit components: Fuses, switches, circuit breakers, contactors, Relay – control transformers.

UNIT II SPEED CONTROL OF DC MACHINES 9

DC shunt motors – Speed Torque characteristics - Ward Leonard method, DC series motor – series parallel control – solid state DC drives – Thyristor bridge rectifier circuits- chopper circuits.

UNIT III SPEED CONTROL OF AC MACHINES 9

Induction motor – Speed torque Characteristics – pole changing, stator frequency variation - slip-ring induction motor – stator voltage variation - Rotor resistance variation, slip power recovery – basic inverter circuits- variable voltage frequency control.

UNIT IV MOTOR STARTERS AND CONTROLLERS 9

DC motor starters: using voltage sensing relays, current sensing relays and time delay relays - wound rotor induction motor starters – starters using frequency sensing relays - DOI –starter and auto transformers starter.

UNIT V HEATING AND POWER RATING OF DRIVE MOTORS 9

Load diagram, over load capacity, insulating materials, heating and cooling of motors, service condition of electric drive – continuous, intermittent and short time – industrial application.

TOTAL: 45 Hours

Course Outcomes:

After successful completion of the Electrical Drives and Control course, the student will be able to

CO1: Identify the need and choice of various electrical drives and their controls.

CO2: Designing the circuit with the Microprocessors.

CO3: Understand the DC motor by Single phase converters.

CO4: Discuss the four quadrant operation of DC drives.

CO5: Explain the control of induction motor; through station voltage.

Text Books:

1. N.K De and P.K Sen ‘Electric Drives’ Prentice Hall of India Private Ltd, 2002.
2. Vedam Subramaniam ‘Electric Drives’ Tata McGraw Hill, New Delhi, 2007.
3. V.K Mehta and Rohit Mehta ‘Principle of Electrical Engineering’, S Chand & Company, 2008.

Reference Books:

1. S.K Bhattacharya Brinjinder Singh ‘Control of Electrical Machines’ New Age International Publishers, 2002.

2. John Bird 'Electrical Circuit theory and technology' Elsevier, First Indian Edition, 2006.

Mapping of Program Outcomes with Course Outcomes

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

Assessment Methods:

CAT1	CAT2	Model Exam	End Semester Exams	Assignments
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**
✓			✓	

	ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3

Course Objectives

- Understand the fundamentals of thermodynamics and applications.
- Analyze the open and closed systems subjected to thermodynamic laws.

UNIT I BASIC CONCEPT AND FIRST LAW 9

Basic concepts - concept of continuum, microscopic and macroscopic approach, thermodynamic systems - closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics – concept of temperature and heat, Concept of ideal and real gases, First law of thermodynamics – application to closed and open systems, internal energy, specific heat capacities, enthalpy, steady flow process with reference to various thermal equipment's.

UNIT II SECOND LAW OF THERMODYNAMICS 9

Limitations of the First Law - Heat Reservoir - source and sink, Second law of thermodynamics – Kelvin's and Clausius statements of second law, Reversibility and irreversibility. Carnot theorem, Carnot cycle, reversed Carnot cycle, efficiency, COP, Thermodynamic temperature scale, Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy. Availability and Irreversibility analysis for open and closed systems.

UNIT III PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE 9

Properties of pure substances – Thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces, thermodynamic properties of steam. Calculations of work done and heat transfer in non-flow and flow processes, standard Rankine cycle, Reheat and regenerative cycle.

UNIT IV IDEAL AND REAL GASES THERMODYNAMIC RELATIONS 9

Properties of Ideal gas, real gas, and their comparison. Equations of state for ideal and real gases. Van der Waal's relation, Reduced properties, Compressibility factor, Principle of corresponding states. Generalized compressibility chart and its use. Maxwell relations, Tds equations, heat capacities relations, Energy equation, Joule-Thomson coefficient, Phase change processes, Clausius-Clapeyron equation. Simple calculations.

UNIT V PSYCHROMETRY 9

Psychrometry and psychrometric charts, property calculations of air vapour mixtures. Psychrometric process – Sensible heat exchange processes. Latent heat exchange processes. Adiabatic mixing, evaporative cooling, problems.

TOTAL : 45 hours

(Use of Steam tables, Mollier chart and psychometrics chart permitted)

Text Books:

1. Lynn D Russell, George A, Adebiyi "Engineering Thermodynamics" Indian Edition, Oxford University Press, New Delhi, 2007
2. Nag. P. K,—Engineering Thermodynamics, 6th Edition, Tata McGraw Hill (2017), New Delhi

Reference Books:

1. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
2. Merala C, Pother, Craig W, Somerton, "Thermodynamics for Engineers", Schaum Outline Series, Tata McGraw-Hill, New Delhi, 2004

3. E. Rathakrishnan, ―Fundamentals of Engineering Thermodynamics‖, 2nd Edition, Prentice Hall of India Pvt. Ltd, 2006.

Web Links:

1. https://www.youtube.com/watch?v=rvZZYeouz_I
2. https://nptel.ac.in/courses/101104063
3. https://nptel.ac.in/courses/112105123

Course Outcomes

CO1	Analyze problems and perform experiment in open/closed system by following first law of thermodynamics.	**K 4**
CO2	Apply and analyze the refrigerator, heat engine, availability and unavailability based on second law of thermodynamics and conduct experiment on refrigerator, IC engine	**K 4**
CO3	Calculate the properties of pure substance using steam table and determine the efficiency of steam power plant using Rankine cycle approach.	**K 5**
CO4	Analyze the behavior of ideal and real gases and derive thermodynamic relations	**K 5**
CO5	Apply and solve the air conditioning related various parameters problems using psychometric chart and expressions and conduct experiment in air conditioning system.	**K 4**

Mapping of Course Outcomes with Program Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	-	2	-	2	-	-	-	-	-	-	3	3
CO2	3	3	-	2	-	3	2	-	-	-	-	-	3	3
CO3	3	3	-	3	-	3	2	-	-	-	-	-	3	3
CO4	3	2	-	1	-	-	-	-	-	-	-	-	3	2
CO5	3	2	-	2	-	3	3	-	-	-	-	-	3	2
	3	2.6	-	2	-	2.2	1.4	-	-	-	-	-	3	2.6

Assessment Methods:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓			✓		

	MANUFACTURING TECHNOLOGY - I	L	T	P	C
		3	0	0	3

Course Objective (Employability)

- To introduce the concepts of basic manufacturing processes and fabrication techniques, such as metal casting, metal joining, metal forming and manufacture of plastic components.

UNIT I METAL CASTING PROCESSES 9

Sand casting – Sand moulds - Type of patterns – Pattern materials – Pattern allowances –Types of Moulding sand – Properties – Core making – Methods of Sand testing – Moulding machines – Types of moulding machines - Melting furnaces –Working principle of Special casting processes – Shell, investment casting – Ceramic mould – Lost Wax process – Pressure die casting – Centrifugal casting – CO2 process – Defects in Casting – Inspection methods.

UNIT II METAL JOINING PROCESSES 9

Fusion welding processes – Types of Gas welding – Equipments used – Flame characteristics – Filler and Flux materials - Arc welding equipments - Electrodes – Coating and Specifications – Principles of Resistance welding – Spot/butt, seam welding – Percusion welding - Gas metal arc welding – Flux cored – Submerged arc welding – Electro slag welding – TIG welding – Principle and application of special welding processes - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding – Diffusion welding – Weld defects – Brazing and soldering process – Methods and process capabilities – Filler materials and fluxes – Types of Adhesive bonding.

UNIT III BULK DEFORMATION PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – Characteristics of the process – Types of Forging Machines – Typical forging operations – Rolling of metals – Types of Rolling mills - Flat strip rolling – Shape rolling operations – Defects in rolled parts - Principle of rod and wire drawing -Tube drawing — Principles of Extrusion – Types of Extrusion – Hot and Cold extrusion — Equipments used.

UNIT IV SHEET METAL PROCESSES 9

Sheet metal characteristics - Typical shearing operations, bending and drawing operations – Stretch forming operations — Formability of sheet metal – Test methods – Working principle and application of special forming processes - Hydro forming – Rubber pad forming – Metal spinning – Introduction to Explosive forming, Magnetic pulse forming, Peen forming, Super plastic forming.

UNIT V MANUFACTURING OF PLASTIC COMPONENTS 9

Types and characteristics of plastics -– Moulding of Thermoplastics – Working principles and typical applications of - Injection moulding – Plunger and screw machines – compression moulding, Transfer moulding - Typical industrial applications – Introduction to Blow moulding – Rotational moulding – Film blowing – Extrusion - Thermoforming - Bonding of Thermoplastics.

TOTAL: 45 Hours

Course Outcomes:

After successful completion of the Production Technology course, the student will be able to

CO1:	Understand the basic concepts of manufacturing processes such as casting and molding and to create different new components using various patterns, materials and allowances.
CO2:	Elaborate the working principle and basic equipment needed for metal joining process and to learn about fabrication techniques of different types of welding and forming process.
CO3:	Learn the importance of metal forging and rolling processes.
CO4:	Plan for making required component using sheet metal operations and application of special forming processes.
CO5:	Make them to select appropriate moulding process based on plastic applications

Text Books:

1. Kalpak Jian, S., "Manufacturing Engineering and Technology", Pearson Education India Edition, 2006.
2. S. Gowri, P. Hariharan, A. Suresh Babu, Manufacturing Technology I, Pearson Education, 2008

Reference Books:

1. Roy. A. Lindberg, Processes and Materials of Manufacture, PHI / Pearson Education, 2006
2. Hajra Choudhury S.K and Hajra Choudhury. A.K., Elements of Workshop Technology, Volume I and II, Media Promoters and Publishers Private Limited, Mumbai, 1997.
3. Paul Degarma E, Black J.T. and Ronald A. Kosher, Elighth Edition, Materials and Processes, in Manufacturing Prentice – Hall of India, 1997.
4. Sharma, P.C., A Text book of Production Technology, S. Chand and Co. Ltd., 2004.
5. P.N. Rao, Manufacturing Technology Foundry, Forming and Welding, TMH-2003; 2nd Edition, 2003.

Mapping of Program Outcomes with Course Outcomes:

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

Assessment Methods:

CAT1	CAT2	Model Exam	End Semester Exams	Assignments
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**
✓			✓	

	ENGINEERING MATERIAL SCIENCE	L	T	P	C
		3	0	0	3

Course Objective

- Develop the knowledge on the structure, properties, Heat treatment, testing of various materials.
- Understands the applications of Engineering metals and non-metallic materials. Identify and select suitable materials for various engineering applications.

UNIT I ALLOYS AND PHASE DIAGRAMS 8

Classification of Materials, Necessity of alloying, Constitution of alloys – Solid solutions, substitution and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – carbon equilibrium diagram. Classification of steel and cast-Iron microstructure, properties and application.

UNIT II HEAT TREATMENT 10

Definition – Full annealing, stress relief, recrystallisation and spheroidising – normalising, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR – Hardenability, Jominy end quench test - Austempering, martempering – case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening.

UNIT III FERROUS AND NON-FERROUS METALS 9

Effect of alloying additions on steel- α and β stabilisers– stainless and tool steels – HSLA, Maraging steels – Cast Iron - Grey, white, malleable, spheroidal – alloy cast irons, Copper and copper alloys – Brass, Bronze and Cupronickel – Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys, Mg-alloys, Ni-based super alloys and Titanium alloys.

UNIT IV NON-METALLIC MATERIALS 9

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)- Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON –Composites-Classifications-Metal Matrix and FRP - Applications of Composites.

UNIT V MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS 9

Mechanisms of plastic deformation, slip and twinning – Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), hardness tests, Impact test lzod and charpy, fatigue and creep failure mechanisms.

TOTAL: 45 Hours

Text Books:

1. Avner, S.H., "Introduction to Physical Metallurgy", McGraw Hill Book Company,1994.
2. Williams D Callister, "Material Science and Engineering" Wiley India Pvt Ltd, Revised Indian Edition 2007.

Reference Books:

1. Raghavan. V, "Materials Science and Engineering", Prentice Hall of India Pvt. Ltd., 1999.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint 2002.
3. Upadhyay. G.S. and Anish Upadhyay, "Materials Science and Engineering", Viva Books Pvt. Ltd., New Delhi, 2006.
4. U.C. Jindal: Material Science and Metallurgy, "Engineering Materials and Metallurgy", First Edition, Dorling Kindersley, 2012

Web Links:

1. **https://www.digimat.in/nptel/courses/video/113107078/L01.html**
2. https://www.digimat.in/nptel/courses/video/113102080/L43.html

Course Outcomes

CO1:	Understanding constitutions of alloys phase diagram, Iron-Iron carbon diagram and steel classification	**K2**
CO2:	Analyze isothermal transformation, continuous cooling diagrams and different heat treatment processes.	**K4**
CO3:	Clarify the effects of alloying elements on ferrous and non-ferrous metals.	**K4**
CO4:	Explain the properties and applications of non-metallic materials.	**K5**
CO5:	Explain the testing of mechanical properties.	**K5**

Mapping of Course Outcomes with Program Outcomes

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

Assessment Methods:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓			✓		

	ELECTRICAL ENGINEERING LABORATORY	L	T	P	C
		0	0	3	1

Course Objectives

- To provide comprehensive idea about AC and D C circuit analysis, working principles and applicationsof basic machines in electrical engineering.
- To expose the students to learn experimental skills about Transformers, DC Motor, Converters.

List of Experiments

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter,oscilloscope. Real-life resistors, capacitors and inductors.
2. Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification.
3. Loading of a transformer: measurement of primary and secondary voltages and currents, and power
4. Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line- line voltage,phase-to-neutral voltage, line and phase currents).
5. Load Characteristics of a DC Motor
6. Torque - Slip Characteristic of an Induction motor
7. Three phase induction motors – Direction reversal by change of phase-sequence of connections.
8. Demonstration of DC-DC Converter.
9. Demonstration of DC-AC converter.
10. Demonstration of AC-DC converter.

TOTAL: 45 hours

Course Outcomes

CO1:	Understand the basic safety precautions and learn to make use of measuring instruments	**K2**
CO2:	Analyse the steady state response of R-L, R-C circuits	**K3**
CO3:	Experiment with loading of transformer to measure the primary and secondary voltages, currents and power and classify the different types of transformer connections	**K3**
CO4:	Understand and Experiment with single phase induction motor and three phaseinduction motor	**K2**
CO5:	Demonstrate DC-DC, DC-AC and AC-DC converters	**K4**

Mapping of Course Outcomes with Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	-	-	-	-	-	-	2	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	3
CO3	3	3	2	3	3	-	-	-	-	-	-	-	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	-	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	-	3	3
Average	3.0	2.6	2.4	2.8	2.6	-	-	-	-	-	-	-	2.8	2.8

Assessment Methods:

CAT 1	CAT 2	Model Exam	End Semester Exams	Observation
		✓	✓	✓
Record	**MCQ**	**Projects**	**Viva**	**Demonstration / Presentation**
✓			✓	✓

	MANUFACTURING TECHNOLOGY - I LABORATORY	L	T	P	C
		0	0	3	1

Course Objective

- To Study and get the practical knowledge of several steps of various operations that can be performed in lathe, and to equip with the practical knowledge required in the core industries.

LIST OF EXPERIMENTS

1. Practice facing and plain turning on the given cylindrical work piece.
2. Practice chamfering and step turning.
3. Practice turning a taper to the specified length on a cylindrical specimen.
4. Production of specified exterior or interior threads on a certain specimen
5. Practice step turning on a particular specimen with specified knurling.
6. Practice boring, reaming, and drilling on the provided work piece.
7. Practice turning an eccentric piece on a lathe using a provided specimen.
8. Practice internal thread drilling on a specified specimen.
9. Experiment on welding for joining given work pieces.
9. Study of lathe machine
10. Study of welding operations

TOTAL: 45 Hours

List of Equipment

1. Center lathe - 14 Nos.
2. Single point cutting tool
3. Measuring devices like Vernier caliber, steel rule
4. Knurling tool, reaming tool, flat file etc.,

Course Outcomes:

After successful completion of the Manufacturing Technology Laboratory course, the student will be able to

CO1:	Understand the components functions and the working of lathe machine and able to use different machine tools for finishing operations
CO2:	Understand the possible various machining operations and selection of correct process
CO3:	Perform experiment based on requirement in lathe machine
CO4:	Distinguish various tools usage and measuring instruments involved in manufacturing operations with a potential cause and remedy
CO5:	Determine the different material joining processes and related faults, along with a potential cause and remedy.

Mapping of Program outcomes with course outcomes

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

Assessment Methods:

CAT 1	CAT 2	Model Exam	End Semester Exams	Observation
		✓	✓	✓
Record	**MCQ**	**Projects**	**Viva**	**Demonstration / Presentation**
✓			✓	✓

	STRENGTH OF MATERIALS	L	T	P	C
		3	1	0	4

Course Objective: (Employability)

- To understand the stresses developed in bars, compounds bars, beams, shafts, cylinders and spheres.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 12

Rigid and Deformable bodies – Strength, Stiffness and Stability – Stresses; Tensile, Compressive and Shear – Deformation of simple and compound bars under axial load – Thermal stress – Elastic constants – Strain energy and unit strain energy – Strain energy in uniaxial loads.

UNIT II BEAMS - LOADS AND STRESSES 12

Types of beams: Supports and Loads – Shear force and Bending Moment in beams – Cantilever, Simply supported and Overhanging beams – Stresses in beams – Theory of simple bending – Stress variation along the length and in the beam section – Effect of shape of beam section on stress induced – Shear stresses in beams – Shear flow.

UNIT III TORSION 12

Analysis of torsion of circular bars – Shear stress distribution – Bars of Solid and hollow circular section – Stepped shaft – Twist and torsion stiffness – Compound shafts – Fixed and simply supported shafts – Application to close-coiled helical springs – Maximum shear stress in spring section including Wahl Factor – Deflection of helical coil springs under axial loads – Design of helical coil springs – stresses in helical coil springs under torsion loads.

UNIT IV BEAM DEFLECTION 12

Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Double integration method, Macaulay Method, and Moment-area Method –Columns and its types – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns.

UNIT V ANALYSIS OF STRESSES IN TWO DIMENSIONS 12

Biaxial state of stresses – Thin cylindrical and spherical shells – Deformation in thin cylindrical and spherical shells – Biaxial stresses at a point – Stresses on inclined plane – Principal planes and stresses – Mohr's circle for biaxial stresses – Maximum shear stress - Strain energy in bending and torsion.

TOTAL: 60 Hours

Course Outcomes:

After successful completion of the Strength of Materials course, the student will be able to

CO1 Analyze the rigid bodies and deformable solids response when subjected to different stresses and measure the strain and the relationship of stress and strain.

CO2 Analyze the different types of beam response when subjected to different types of loads, shear stresses and evaluation of shear force and bending moment diagram.

CO3 Analyze the different types of shaft and spring response when subjected to torsion forces axially and design of helical coil spring, analysis of deflection and stresses.

CO4 Evaluation of beam deflection and slope using different mathematical methods and column subjected to different end conditions.

CO5 Analyses of stresses in two dimensions of thin cylindrical and spherical shells and solve stresses at a point and inclined planes.

Text Books:

1. Popov E.P, “Engineering Mechanics of Solids”, Prentice-Hall of India, New Delhi, 1997.
2. Beer F. P. and Johnston R, “Mechanics of Materials”, McGraw-Hill Book Co, Third Edition, 2002.

Reference Books:

1. Nash W.A, “Theory and problems in Strength of Materials”, Schaum Outline Series, McGraw-Hill Book Co, New York, 1995
2. Kazimi S.M.A, “Solid Mechanics”, Tata McGraw-Hill Publishing Co, New Delhi, 1981
3. Ryder G.H, “Strength of Materials”, Macmillan India Ltd., Third Edition, 2002
4. Ray Hulse, Keith Sherwin & Jack Cain, “Solid Mechanics”, Palgrave ANE Books, 2004.
5. Singh D.K “Mechanics of Solids” Pearson Education 2002.
6. Timoshenko S.P, “Elements of Strength of Materials”, Tata McGraw-Hill, New Delhi 1997.

Mapping of Program Outcomes with Course Outcomes

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

Assessment Methods:

CAT1	CAT2	Model Exam	End Semester Exams	Assignments
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**
✓			✓	

	KINEMATICS OF MACHINERY	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the basic components and layout of linkages in the assembly of a system / machine.
- To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- To understand the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components.

UNIT I BASICS OF MECHANISMS 9

Introduction- resistant bodies- kinematic link- kinematic pair- kinematics constraint kinematic chain- mechanism- structure – Inversion of four bar chain- inversion of single slider crank chain – inversion of double crank chain – Grashof‘s law – Degrees of freedom – Kutzbach criterion – Grobler’s criterion. Classification of mechanisms Ratchets and Escapement mechanisms- Indexing mechanisms- Analysis of Hooke‘s joint– Double Hooke‘s joint- Pantograph – Straight line motion Mechanisms (Exact and Approximate) - Steering gear mechanisms.

UNIT II KINEMATICS AND SYNTHESIS OF LINKAGE MECHANISMS 9

Displacement, velocity and acceleration analysis of mechanisms – Velocities and accelerations by relative velocity method-Velocity analysis using instantaneous center method- Velocities and accelerations by Analytical method - Coriolis component of acceleration. Analysis and synthesis of simple mechanisms using Graphical and Analytical Methods.

UNIT III KINEMATICS OF CAM MECHANISMS 9

Nomenclature of Cam and Cam shaft assembly. Classification of cams and followers – law of cams- Terminology and definitions – Displacement diagrams – Uniform velocity, parabolic, simple harmonic, Cycloidal – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams – Pressure angle and undercutting – sizing of cams.

UNIT IV GEARS AND GEAR TRAINS 9

Law of gearing – Spur Gear terminology and definitions – Involutes and cycloidal tooth profiles Gear tooth action – Contact ratio – Interference and undercutting – corrected and uncorrected gear teeth – Gear terminology and definitions - Helical, Bevel, Worm, Rack and Pinion gears– Gear trains – Speed ratio, train value – Epicyclic Gear Trains.

UNIT V FRICTION IN MACHINE ELEMENTS 9

Surface contacts - Sliding and Rolling friction - Friction drives - Friction in screw threads - Bearings and lubrication - Friction clutches - Belt and rope drives - Friction aspects in brakes.

TOTAL: 45 hours

Text Books:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., ―Theory of Machines and Mechanisms, 5th Edition, Oxford University Press, 2017.
2. Rattan, S.S, ―Theory of Machines, 4th Edition, Tata McGraw-Hill, 2017.
3. R.S. Khurmi, Theory of Machines, 14th Edition, S Chand publication, 4 March 2020.

Reference Books:

1. Robert L. Norton, ―Kinematics and Dynamics of Machinery, Tata McGrawHill, 2010.
2. Kenneth J Waldron, Gary L Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley India Pvt Ltd – 2nd Edition, 2003.
3. R.K. Bansal and J.S. Brar, Theory of Machines, Laxmi Publications, 2016.

4. Sadhu Singh, Theory of machines, Pearson, 2013.
5. Ghosh. A and Mallick, A.K., ―Theory of Mechanisms and Machines, Affiliated East- West Pvt. Ltd., New Delhi, 2016.
6. Rao.J.S. and Dukkipati. R.V. ―Mechanisms and Machine Theory, Wiley-Eastern Ltd., NewDelhi, 2nd Edition, 1992, Reprint 2006.
7. John Hannah and Stephens R.C., ―Mechanics of Machines, Viva Low-Prices Student Edition, 1999.
8. V.Ramamurthi, ―Mechanics of Machines, Narosa Publishing House, 3 rd. Edition 2012.

Web Links:

1. **https://nptel.ac.in/courses/112105268**
2. **https://nptel.ac.in/courses/112104121**
3. **https://unacademy.com/course/theory-of-machines-473/KW3UHY0N**

Course Outcomes

CO1:	Explain the concepts of machines, mechanisms and related terminologies in the assembly of a system /machine.	K1
CO2:	Analyze simple mechanism for displacement, velocity and acceleration by graphical method	K4
CO3:	Analyze the kinematics of CAM mechanism.	K4
CO4:	Analyze and design gears and gear trains.	K4
CO5:	Evaluate friction and its effects in machine components.	K3

Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	2	-	-	-	-	-	1	-	1	3	1
CO2	3	3	2	3	3	-	-	-	-	2	-	1	3	3
CO3	3	3	3	3	2	-	-	-	-	2	-	1	3	3
CO4	3	3	2	3	2	-	-	-	-	2	-	1	3	3
CO5	3	2	1	1	-	-	-	-	-	1	-	1	3	2
	3	2.4	1.8	2.4	1.4	-	-	-	-	1.6	-	1	3	2.4

Assessment Methods:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓			✓		

	FLUID MECHANICS AND MACHINERY	L	T	P	C
		3	0	0	3

Course Objective: (Employability)

- The applications of the conservation laws to flow through pipes and hydraulic machines are studied
- To understand the importance of dimensional analysis.
- To understand the importance of various types of flow in pumps and turbines.

UNIT I INTRODUCTION 9

Units & Dimensions. Properties of fluids – Specific gravity, specific weight, viscosity, compressibility, vapour pressure and gas laws – capillarity and surface tension. Flow characteristics: concepts of system and control volume. Application of control volume to continuity equation, energy equation, momentum equation and moment of momentum equation.

UNIT II FLOW THROUGH CIRCULAR CONDUITS 9

Laminar flow through circular conduits and circular annuli, Boundary layer concepts, Boundary layer thickness. Hydraulic and energy gradient, Darcy – Weisbach equation, Friction factor and Moody diagram, Commercial pipes, Minor losses, Flow through pipes in series and in parallel.

UNIT III DIMENSIONAL ANALYSIS 9

Dimension and units: Buckingham's π theorem, Discussion on dimensionless parameters, Models and similitude, Applications of dimensionless parameters.

UNIT IV ROTO DYNAMIC MACHINES 9

Homologus units, Specific speed, Elementary cascade theory, Theory of turbo machines, Euler's equation, Hydraulic efficiency, Velocity components at the entry and exit of the rotor. Velocity triangle for single stage radial flow and axial flow machines, Centrifugal pumps, turbines, performance curves for pumps and turbines.

UNIT V POSITIVE DISPLACEMENT MACHINES 9

Positive displacement pumps and classification of pumps, Reciprocating pumps, characteristics of reciprocating pump, Indicator diagrams, Work saved by air vessels. Rotary pumps, Classification, Working and performance curves.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Fluid Mechanics and Machinery course, the student will be able to

CO1:	Understand and apply the basic concepts of Fluid Mechanics to carry out professional engineering activities in the field of fluids and to apply scientific method strategies to fluid mechanics: analyzed qualitatively and quantitatively the problem situation, propose hypotheses and solutions.
CO2:	Use the appropriate means of knowledge, procedures, results, skills and aspects inherent to fluid mechanics and to understand the major and minor losses in flow through circular conduits.
CO3:	Plan and carry out dimensional analysis, similitude and model analysis in accordance with the relevant specific technology
CO4:	To estimate the conservation laws to flow through pipes and hydraulic machines and the importance of various types of flow in pumps and turbines.
CO5:	To apply and study the basic concepts of pumps, air vessels and its performance curves.

Text Books:

1. Streeter. V. L., and Wylie, E.B., Fluid Mechanics, McGraw Hill, 1983.
2. Rathakrishnan. E, Fluid Mechanics, Prentice Hall of India (II Ed.), 2007.

Reference Books:

1. Ramamritham. S, Fluid Mechanics, Hydraulics and Fluid Machines, Dhanpat Rai & Sons, Delhi, 1988.
2. Kumar. K.L., Engineering Fluid Mechanics (VII Ed.)Eurasia Publishing House (P) Ltd., New Delhi, 1995.
3. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi.

Mapping of Program Outcomes with Course Outcomes

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

Assessment Methods:

CAT1	CAT2	Model Exam	End Semester Exams	Assignments
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/Presentation**
✓			✓	

	MANUFACTURING TECHNOLOGY-II	L	T	P	C
		3	0	0	3

Course Objective: (Employability)

- The main objective of this course is to provide wider and depth knowledge to the students in machine tools cutting methodology of various manufacturing machines.

UNIT I THEORY OF METAL CUTTING 9

Introduction to types of machine tools, Theory of metal cutting -material removal processes: chip formation, orthogonal cutting and oblique cutting. Merchant circle-problems, cutting tool materials, tool wear, tool life-problems, surface finish, cutting fluids.

UNIT II CENTRE LATHE AND SPECIAL PURPOSE LATHES 9

Centre lathe, constructional features, cutting tools, various operations, taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes – automatic lathes: semi-automatic, automats – single spindle: cutting off, swiss type, automatic screw type – multi spindle; cutting off, bar type.

UNIT III RECIPROCATING AND MILLING MACHINES 9

Reciprocating machine tools: shaper, planer, slotter; milling: types, milling cutters, operations; hole making: drilling, reaming, boring, tapping.

UNIT IV SURFACE FINISHING PROCESSES 9

Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centre less grinding – honing, lapping, super finishing, polishing and buffing, abrasive jet grinding.

UNIT V SAWING, BROACHING AND GEAR CUTTING 9

Sawing machine: hack saw, band saw, circular saw; broaching machines: broach construction – push, pull, surface and continuous broaching machines, gear cutting: forming, generation, shaping, hobbing.

TOTAL: 45 Hours

Course Outcomes:

After successful completion of the Manufacturing Technology course, the student will be able to

CO1:	Understand the concept and basic mechanics of metal cutting process and classify ideas about cutting tool materials, tool life, tool wear.
CO2:	To learn the importance of constructional features and working principle of center lathe and special purpose lathe.
CO3:	Develop knowledge about reciprocating machine tools and milling machines for various machining operations.
CO4:	To create the constructive knowledge in surface finishes process such as surface grinding, honing, lapping, polishing, buffing and abrasive jet grinding.
CO5:	To understand the concept and working principle of various sawing machines, broaching machines and various gear cutting operations.

Text Books:

1. Rao, P.N. “Manufacturing Technology”, Metal Cutting and Machine Tools, Tata McGraw–Hill, New Delhi, 2003.

2. Richerd R. Kibbe, John E. Neely, Roland O. Merges and Warren J. White, “Machine Tool Practices”, Prentice Hall of India, 2003.

Reference Books:

1. HMT, “Production Technology”, Tata McGraw-Hill, 1998.
2. P.C. Sharma, “A Text Book of Production Engineering”, S.Chand and Co. Ltd, IV edition, 1993.
3. Hajra Choudry, “Elements of Work Shop Technology – Vol. II”, Media Promoters. 2002.
4. Geofrey Boothroyd, “Fundamentals of Metal Machining and Machine Tools”, McGraw Hill, 1984.

Mapping of Program Outcomes with Course Outcomes

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

Assessment Methods:

CAT1	CAT2	Model Exam	End Semester Exams	Assignments
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/Presentation**
✓			✓	

	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective: (Skill development)

- To inculcate the importance of environmental pollution, preservation of nature and environmental management for human welfare.
- The student is expected to understand what constitutes the environment, what precious resources in the environment are, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity.
- The role of government and non – governmental organization in environmental managements.

UNIT I ENVIRONMENT, ECOSYSTEM AND BIODIVERSITY 9

Definition – Scope and importance – Need for public awareness – Concepts of an Ecosystem – Structure and Function of an Ecosystem –Producers, Consumers and Decomposers – Energy Flow in the Ecosystem – Ecological Succession – Food Chains, Food Webs and Ecological Pyramids – Introduction, Types, Characteristic Features, Structure and Function of the (A) Forest Ecosystem (B) Grassland Ecosystem (C) Desert Ecosystem (D) Aquatic Ecosystems (Ponds, Streams, Lakes, Rivers, Oceans, Estuaries) – Introduction to Biodiversity – Definition: Genetic, Species and Ecosystem Diversity – Biogeographical Classification of India – Value of Biodiversity: Consumptive Use, Productive Use, Social, Ethical, Aesthetic and Option Values – Biodiversity at Global, National and Local Levels – India as a Mega-Diversity Nation – Hot-Spots of Biodiversity – Threats to Biodiversity: Habitat Loss, Poaching of Wildlife, Man-Wildlife Conflicts – endangered and Endemic Species of India – Conservation of Biodiversity: In-Situ and Ex-Situ conservation of Biodiversity.

Field Study of Common Plants, Insects and Birds. Field study of simple ecosystems - pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 9

Definition – Causes, Effects and Control Measures of (A) Air Pollution (B) Water Pollution (C) Soil Pollution (D) Marine Pollution (E) Noise Pollution (F) Thermal Pollution (G) Nuclear Hazards – Solid Waste Management:- Causes, Effects and Control Measures of municipal solid Wastes – Role of an Individual in Prevention of Pollution – Pollution Case Studies – disaster Management - Floods, Earthquake, Cyclone and Landslides.

Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 9

Forest resources -Use and over – Exploitation – Deforestation – Case studies – Timber extraction – Mining – Dams and their ground water – Floods – Drought – Conflicts over water –Dams – Benefits and Problems – Mineral Resources- Use and Exploitation, Environmental Effects of Extracting and Using Mineral Resources, Case Studies – Food Resources: World Food Problems, Changes caused by Agriculture and Overgrazing, Effects of Modern Agriculture, Fertilizer- Pesticide Problems, Water Logging, salinity, Case Studies – Energy Resources:- Growing Energy Needs, Renewable and Non Renewable Energy Sources, Use of Alternate Energy Sources, Case Studies – Land Resources - Land as a Resource, Land Degradation, Man Induced Landslides, Soil Erosion and Desertification – Role of an Individual in Conservation of Natural Resources – Equitable use of Resources for Sustainable Lifestyles.

Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 9

From Unsustainable To Sustainable Development – Urban Problems Related to energy – Water conservation, Rain Water Harvesting, Watershed Management – Resettlement and Rehabilitation of People, its Problems and Concerns, Case Studies Role of non – governmental organization - Environmental Ethics- Issues and Possible Solutions – Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion, Nuclear Accidents and Holocaust, Case Studies –Wasteland Reclamation – Consumerism and Waste Products – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and Control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act –enforcement machinery involved in environmental Legislation – Central and state pollution control boards - Public Awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 9

Population Growth, Variation among Nations – Population Explosion Family Welfare Programme – environment and Human Health – Human Rights –Value Education – HIV /AIDS – Women and Child Welfare – Role of Information Technology in Environment and Human Health – Case Studies.

TOTAL: 45 Hours

Course Outcome

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

CO1:	Understand the nature and facts about environment and implement scientific, technological, economic solutions to environmental problems and interrelationship between living organisms and environment.
CO2:	Understand the integrated themes and biodiversity, natural resources, pollution control and waste management.
CO3:	Analyze the importance of environment by assessing its impact on the human world.
CO4:	Study the dynamic processes and understand the features of the earth's interior and surface; know the role of an individual in Conservation of Natural Resources and the various social issues.
CO5:	Understand the role of government in solving the environmental problems and Know about Population Growth and variation among Nations.

Text Books:

1. De AK, Environmental Chemistry, Wiley Eastern Ltd.
2. BharuchaErach, 2003. The Biodiversity of India, Mapin Publishing Pvt. Ltd, India.
3. Brunner RC, 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480pgs.
4. Clark RS, Marine Pollution, Clanderson Press, Oxofrd (TB).

Reference Books:

1. Agarwal KC, 2001. Environmental Biology, Nidi Publishers Ltd. Bikaner.
2. Gleick HP, 1993. Water in Crisis, Pacific Institute for Studies in Development, Environment and Security. Stockholm Environmental Institute, Oxford University Press.
3. Heywood VH, and Watson RT, 1995. global Biodiversity Assessment. Cambridge University Press 1140pgs.
4. Jadhav H and Bhosale VM, 1995. Environmental Protection and Laws. Himalaya Publishing House, Delhi 284pgs.
5. Miller TG, Jr. Environmental Science, Wadsworth Publishing CO. (TB)

Mapping of program outcomes with course outcomes

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

Assessment Methods:

CAT1	CAT2	Model Exam	End Semester Exams	Assignments
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**
✓			✓	

	FLUID MECHANICS AND STRENGTH OF MATERIALS LABORATORY	L	T	P	C
		0	0	3	1

Course Objective: (Skill development)

- Upon Completion of this subject, the students can able to have hands on experience in flow measurements using different devices and also perform calculation related to losses in pipes and also perform characteristic study of pumps, turbines etc.
- After completion of this laboratory the students can ability to use the measurement equipments for flow measurement and they can ability to do performance trust on different fluid machinery.

LIST OF EXPERIMENTS

1. Calibration of Flow Measuring instruments – venturimeter, orifice meter, rotometer,
2. Calibration of flows in open channels – weirs and notches.
3. Estimation of friction factor in flow through pipes.
4. Determination of performance characteristics of pumps – centrifugal pumps, submersible pumps, turbine pumps and positive displacement pumps and reciprocating and gear pumps.
5. Determination of performance characteristics of turbines – reaction turbines and impulse turbines.

STRENGTH OF MATERIALS LAB

Course Objective:

- To supplement the theoretical knowledge gained in Mechanics of Solids with practical testing for determining the strength of materials under externally applied loads. This would enable the student to have a clear understanding of the design for strength and stiffness.

LIST OF EXPERIMENTS

1. Tension test on mild steel rod.
2. Double shear test on metals.
3. Torsion test on mild steel rod.
4. Impact test on metal specimen.
5. Hardness test on metals.
6. Compression test on helical spring.
7. Deflection test on carriage spring.

TOTAL: 45 Hours

After successful completion of the Fluid Mechanics Laboratory course, the student will be able to

CO1:	Understanding of the fundamental principles of mechanics of materials and determining the strength of materials under externally applied loads
CO2:	Analyzing deflection test on beams and compression test on helical springs and Measure deformations, forces, and strains under a variety of loading conditions, including tension compression, bending.

CO3:	Understand the calibration of flow measuring instruments and estimations of friction factor through pipes
CO4:	Determine the performance characteristics of pumps
CO5:	Determine the performance characteristics of turbines

Mapping of program outcomes with course outcomes

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

Assessment Methods:

CAT1	CAT2	Model Exam	End Semester Exams	Observation
		✓	✓	✓
Record	**MCQ**	**Projects**	**Viva**	**Demonstration/ Presentation**
✓			✓	✓

	MANUFACTURING TECHNOLOGY - II LABORATORY	L	T	P	C
		0	0	3	1

Course Objective

- To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required in the core industries.

LIST OF EXPERIMENTS

1. Assembly of core and cavity
2. Assembly of die and punch
3. Machining an internal keyway using slotting machine
4. Shaping round to square
5. Surface grinding
6. Keyway milling
7. Drilling and tapping
8. Turning and cylindrical grinding

TOTAL: 45 Hours

LIST OF EQUIPMENT

1. Center lathe - 14 Nos.
2. Capstan lathe - 01 No.
3. Turret lathe - 01 No.
4. Pillar type drilling machine - 01 No.
5. Radial drilling machine - 01 No.
6. Shaper - 02 Nos.
7. Surface grinding machine - 01 No.
8. Cylindrical grinding machine - 01 No.
9. Gear hobbing machine - 01 No.
10. Horizontal milling machine - 02 Nos.
11. Slotting machine - 01 No.

Course Outcomes:

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

CO1:	Practice on Mechanics of metal cutting & Machining Operations Study and practice the various operations that can be performed in lathe machines
CO2:	Understand the concept of shaper machines and its functions and Study the drilling operations performed in different types of drilling machine and its applications.
CO3:	Study and practice the milling machines for various operations that can be performed in milling machine and Equip with the practical knowledge required in the core industries.
CO4:	Study of the construction details of different types of machines used in manufacturing process and Different types of tools used in machines and the measuring instruments.
CO5:	Propose the most economical route to fabricate the required engineering component and predict and develop a methodology and establish a manufacturing sequence to fabricate engineering components.

Mapping of Program outcomes with course outcomes

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

Assessment Methods:

CAT 1	CAT 2	Model Exam	End Semester Exams	Observation
		✓	✓	✓
Record	**MCQ**	**Projects**	**Viva**	**Demonstration/ Presentation**
✓			✓	✓

	DESIGN OF MACHINE ELEMENTS	L	T	P	C
		3	1	0	4

Course Objectives

- To familiarize the various steps involved in the Design Process
- To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components
  (Use of P S G Design Data Book is permitted)

UNIT I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 12

Fundamentals of Machine Design-Engineering Design, Phases of Design, Design Consideration - Standards and Codes - Selection of Materials –Design against Static and Dynamic Load –Modes of Failure, Factor of Safety, Principal Stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame, Theories of Failure-Stress Concentration, Stress Concentration Factors, Variable Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria.

UNIT II SHAFTS AND COUPLINGS 12

Design of Shaft –For Static and Varying Loads, For Strength and Rigidity-Keys, keyways and splines - Design of Coupling-Types, Flange, Muff and Flexible Coupling.

UNIT III TEMPORARY AND PERMANENT JOINTS 12

Threaded fastners – Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures – theory of bonded joints.

UNIT IV ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 12

Various types of springs, optimization of helical springs – rubber springs – Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

UNIT V BEARINGS 12

Sliding contact and rolling contact bearings – Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, — Selection of Rolling Contact bearings.

TOTAL : 60 hours

Text Books:

T1: Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016.
T2: Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 9th Edition, Tata McGraw-Hill, 2011.

Reference Books:

R1: Machine Design, Robert L. Norton, Pearson Education Asia, 2001.
R2: Engineering Design, George E. Dieter, Linda C Schmidt, McGraw Hill Education, Indian Edition, 2013.
R3: Design of Machined Elements, S C Pilli and H. G. Patil, I. K. International Publisher, 2017.
R4: Machine Design, Hall, Holowenko, Laughlin (Schaum's Outline series) adapted by S.K Somani, tata McGraw Hill Publishing company Ltd., New Delhi, Special Indian Edition, 2008.
R5: Machine Design- an integrated approach Robert L. Norton Pearson Education 2nd edition.
R6: Design and Machine Elements Spotts M.F., Shoup T.E Pearson Education 8th edition,2006.
R7: Machine Component Design Orthwein W Jaico Publishing Co 2003.
R8: Machine Design Hall, Holowenko, Laughlin (Schaum's Outline series) adapted by S.K.Somani Tata McGraw Hill Publishing Company Ltd Special Indian Edition, 2008.

R9: Elements of Machine Design H.G.Patil, S.C.Pilli, R.R.Malagi, M.S.Patil IK International First edition, 2019.
R10: Design of Machine Elements Volume I T. Krishna Rao IK international publishing house, New Delhi. 2012.
R11: Hand book of Mechanical Design G. M. Maithra and L.V.Prasad Tata McGraw Hill 2nd edition, 2004.

Design Data Hand Book:

1. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd edition, 2003.
2. Design Data Hand Book, K. Mahadevan and Balaveera Reddy, CBS publication.
3. Design Data Hand Book, H.G.Patil, I. K. International Publisher, 2010
4. PSG Design Data Hand Book, PSG College of technology, Coimbatore.

Web Links:

1. http://nptel.ac.in/courses/Webcoursecontents/IIT%20Kharagpur/Machine%20design1/pdf/mod1les 3.pdf
2. http://nptel.ac.in/cour ses/112105125/pdf/ Module-1_Lesson2.pdf

Course Outcomes

CO1	Explain the influence of steady and variable stresses in machine component design.	**K 2**
CO2	Apply the concepts of design to shafts, keys and couplings.	**K 4**
CO3	To analyze and design structural joints such as Riveted joints, welded joints, Bolts	**K 4**
CO4	Apply the concepts of design to energy absorbing members, connecting rod and crank shaft.	**K 2**
CO5	Apply the concepts of design to bearings.	**K 3**

Mapping of Course Outcomes with Program Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	2	2	0	2	1	0	0	3	2
CO2	3	3	3	3	2	0	1	1	0	0	3	3
CO3	3	3	3	3	2	0	1	0	0	0	3	3
CO4	3	3	3	3	3	0	1	0	0	0	3	3
CO5	3	3	3	2	2	0	1	0	0	0	3	3

Assessment Methods:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**
✓			✓	

	DYNAMICS OF MACHINERY	L	T	P	C
		3	0	0	3

Course Objectives

- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the effect of dynamics of undesirable vibrations.
- To understand the principles in mechanisms used for speed control and stability control.

UNIT I FORCE ANALYSIS 9 hours

Applied and constraint forces – Free body diagrams – Static equilibrium conditions – force equilibrium analysis of simple mechanisms - friction in mechanisms– Dynamic force analysis – Inertia force and Inertia torque – D Alembert‘s principle–Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams – Flywheels for engines and punching presses. –Effect of mass moment Inertia on automotive engines.

UNIT II BALANCING 9 hours

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi- cylinder inline engines, V-engines – Partial balancing in engines– Balancing of linkages–Balancing Machines-Balancing standards - Field balancing of single disc.

UNIT III FREE VIBRATION 9 hours

Basics of vibratory systems – Degrees of freedom – Natural frequency -spring mass system Equations of motion — Viscously damped free vibration- Logarithmic decrement Transverse vibration – Dunkley‘s method- Critical speed of shafts -Two and three rotor torsional vibration – Non-linear and random vibrations (Basics Only). Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination. Multi degree freedom suspension system – Determination of influence coefficient.

UNIT IV FORCED VIBRATION 9 hours

Response of one degree freedom system to Harmonic excitation force – Basics of Forced vibration of multi degree freedom– Vibration Isolation - rotating unbalance - support motion – Transmissibility - Energy dissipated by damping- Vibration measuring instruments – Introduction to condition Monitoring and noise control.

UNIT V MECHANISMS FOR CONTROL 9 hours

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force. Gyroscopes – Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

TOTAL: 45 hours

Text Books:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., - Theory of Machines and Mechanisms, 5th Edition, Oxford University Press, 2017.
2. Rattan, S.S, ―Theory of Machines, 4th Edition, Tata McGraw-Hill, 2017.
3. R.S. Khurmi, Theory of Machines, 14th Edition, S Chand publication, 4 March 2020.

Reference Books:

1. Robert L. Norton, ―Kinematics and Dynamics of Machinery, Tata McGrawHill, 2010.

2. Kenneth J Waldron, Gary L Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley India Pvt Ltd – 2nd Edition, 2003.
3. R.K. Bansal and J.S. Brar, Theory of Machines, Laxmi Publications, 2016.
4. Sadhu Singh, Theory of machines, Pearson, 2013.
5. Ghosh. A and Mallick, A.K., ―Theory of Mechanisms and Machines, Affiliated East- West Pvt. Ltd., New Delhi, 2016.
6. Rao.J.S. and Dukkipati. R.V. ―Mechanisms and Machine Theory, Wiley-Eastern Ltd., New Delhi, 2nd Edition, 1992, Reprint 2006.
7. John Hannah and Stephens R.C., ―Mechanics of Machines, Viva Low-Prices Student Edition, 1999.
8. V.Ramamurthi, ―Mechanics of Machines, Narosa Publishing House, 3 rd. Edition 2012.

Web Links:

1. **https://www.digimat.in/nptel/courses/video/112104114/L01.html**
2. **https://www.youtube.com/watch?v=OlZXxPVpmBs**
3. **https://onlinecourses.nptel.ac.in/noc21_me96/preview**
4. **https://nptel.ac.in/courses/112104114**

Course Outcomes

CO1:	Calculate the dynamic forces in reciprocating engines and determine energy, speed fluctuation using turning moment diagram of engine.	**K2**
CO2:	Solve mass balancing and identify their locations of reciprocating and rotating masses.	**K3**
CO3:	Examine the natural frequency of free vibration systems.	**K3**
CO4:	Analyze the natural frequency damping coefficient of forced vibration systems.	**K4**
CO5:	Evaluate the speed and lift of the governor and estimate the gyroscopic effect on automobiles, ships and airplanes.	**K3**

Mapping of Course Outcomes with Program Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO 1	3	2	1	-	1	-	-	-	-	-	-	1	3	2
CO 2	3	3	1	1	2	-	-	-	-	-	-	1	3	3
CO 3	3	3	1	1	2	-	2	-	-	-	-	2	3	3
CO 4	3	3	1	1	1	-	1	-	-	-	-	2	3	3
CO 5	3	3	1	1	1	-	-	-	-	-	-	2	3	3
	3	2.8	1	0.8	1.4	-	0.6	-	-	-	-	1.6	3	2.8

Assessment Methods:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	MCQ	Projects	Seminars	Demonstration/ Presentation	Open book test
✓			✓		

	APPLIED HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

Course Objective:

- To learn fundamentals of hydraulic power control components and their circuits with industrial applications
- To learn fundamentals of pneumatic power control components and their circuits with industrial applications

UNIT I FLUID POWER SYSTEMS AND FUNDAMENTALS 9 hours

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids – General types of fluids – Fluid power symbols. Basics of Hydraulics-Applications of Pascals Law- Laminar and Turbulent flow – Reynold's number – Darcy's equation – Losses in pipe, valves and fittings.

UNIT II HYDRAULIC CIRCUITS AND SYSTEMS 9 hours

Accumulators, Intensifiers, Industrial hydraulic circuits — Regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT III HYDRAULIC CONTROL AND CIRCUITS 9 hours

Construction of Control Components : Director control valve – 3/2 way valve – 4/2 way valve – Shuttle valve – check valve – pressure control valve – pressure reducing valve, sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram. Accumulators and Intensifiers: Types and sizing of accumulators – intensifier – Applications of Intensifier. Circuits for controlling single acting and double acting cylinders, Accumulators circuits – Intensifier circuit.

UNIT IV PNEUMATIC CONTROL AND CIRCUITS 9 hours

Pneumatic Components: Properties of air – Compressors – Filter, Regulator, Lubricator unit – Air control valves, Quick exhaust valves, pneumatic actuators. Fluid power circuit design, Speed control circuits, synchronizing circuit Pneumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.

UNIT V SERVO SYSTEMS, FLUIDICS AND FLUID POWER TROUBLE SHOOTING 9 hours

Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves, Fluidics – Introduction to fluidic devices, simple circuits, Introduction to Electro Hydraulic Pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control. Fluid power circuits; failure and troubleshooting

TOTAL: 45 hours

Text Books

1. Anthony Esposito, "Fluid Power with Applications", 7th Edition, Pearson Education 2013.
2. Majumdar S.R., "Oil Hydraulics: Principles and Maintenance", Tata McGraw-Hill, 2011.

References

1. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 1995.
2. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989.
3. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
4. Srinivasan.R, "Hydraulic and Pneumatic controls", Tata McGraw-Hill, 2011.

Course Outcomes

CO1:	Understand properties of fluid and fluid power systems. Understand the concepts of fluid statics and dynamics applied to Fluid power applications.	K2
CO2:	Application of various components such as pumps, cylinders, motors, rotary actuators for fluid power principles.	K3
CO3:	Construction and Design of valves and hydraulic circuits	K3
CO4:	Construction, design and working of system components used in pneumatic systems	K3
CO5:	Understand the servo system and fluid power trouble shooting. Demonstrate application of fluid power in electro hydraulic pneumatic logic circuits an construction of ladder diagrams pneumatic control and PLC applications."	K4

Mapping of Course Outcomes with Program Outcomes

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

Assessment Methods:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	MCQ	Projects	Seminars	Demonstration/ Presentation	Open book test
✓			✓	✓	

	ENGINEERING METROLOGY AND MEASUREMENTS	L	T	P	C
		3	0	0	3

Course Objective:

- To acquire knowledge on various measuring instruments. Further, to expose the science behind the measurements and their applications in manufacturing industries in quality control.
- To understand the principles of measurements of form, surface finish, transmission elements and the basics of computer aided metrology.

UNIT I CONCEPT OF MEASUREMENT 9

General concept – Units and types of standards-measuring instruments: sensitivity, stability, range, accuracy and precision-static and dynamic response-repeatability-systematic and random errors-correction, calibration - interchangeability.

UNIT II LINEAR AND ANGULAR MEASUREMENT 9

Definition of metrology-Linear measuring instruments: Vernier, micrometer, Slip gauges and classification, - Tool Makers Microscope - Comparators: limit gauges Mechanical, pneumatic and electrical comparators, applications. Angular measurements: -Sine bar, Sine center, bevel protractor and angle Decker, Autocollimator, Alignment telescope.

UNIT III FORM MEASUREMENT 9

Measurement of screw threads: Thread gauges, measurement of gear tooth thickness: constant chord and base tangent method-Gleason gear testing machine – radius measurements-surface finish: equipment and parameters, straightness, flatness and roundness measurements. Surface roughness tester, Scanning electron microscope, Profile projector.

UNIT IV LASER AND ADVANCES IN METROLOGY 9

Precision instruments based on laser-Principles- laser interferometer-application in measurements and machine tool metrology- Coordinate measuring machine (CMM): need, construction, types, and applications- computer aided inspection, Basic concepts of Machine Vision System.

UNIT V MEASUREMENT OF MECHANICAL PARAMETERS 9

Force, torque, power:-mechanical, pneumatic, hydraulic and electrical type-Pressure measurement - Flow: Venturi, orifice, rotameter, pitot tube –Temperature: bimetallic strip, thermocouples, pyrometer, electrical resistance thermistor, Readability and Reliability

TOTAL: 45 Hours

Text Books:

1. Jain R.K., “Engineering Metrology”, Khanna Publishers, 2005
2. Alan S. Morris, “The Essence of Measurement”, Prentice Hall of India, 1997
3. Gupta S.C, “Engineering Metrology”, Dhanpatrai Publications, 2005

References:

1. Jayal A.K, “Instrumentation and Mechanical Measurements”, Galgotia Publications 2000
2. Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education, 2006.
3. Alan S. Morris, “The Essence of Measurement”, Prentice Hall of India, 1997
4. Raghavendra, Krishnamurthy “Engineering Metrology & Measurements”, Oxford Univ. Press, 2013.

Web Links:

1. https://archive.nptel.ac.in/courses/112/104/112104250/
2. https://onlinecourses.nptel.ac.in/noc20_me94/preview

Course Outcomes

CO1:	Illustrate the concepts of standards, errors and its control and perform calibration of measuring instruments	K2
CO2:	Distinguish the principle, operation of various linear and angular measuring instruments	K4
CO3:	Explain and demonstrate surface and form measurement techniques and applications	K5
CO4:	Explain and demonstrate of the Precision instruments based on laser and Coordinate measuring machine	K5
CO5:	Explain the working principle of force, torque, power and temperature measuring instruments	K5

Mapping of Course Outcomes with Program Outcomes

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

Assessment Methods:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
√	√	√	√	√	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
√			√	√	

	METROLOGY AND MEASUREMENTS LABORATORY	L	T	P	C
		0	0	3	1

Course Objective:

- To familiar with different measurement equipments and use of this industry for quality inspection and ability to handle different measurement tools and performs measurements in quality impulsion.

LIST OF EXPERIMENTS

1. Calibration of Vernier / Micrometer / Dial Gauge
2. Checking Dimensions of part using slip gauges
3. Measurements of Gear Tooth Dimensions
4. Measurement of Angle using sine bar / sine center / tool makers microscope
5. Measurement of straightness and flatness
6. Measurement of thread parameters
7. Setting up of comparators for inspection (Mechanical / Pneumatic / Electrical)
8. Measurement of Temperature using Thermocouple / Pyrometer
9. Measurement of Displacement
10. Measurement of Force
11. Measurement of Torque
12. Measurement of Vibration / Shock

TOTAL: 45 Hours

LIST OF EQUIPMENTS (For a batch of 30 students)

Micrometer	-	5 Nos.
Vernier Caliper	-	5 Nos.
Vernier Height Gauge	-	2 Nos.
Vernier depth Gauge	-	2 Nos.
Slip Gauge Set	-	1 No.
Gear Tooth Vernier	-	1 No.
Sine Bar	-	1 No.
Sine Center	-	1 No.
Bevel Protractor	-	1 No.
Floating Carriage Micrometer	-	1 No.
Profile Projector / Tool Makers Microscope	-	1 No.
Mechanical / Electrical / Pneumatic Comparator	-	1 No.
Autocollimator	-	1 No.
Temperature Measuring Setup	-	1 No.

Displacement Measuring Setup	-	1 No.
Force Measuring Setup	-	1 No.
Torque Measuring Setup	-	1 No.
Vibration / Shock Measuring Setup	-	1 No.

Course Outcomes:

After successful completion of the Metrology and Measurements Laboratory course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Measure the error in Vernier height gauge, Micrometer and Vernier caliper using given slip gauge.	K3
CO2:	Evaluate the important parameter in thread using Tool makers Microscope, Floating carriage micrometer and Gear tooth Vernier.	K3
CO3:	Estimate the bore diameter using Telescope gauge, Micrometer and Comparator.	K3
CO4:	Estimate the surface finish using surface finish measuring equipment's and Auto collimator.	K3
CO5:	Measure, Force, Torque, Temperature and angle using Proving ring measurement, LVDT measurement, Thermocouple measurement and sine bar measurement devices.	K4

Assessment Methods:

CAT1	CAT2	Model Exam	End Semester Exams	Observation
		✓	✓	✓
Record	MCQ	Projects	Viva	Demonstration/ Presentation
✓			✓	✓

	COMPUTER AIDED MACHINE DESIGN LABORATORY	L	T	P	C
		0	0	3	1

Course Objectives

- To make the students understand and interpret drawings of machine components
- To create assembly designs manually and with the aid of common CAD software.
- To acquaint the pupils with Indian norms regarding standard components and drawing techniques
- To obtain hands-on experience using software for 2D drawing and 3D modelling

UNIT I INTRODUCTION

Introduction to machine components and interpret drawings of machine component so as to prepare assembly drawing either manually and using standard CAD packages.

UNIT II DRAWING STANDARDS

Code of practice for engineering drawing, BIS specifications-conventional representation of details-Welding symbols, riveted joints, keys, Fasteners. Reference to hand book for the selection of standard components like-bolts, nuts, washers, screws, cotters, pins, circlips, bearings, gears, springs and flanges.

UNIT III 2-D DRAWINGS

Limits, Fits - Tolerancing of Individual Dimensions-Specification of Fits - Manual preparation of production drawings and reading of part and assembly drawings.

UNIT IV CAD PRACTICE (USING APPLICATION PACKAGES)

Drawing, Editing, Dimensioning, Plotting Commands, Layering Concepts, Hatching, Detailing, Assembly, Basic principles of GD&T (geometric dimensioning & tolerancing).

UNIT V ASSEMBLY DRAWING (MANUAL & USING APPLICATION PACKAGES)

Making free hand sketches of typical subassemblies-Plummer block, Screw jack, Lathe Tailstock, Universal Joint-Machine Vice-Stuffing Box-safety Valves-rolling element bearings, keyed joints, cotter joints, C clamp.

TOTAL: 45 hours

Text Books:

T1. Gopalakrishna K R, "Machine Drawing", Subhas Stores, Bangalore, 2017.

T2. CAD/CAM Manual, PSG College of Technology, Coimbatore, 2002.

Reference Books:

R1. Varghese P I and John K C, "Machine Drawing", Jovast Publishers, Thrissur, 2007.

R2. BIS, SP: 46-2003 – "Engineering Drawing Practice for Schools and Colleges", New Delhi, 2003.

R3. Faculty of Mechanical Engineering, PSG College of Technology," Design Data Book", M/s. DPV Printers, Coimbatore, 1993.

R4. ASME Y 14.5M-1994, "Dimensioning and Tolerancing", ASME, New York, 1995.

Web Links:

1. https://nptel.ac.in/courses/112102101
2. **https://www.kprietdesignsociety.in/tutorials/anna-university-cad-lab-exercises**
3. **https://www.youtube.com/watch?v=cmR9cfWJRUU&t=32s**
4. **https://www.youtube.com/watch?v=4b1l3hbAylU**

Course Outcomes

CO1	Discuss the code of practices and standard for engineering drawing.	**K2**
CO2	Construct both 2-D of any components using Auto CAD software.	**K6**
CO3	Construct assemblies such as vice, screw jack and tailstock of the lathe, etc. from the concepts learned using drafting software and create the different wireframe primitives using parametric representations	**K6**
CO4	Apply geometric transformations on the created wireframe, surface and solid models.	**K4**
CO5	Evaluate the validity of the sketch for later operations.	**K3**

Mapping of Course Outcomes with Program Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	1	1	3	-	-	-	-	2	-	3	1	2
CO2	2	2	1	1	3	-	-	-	-	3	1	3	2	2
CO3	2	2	1	1	3	-	-	-	-	3	1	3	2	2
CO4	2	2	1	1	3	-	-	-	-	3	1	3	2	2
CO5	2	2	1	1	3	-	-	-	-	2	-	3	2	2
	1.8	2	1	1	3	-	-	-	-	2.6	0.6	3	1.8	2

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Observation**
		✓	✓	✓
Record	**MCQ**	**Projects**	**Viva**	**Demonstration Presentation**
✓			✓	✓

	THERMAL ENGINEERING	L	T	P	C
		3	1	0	4

Course Objectives

- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes
- To apply the thermodynamic concepts into various thermal application like IC engines, Steam.
- Turbines, Compressors and Refrigeration and Air conditioning systems
- (Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart permitted)

UNIT I GAS POWER CYCLES 12 hours

Air Standard Cycles, Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure, and air standard efficiency, Comparison of cycles.

UNIT II RECIPROCATING AIR COMPRESSOR 12 hours

Classification and comparison, working principle, work of compression, with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling. Working principle and comparison of Rotary compressors with reciprocating air compressors.

UNIT III INTERNAL COMBUSTION ENGINES AND COMBUSTION 12 hours

IC engine, Classification, working, components and their functions. Ideal and actual: Valve and port timing diagrams, p-v diagrams- two stroke & four stroke, and SI & CI engines, comparison. Geometric, operating, and performance comparison of SI and CI engines. Desirable properties and qualities of fuels. Air-fuel ratio calculation, lean and rich mixtures. Combustion in SI & CI Engines, Knocking, phenomena and control.

UNIT IV STEAM NOZZLES AND TURBINES 12 hours

Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow. Impulse and Reaction principles, compounding, velocity diagram for simple and multi-stage turbines, speed regulations, Governors.

UNIT V REFRIGERATION AND AIR CONDITIONING 12 hours

Refrigerants, Vapour compression refrigeration cycle, super heat, sub cooling, Performance calculations, working principle of vapour absorption system, Ammonia – Water, Lithium bromide water systems (Description only). Air conditioning system, Processes, Types and Working Principles, Concept of RSHF, GSHF, ESHF, Cooling Load calculations.

TOTAL : 60 hours

Text Books:

1. Kothandaraman.C.P, Domkundwar. S, Domkundwar. A.V., “A course in thermal Engineering", Fifth Edition, ”Dhanpat Rai & sons , 2016
2. Rajput. R. K., “Thermal Engineering” S.Chand Publishers, 2017

Reference Books:

1. Arora.C.P, ”Refrigeration and Air Conditioning ,” Tata McGraw-Hill Publishers 2017
2. Ganesan V..” Internal Combustion Engines” , Third Edition, Tata McGraw-Hill 2017
3. Ramalingam. K.K., "Thermal Engineering", SCITECH Publications (India) Pvt.Ltd.,2016

Web Links:

1. https://nptel.ac.in/courses/112106133
2. https://nptel.ac.in/courses/112107208

Course Outcomes

CO1:	Analyse Otto, Diesel, Dual and Brayton cycles and estimate the mean effective pressure and air standard efficiency for Otto, Diesel, Dual and Brayton cycles.	**K4**
CO2:	Solve problems and perform an experiment in single and multi-stage air compressor.	**K3**
CO3:	Evaluate the I C Engine performance	**K5**
CO4:	Analyze the vapour cycle concepts in Steam Turbines and Steam nozzles.	**K4**
CO5:	Analyze the usage of Refrigeration and Air conditioning.	**K4**

Mapping of Course Outcomes with Program Outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO1**	**PSO2**
CO1	2	2	1	1	0	0	0	0	0	0	0	1	3	2
CO2	2	2	1	2	1	2	0	0	0	0	0	0	2	3
CO3	2	2	1	2	0	0	0	0	0	0	0	0	3	2
CO4	3	1	1	1	0	0	0	0	0	0	0	0	2	3
CO5	2	1	1	1	0	0	0	0	0	0	0	0	3	2

Assessment Methods:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	MCQ	Projects	Seminars	Demonstration/ Presentation	Open book test
✓			✓		

	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives

- To gain knowledge on the principles and procedure for the design of mechanical power transmission components.
- To understand the standard procedure available for Design of transmission of mechanical elements.
- To learn to use standard data and catalogues

(Use of PSG Data Book Permitted)

UNIT I DESIGN OF TRANSMISSION SYSTEMS FOR FLEXIBLE ELEMENTS 9

Selection of V belts and pulleys – selection of Flat belts and pulleys - Wire ropes and pulleys – Selection of Transmission chains and Sprockets, Design of pulleys and sprockets.

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9

Gear Terminology-Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects - Fatigue strength - Factor of safety - Gear materials – Module and Face width-power rating calculations based on strength and wear considerations - Parallel axis Helical Gears – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces and stresses, Estimating the size of the helical gears.

UNIT III BEVEL, WORM AND CROSS HELICAL GEARS 9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears.

Worm Gear: Merits and demerits- Terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair.

Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT IV DESIGN OF GEAR BOXES 9

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box -Constant mesh gear box. – Design of multi speed gear box.

UNIT V DESIGN OF CAM CLUTCHES AND BRAKES 9

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-internal and external shoe brakes.

TOTAL : 45 hours

Text Books:

1. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.

2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8th Edition, Tata McGraw-Hill, 2008.

Reference Books:

R1: Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003.

R2: Gitin Maitra, L. Prasad "Hand book of Mechanical Design", 2nd Edition, Tata McGrawHill, 2001.

R3: C.S.Sharma, Kamlesh Purohit, "Design of Machine Elements", Prentice Hall of India, Pvt. Ltd., 2003.

R4: Bernard Hamrock, Steven Schmid, Bo Jacobson, "Fundamentals of Machine Elements", 2nd Edition, Tata McGraw-Hill Book Co., 2006.

R5: Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley, 2005

R6: Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill BookCo.(Schaum‟s Outline), 2010 8. Orthwein W, “Machine Component Design”, Jaico Publishing Co, 2003.
R7: Ansel Ugural, “Mechanical Design – An Integral Approach", 1st Edition, Tata McGrawHill Book Co, 2003.
R8: Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, “Design of Machine Elements” 8th Edition, Printice Hall, 2003.
R9: U.C.Jindal : Machine Design, "Design of Transmission System", Dorling Kindersley, 2010.

Web Links:

1. https://www.youtube.com/watch?v=z3WJLFtUjYA
2. https://www.youtube.com/watch?v=YRxfwIi5MiU

Course Outcomes

CO1:	Apply the concepts of design to belts, chains and rope drives	**K 2**
CO2:	To analyze and design of design to spur, helical gears	**K 4**
CO3:	To analyze and design of design to worm and bevel gears	**K 4**
CO4:	Apply the concepts of design to gear boxes	**K 2**
CO5:	Apply the concepts of design to cam, brakes and clutches	**K 3**

Mapping of Course Outcomes with Program Outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**
CO1	3	3	3	2	2	0	2	0	0	1	0	0	3	2
CO2	3	3	3	3	2	0	1	0	0	1	0	0	2	3
CO3	3	3	3	3	2	0	1	0	0	0	0	0	3	2
CO4	3	3	3	3	3	0	1	0	0	0	0	0	2	3
CO5	3	3	3	2	2	0	1	0	0	0	0	0	3	2

Assessment Methods:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓			✓		

	THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	3	1

Course Objectives

- To Study Valve timing and port timing diagram and performance of I.C Engine
- To Study the characteristics of fuels/Lubricates used in IC Engines.
- To study the Performance of steam generator/ turbine.

LIST OF EXPERIMENTS

I.C ENGINE LAB AND FUELS LAB

1. Valve Timing and Port Timing Diagrams
2. Performance Test on 4-stroke Diesel Engine.
3. Heat Balance Test on 4-stroke Diesel Engine
4. Morse Test on Multi cylinder Petrol Engine
5. Determination of Viscosity – Red Wood Viscometer
6. Determination of Flash Point and Fire Point
7. Study of Steam Generators and Turbines

HEAT TRANSFER

1. Thermal conductivity of pipe insulation using lagged pipe apparatus
2. Natural convection heat transfer from a vertical cylinder
3. Forced convection inside tube
4. Determination of Stefan-Boltzmann constant
5. Effectiveness of Parallel/counter flow heat exchanger

REFRIGERATION AND AIR CONDITIONING

1. Determination of COP of a refrigeration/ air conditioning system
2. Performance test on single/two stage reciprocating air compressor

TOTAL: 45 Hours

Reference Books:

1. Rajput. R. K., “Thermal Engineering”, S. Chand publishers, 2017
2. Rudramoorthy R, “Thermal Engineering”, Tata McGraw-Hill, New Delhi, 2017.
3. Kothandaraman.C.P., Domkundwar. S. and A.V. Domkundwar., “A course in Thermal Engineering”, DhanpatRai& Sons, Fifth edition, 2016.

Web Links:

1. https://www.youtube.com/watch?v=2b0YaDrdO1I
2. https://www.youtube.com/watch?v=rtrOcFq6QSs

Course Outcomes

CO1:	Analyze the performance of internal combustion Engines	**K 3**
CO2:	Estimate the performance of different thermal equipment's like reciprocating compressors, refrigeration and air conditioning systems	**K 5**
CO3:	Develop the valve timing diagram and port timing diagram of IC engines	**K 3**
CO4:	Estimate the Thermal conductivity of pipe insulation using lagged pipe apparatus	**K 5**
CO5:	Evaluate the Natural convection heat transfer from a vertical cylinder	**K 3**

Mapping of Course Outcomes with Program Outcomes

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

Assessment Methods:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Record**
		✓	✓	✓
Observation	**MCQ**	**Projects**	**Viva**	**Demonstration/ Presentation**
✓			✓	✓

	ADVANCED MACHINING LABORATORY	L	T	P	C
		0	0	3	1

Course Objective: (Skill development)

- To gain practical experience in handling 2D drafting and 3D modeling software systems.
- To study the features of CNC Machine Tool.
- To expose students to modern control systems (Fanuc, Siemens etc.,)
- To know the application of various CNC machines like CNC lathe, CNC Vertical Machining centre, CNC EDM and CNC wire-cut and studying of Rapid prototyping.

1. MANUAL CNC PART PROGRAMMING(Ex: Manual CNC Part Programming Using Standard G and M Codes - Tool Path Simulation – Exposure to Various Standard Control Systems- Machining simple components by Using CNC machines.

2. COMPUTER AIDED PART PROGRAMMING

(Ex**:** CL Data Generation by Using CAM Software– Post Process Generation for Different Control System – Machining of Computer Generated Part Program by Using Machining Center and Turning Center.)

3. STUDY EXPERIMENTS

Multi-axial Machining in CNC Machining Center –EDM – EDM Wire Cut - Rapid Prototyping

LIST OF EQUIPMENTS (Requirement for a batch of 30 students)

S.No.	Description of Equipment	Quantity Required
	HARDWARE	
1.	Computer Server	1 No.
2.	Computer nodes or systems (High end CPU with at least 1 GB main memory) networked to the server	30 Nos.
3.	A3 size plotter	1 No.
4.	Laser Printer	1 No.
5.	Trainer CNC Lathe	1 No.
6.	Trainer CNC milling	1 No.
	SOFTWARE	
7.	CAD/CAM software (Pro-E or IDEAS or Unigraphics or CATIA)	15 licenses
8.	CAM Software (CNC Programming and tool path simulation for FANUC /Sinumeric and Heiden controller)	15 licenses
9.	Licensed operating system	Adequate
10.	AutoCAD	
11.	ANSYS	
12.	Master CAM	

TOTAL: 45 Hours

Course Outcomes:

After successful completion of the CAM Laboratory course, the student will be able to

CO1: Understanding the Computer Aided Design concepts and Fundamentals of AutoCAD.

CO2: Build the 3D modeling including Solids, Curves, and Surfaces.

CO3: Creation of Flange coupling, screw jack, bushed bearing and stuffing box assembly using Solid Works.

CO4: Understand the basic concepts of Tolerance Analysis, concept of Geometric dimensioning and Tolerance from 2D Drawings.

CO5: Formulate the manual part programming for given drawing to execute CNC turning lathe and milling machine.

	MECHATRONICS	L	T	P	C
		3	1	0	4

Course Objective:

- To impart knowledge of the elements and techniques involved in mechatronics systems for industrial automation

UNIT I MECHATRONICS, SENSORS AND TRANSDUCERS 12

Introduction to Mechatronics Systems – Measurement Systems – Control Systems – Microprocessor based Controllers. Sensors and Transducers – Performance Terminology – Sensors for Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors – Selection of Sensors.

UNIT II ACTUATION SYSTEMS 12

Pneumatic and Hydraulic Systems – Directional Control Valves – Rotary Actuators. Mechanical Actuation Systems – Cams – Gear Trains – Ratchet and pawl – Belt and Chain Drives – Bearings. Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – Construction and working principle of DC and AC Motors – speed control of AC and DC drives, Stepper Motors-switching circuitries for stepper motor – AC & DC Servo motors.

UNIT III SYSTEM MODELS AND CONTROLLERS 12

Building blocks of Mechanical, Electrical, Fluid and Thermal Systems, Rotational – Transnational Systems, Electromechanical Systems – Hydraulic – Mechanical Systems. Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers – Digital Controllers – Velocity Control – Adaptive Control – Digital Logic Control – Micro Processors Control.

UNIT IV PROGRAMMING LOGIC CONTROLLERS 12

Programmable Logic Controllers – Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Shift Registers – Master and Jump Controls – Data Handling – Analogs Input / Output – Selection of a PLC.

UNIT V DESIGN OF MECHATRONICS SYSTEM 12

Stages in designing Mechatronics Systems – Traditional and Mechatronic Design - Possible Design Solutions. Case studies of Mechatronics systems- Pick and place Robot- Autonomous mobile robot- Wireless surveillance balloon- Engine Management system- Automatic car park barrier.

TOTAL: 60 Hours

Text Books:

1. Bolton,W, “Mechatronics” , Pearson education, sixth edition, 2015
2. Smaili.A and Mrad.F , " Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008

Reference Books:

1. Rajput. R.K, A textbook of mechatronics, S. Chand & Co, 2007
2. Michael B. Histand and David G. Alciatore, “Introduction to Mechatronics and Measurement Systems”, McGraw-Hill International Editions, 2000.
3. Bradley D. A., Dawson D., Buru N.C. and. Loader A.J, “Mechatronics”, Chapman and Hall, 1993.

4. Dan Necsulesu, “Mechatronics”, Pearson Education Asia, 2002.
5. Lawrence J. Kamm, “Understanding Electro – Mechanical Engineering”, An Introduction to Mechatronics, Prentice – Hall of India Pvt., Ltd., 2000.
6. Nitaigour Premchand Mahadik, “Mechatronics”, Tata McGraw-Hill publishing Company Ltd, 2003.

Web Links:

1. https://www.youtube.com/watch?v=Ro_tFv1iH6g
2. https://www.youtube.com/watch?v=3E4l2-2VIHY

Course Outcomes:

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

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO 1	Familiar to identify, analyze and control engineering systems.	K4
CO 2	Identify sensors, transducers and actuators to monitor and control the behavior of a process or product.	K3
CO 3	Design and develop mechatronics systems and primary actuating systems.	K6
CO 4	Evaluate the performance of mechatronics systems.	K5
CO 5	Apply the mechatronics principles to engineering application.	K3

Mapping of Program outcome with course outcome based on attainment levels

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	3	2	-	-	-	-	-	1
CO2	3	2	1	1	2	1	-	-	-	-	-	-
CO3	-	1	2	2	2	2	-	-	-	-	-	3
CO4	1	2	3	3	3	3	-	-	-	-	-	2
CO5	3	2	1	1	2	1	-	-	-	-	-	-
Average	2.2	2	1.8	1.8	2.4	1.8	-	-	-	-	-	2

Assessment Methods:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
√	√	√	√	√	√
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
√			√	√	

	MECHATRONICS LABORATORY	L	T	P	C
		0	0	3	1

Course Objective:

- To know the method of programming the microprocessor and also the design, modeling & analysis of basic electrical, hydraulic & pneumatic Systems which enable the students to understand the concept of mechatronics.

LIST OF EXPERIMENTS

1. Design and testing of pneumatic circuits to control
   (i) Velocity (ii) direction and (iii) force of single and double acting actuators
2. Design of circuits with logic sequence using Electro pneumatic trainer kits.
3. Simulation of basic Hydraulic, Pneumatic and Electric circuits using software
4. Circuits with multiple cylinder sequences in Electro pneumatic using PLC
5. Speed Control of AC & DC drives
6. Servo controller interfacing for DC motor
7. PID controller interfacing
8. Stepper motor interfacing with 8051 Micro controller
   (i) Full step resolution (ii) half step resolution
9. Modeling and analysis of basic electrical, hydraulic and pneumatic systems using LAB VIEW
10. Computerized data logging system with control for process variables like pressure flow and temperature.

TOTAL: 45 Hours

LIST OF EQUIPMENTS (For a batch of 30 Students)

S.No.	Description of Equipment	Quantity Required
1	Basic Pneumatic Trainer Kit with manual and electrical controls/ PLC Control each	1 No.
2	Basic Hydraulic Trainer Kit	1 No.
3	Hydraulics and Pneumatics Systems Simulation Software / Automation studio sets	10 Nos
4	8051 - Microcontroller kit with stepper motor and drive circuit sets	2 Nos.
5	LAB VIEW software with Sensors to measure Pressure, Flow rate, direction, speed, velocity and force. seats	2 Nos

Course Outcomes:

After successful completion of the Mechatronics Laboratory course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1	Design and test of pneumatic test circuits	K6
CO2	Design of simple mechatronics system.	K6

CO3	Apply the PID control to AC and DC motors.	K3
CO4	Measure load, displacement and temperature using analogue and digital sensors.	K5
CO5	Develop microcontroller programming to guide a robot.	K3

Mapping of Program outcome with course outcome based on attainment levels

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO10	PO11	PO12
CO1	0	1	2	2	2	2	-	-	-	3
CO2	0	1	2	2	2	2	-	-	-	3
CO3	3	2	1	1	1	1	-	-	-	0
CO4	0	2	3	3	3	3	-	-	-	2
CO5	3	2	1	1	1	1	-	-	-	0
Average	3	1.6	1.8	1.8	1.8	1.8				2.6

PSOs matrices of courses selected

CO	PSO1	PSO2
CO1	3	2
CO2	2	1
CO3	3	3
CO4	2	2
CO5	2	1
Average	2.4	1.8

Assessment Methods:

CAT 1	CAT 2	Model Exam	End Semester Exams	Record
		✓	✓	✓
Observation	MCQ	Projects	Viva	Demonstration/ Presentation
✓			✓	✓

	SIMULATION AND ANALYSIS LABORATORY	L	T	P	C
		0	0	3	1

Course Objective:

- To give exposure to software tools needed to analyze engineering problems.
- To expose the students to different applications of simulation and analysis tools.

LIST OF EXPERIMENTS

A. SIMULATION

1. Simulation of Air conditioning system with condenser temperature and evaporator temperatures as input to get COP using C /MAT Lab.
2. Simulation of Hydraulic / Pneumatic cylinder using C / MAT Lab.
3. Simulation of cam and follower mechanism using C / MAT Lab.

B. ANALYSIS (SIMPLE TREATMENT ONLY)

1. Stress analysis of a plate with a circular hole.
2. Stress analysis of rectangular L bracket
3. Stress analysis of an axi-symmetric component
4. Stress analysis of beams (Cantilever, Simply supported, Fixed ends)
5. Mode frequency analysis of a 2 D component
6. Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends)
7. Harmonic analysis of a 2D component
8. Thermal stress analysis of a 2D component
9. Conductive heat transfer analysis of a 2D component
10. Convective heat transfer analysis of a 2D component

TOTAL: 45 Hours

LIST OF EQUIPMENTS (For a batch of 30 students)

Computer System	30
17" VGA Color Monitor	
Pentium IV Processor	
40 GB HDD	
512 MB RAM	
Color Desk Jet Printer	01

Software

Suitable analysis software	30 licenses
C / MATLAB	5 licenses

Course Outcomes:

After successful completion of the Computer Aided Simulation and Analysis Laboratory course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	Knowledge Level
CO1	Understand and solve simple problems in vibration using MATLAB	**K2**
CO2	Analyze mechanism simulation using Multibody Dynamic software	**K4**
CO3	Solve stress analysis problems of link elements in Trusses, cables, beams, flat plates, simple shells and axi – symmetric components.	**K6**
CO4	Solve thermal stress and heat transfer analysis of plates, cylindrical shells.	**K6**
CO5	Examine the model analysis of beams and harmonic, transient and spectrum analysis of simple systems.	**K4**

Mapping of Program outcome with course outcome based on attainment levels

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	1	-	-	-	-	-	-	-
CO2	2	3	2	2	3	-	-	-	1	-	1	1
CO3	-	1	2	2	2	-	-	-	3	-	3	3
CO4	-	1	2	2	2	-	-	-	3	-	3	3
CO5	2	3	2	2	3	-	-	-	1	-	1	1
Avg	2	1.8	2	2	2.2	-	-	-	2	-	2	2

PSOs matrices of courses selected

CO	PSO1	PSO2
CO1	3	2
CO2	3	2
CO3	3	2
CO4	3	2
CO5	3	2
Average	3	2

Assessment Methods:

CAT 1	CAT 2	Model Exam	End Semester Exams	Record
		✓	✓	✓
Observation	MCQ	Projects	Viva	Demonstration/ Presentation
✓			✓	✓

	PROJECT PHASE - I	L	T	P	C
		0	0	4	5

Course Objective:

- The main objective is to give an opportunity to the student to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them.

GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped into 2 to 4 and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

Total 45 hours

After successful completion of the project phase I, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Identify a topic in advanced areas of Mechanical Engineering.	K3
CO2:	Develop a prototypes/models, experimental set-up and software systems necessary to meet the objectives.	K3
CO3:	Conclude and search the literature.	K4
CO4:	Identify and compare technical and practical issues related to the area of course specialization.	K3
CO5:	Adapt to the presentation skills by seminars in front of grown without fairness.	K6

Mapping of Program outcome with course outcome based on attainment levels

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	2	1	3	1	-	-	-	-
CO2	3	2	1	1	2	1	3	1	-	-	-	-
CO3	2	3	2	2	3	2	2	2	1	1	1	1
CO4	3	2	1	1	2	1	3	1	-	-	-	-
CO5	-	1	2	2	2	2	-	2	3	3	3	3
Avg	2.2	2	1.4	1.4	2.2	1.4	2.2	1.4	2	2	2	2

PSOs matrices of courses selected

CO	PSO1	PSO2
CO1	3	3
CO2	3	3
CO3	3	2
CO4	2	1
CO5	1	2
Avg	2.4	2.2

	PROJECT PHASE - II	L	T	P	C
		0	0	6	12

Course Objective:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination

GUIDELINE FOR REVIEW AND EVALUATION

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

After successful completion of the project work, the student will be able to

CO	Course Outcome Statements	K Level
CO1:	Identify and compare the technical and practical issues related to the area of course specialization.	**K5**
CO2:	Organize a report by employing the elements of technical writing and critical thinking.	**K3**
CO3:	Identify the methods and materials to carry out experiments/develop code.	**K3**
CO4:	Analyze and discuss the results to draw valid conclusions.	**K4**
CO5:	Develop the possibility of publishing papers in peer reviewed journals/conference proceedings.	**K3**

Mapping of Program outcome with course outcome based on attainment levels

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3	3	3	3	1	3	2	2	2	2
CO2	3	2	1	1	2	1	3	1	-	-	-	-
CO3	3	2	1	1	2	1	3	1	-	-	-	-
CO4	1	-	1	1	-	1	1	1	2	2	2	2
CO5	3	2	1	1	2	1	3	1	-	-	-	-
	2.2	2	1.4	1.4	2.25	1.4	2.2	1.4	2	2	2	

PSOs matrices of courses selected

CO	PSO1	PSO2
CO1	3	3
CO2	3	3
CO3	3	2
CO4	2	1
CO5	1	2
Average	2.4	2.2

PROFESSIONAL ELECTIVE COURSES

L T P C

SPECIAL CASTING TECHNIQUES 3 0 0 3

COURSE OBJECTIVE:

- To introduce the concepts of basic casting processes and fabrication techniques and study the various special casting technique such as shell moulding, investment casting, centrifugal and die-casting, etc..

UNIT I INTRODUCTION 9

Introduction to sand casting - Conventional mould and Core making - Need for special casting process – applications.

UNIT II SHELL MOULDING 9

Process - Machines - Pattern - Sand, resin and other materials - Process parameters characteristics of shell mould castings - 'D' Process - Applications.

UNIT III INVESTMENT CASTING 9

Process - Pattern and mould materials - Block mould and ceramic shell mould - Mercast and shaw process - Application.

UNIT IV CENTRIFUGAL AND DIE-CASTING 9

Types of Centrifugal processes - calculation of rotating speed of the mould - Equipment - Application.

UNIT V CONTINOUS CASTING CO_2 SAND PROCESS AND FULL MOULD PROCESSES 9

Reciprocating continuous mould process - Direct chill process - Use of steel, aluminium, brass material in continuous casting.CO_2mould / core hardening process - principles Full mould process - Applications. Other special process like squeeze casting and electro slag casting processes.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Special Casting Techniques course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Develop the conventional mould and Core making knowledge for special casting process.	K5
CO2:	Understand process parameters and characteristics of shell mould castings.	K2
CO3:	Explain the block mould and ceramic shell moulding techniques	K3
CO4:	Compare the centrifugal and Die-casting methods.	K5
CO5:	Understand the Continuous casting process, CO_2 sand process and full mould processes.	K2

TEXT BOOKS:

1. Beeley, P. R., “Foundry Technology”, Butterworths, London, 1982.

2. Clegg. A J., “Precision Casting Processes”, Pergamon Press, London, U.K, 1991.

REFERENCES:

1. Heine, Loperand Rosenthal, “Principles of Metal Casting”, Tata McGraw-Hill Publishing’s Co., Ltd, New Delhi, 1995.
2. Dumond. T C, “Shell Moulding and Shell Moulded Castings”, Reinhold Publishing Corporation Inc, 1984.
3. Doehler.E.H, “Die Casting”, McGraw-Hill Book Co, New York, 1991.
4. Barton H K, “Die Casting Processes”, Odhams Press Ltd, 1985.
5. ASM Metals Hand Book, “Casting”, Volume 15, ASM International, 10th Edition, 1991.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name	SPECIAL CASTING TECHNIQUES											
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	0	0	1	0	2	0	0	0	0	0
CO2	3	2	1	1	2	1	3	1	0	0	0	0
CO3	2	3	2	1	3	2	2	2	1	1	1	1
CO4	0	1	2	2	1	2	0	2	3	3	3	3
CO5	1	2	3	3	2	3	1	3	2	2	2	2
Average	1.6	1.8	1.6	1.4	1.8	1.4	1.8	1.4	1.2	1.2	1.2	1.2

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	SPECIAL CASTING TECHNIQUES		
CO	**PSO1**		**PSO2**
CO1	2		1
CO2	1		2
CO3	2		1
CO4	2		3
CO5	1		1
Average	1.6		1.8

	FAILURE ANALYSIS AND DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To enable the student to understand the principles of failure analysis and design.

UNIT I MATERIALS AND DESIGN PROCESS 9

Factors affecting the behavior of materials in components, effect of component geometry and shape factors, design for static strength, stiffness, designing with high strength and low toughness materials, designing for hostile environments, material processing and design, processes and their influence on design, process attributes, systematic process selection, screening, process selection diagrams, ranking, process cost.

UNIT II FRACTURE MECHANICS 9

Ductile fracture, brittle fracture, Cleavage-fractography, ductile-brittle transition-Fracture mechanics approach to design-energy criterion, stress intensity approach, time dependent crack growth and damage.

UNIT III LINEAR ELASTIC FRACTURE MECHANICS 9

Griffith theory, Energy release rate, instability and R-curve, stress analysis of cracks-stress intensity factor, K-threshold, crack growth instability analysis, crack tip stress analysis. Crack tip opening displacement (CTOD), J integral, relationship between J and CTOD.

UNIT IV DYNAMIC AND TIME-DEPENDENT FRACTURE 9

Dynamic fracture, rapid loading of a stationary crack, rapid crack propagation, dynamic contour integral, Creep crack growth-C Integral, Visco elastic fracture mechanics, viscoelastic J integral, Experimental determination of plane strain fracture toughness, K- R curve testing, J measurement, CTOD testing, effect of temperature, strain rate on fracture toughness.

UNIT V FAILURE ANALYSIS TOOLS 9

Reliability concept and hazard function, life prediction, life extension, application of poisson, exponential and Weibull distribution for reliability, bath tub curve, parallel and series system, MTBF, MTTR, FMEA definition-Design FMEA, Process FMEA , analysis causes of failure, modes, ranks of failure modes, fault tree analysis, industrial case studies/projects on FMEA.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Failure Analysis and Design course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Understand the theories of failure analysis for all types of materials.	K6

CO2:	Understand the basic principles and approaches for static loading and dynamic loading.	K6
CO3:	Identify the factors affecting the behavior of materials under various force condition.	K3
CO4:	Design the component based on statics strength and stiffness.	K6
CO5:	Understand different fracture mechanics of brittle and ductile materials	K5

TEXT BOOKS:

1. John M Barsoom and Stanley T Rolte "Fracture and Fatigue Control in Structures", Prentice Hall, New Delhi, 1987.
2. Michael F Ashby, “Material Selection in Mechanical Design”, Butterworth – Heinemann, Third Edition, 2005.

REFERENCES:

1. Shigley and Mische, "Mechanical Engineering Design", McGraw Hill Inc., New York, 1992.
2. Mahmoud M Farag, “Material Selection for Engineering Design”, Prentice Hall, New Delhi, 1997.
3. Faculty of Mechanical Engineering, “Design Data Book”, PSG College of Technology, DPV Printers, Coimbatore, 1993.
4. ASM Metals Handbook, "Failure Analysis and Prevention", ASM Metals Park, Ohio, USA, Vol. 10, Tenth Edition, 1995.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name	**FAILURE ANALYSIS AND DESIGN**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	0	1	2	2	1	2	0	2	3	3	3	3
CO2	2	3	2	2	3	2	2	2	1	1	1	1
CO3	0	1	2	2	1	2	0	2	3	3	3	3
CO4	0	1	2	2	1	2	0	2	3	3	3	3
CO5	1	2	3	3	2	3	1	3	2	2	2	2
Average	0.6	1.6	2.2	2.2	1.6	2.2	0.6	2.2	2.4	2.4	2.4	2.4

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**FAILURE ANALYSIS AND DESIGN**		
CO	**PSO1**	**PSO2**	
CO1	2	3	
CO2	1	2	
CO3	3	1	
CO4	2	3	
CO5	1	1	
Average	1.8	2	

	MANUFACTURE AND INSPECTION OF GEARS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the basic terminology of gear and the various inspection techniques for checking of gears.

UNIT I INTRODUCTIONTOGEARS AND GEAR MATERIALS 9

Types of gears, classification, gear drawings, gearboxes, application of gears, gear production methods, an overview. Non-metallic, ferrous and non-ferrous gears, Properties of gear materials, selection of material for typical gears and applications – blank preparation methods for different gears, size, type and material.

UNIT II PRODUCTION OF GEARS & SCREW THREADS 9

Gear milling different gears, cut quality obtainable. Gear hobbling, types of gears cut, hobbling cutters, workholding methods gear shaping, disc type and rack type gear shapers, Production of straight bevel gears and spiral gears, milling, and generation by straight bevel gear generator. Screw thread terminology, Types of screw thread, Methods of producing screw threads, Effect of pitch errors, measurement of various elements of screw threads. Thread rolling, Thread Grinding, Mass Production of Screws.

UNIT III HEAT TREATMENT OF GEARS 9

Through hardening, case hardening, flames hardening, induction hardening of gears, Nit riding of gears. Tuft riding of gears. Inspection of gears for hardening defects. Gear finishing advantages, finishing of gears by grinding, shaving, lapping, honing methods and cold rolling of gears, Description of machines, process and process parameters.

UNIT IV GEAR INSPECTION 9

Types of gear errors, gear quality standards tooth thickness and base tangent length measurement, pitch errors, radial run out errors, profile errors and pitch error measurement. Composite error measurement, computerized gear inspection centers. Reasons and remedies for gearerrors.

UNIT V MODERN GEAR PRODUCTION METHODS 9

Gear production by stamping, die casting, power metal process, injection and compression Moulding in plastics. Die casting, cold and hot rolling, mass production methods shear speed shaping. Gear broaching – Gleason. G-Trac Gear generation method

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Manufacture and Inspection of Gears course, the student will be able to

CO	Course Outcome Statements	Knowledge Level

CO1:	Understand the basic terminology of gear.	K2
CO2:	Understand various inspection techniques for checking of gears.	K2
CO3:	Understand manufacturing of gears through gear hobbing machines.	K2
CO4:	Understand Manufacturing of gears through milling machines.	K2
CO5:	Understand Modern Gear Production Methods	K2

TEXT BOOKS:

1. Watson, "Modern Gear Production", Persman Press Oxford, 1984.
2. HMT, "Production Technology", Tata McGraw Hill, New Delhi, 1992.

REFERENCES:

1. SAE, "Gear Design Manufacturing Inspection Manual", SAE, 1990.
2. Weck M., "Hand Book of Machine Tools", Technology & Sons, 1984.
3. Faydor L. Litvin, Alfonso Fuentes-Aznar, Ignacio Gonzãlez-Perez, and Kenichi Hayasaka, "Noncircular Gears: Design and Generation", Cambridge University Press, 2009

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name	**MANUFACTURE AND INSPECTION OF GEARS**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	0	0	1	0	2	-	0	-	-	0
CO2	3	2	1	1	1	1	3	-	0	-	-	0
CO3	1	2	3	3	3	3	1	-	2	-	-	2
CO4	1	2	2	2	2	2	0	-	3	-	-	3
CO5	2	3	2	2	2	2	2	-	1	-	-	1
Average	1.8	2	2	2	1.8	2	2	-	2	-	-	2

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**MANUFACTURE AND INSPECTION OF GEARS**		
CO	**PSO1**	**PSO2**	
CO1	3	0	
CO2	2	1	
CO3	1	2	
CO4	1	2	
CO5	2	1	
Average	1.8	1.2	

	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
- To provide knowledge on design aspects of Refrigeration & Air conditioning systems.

UNIT I INTRODUCTION 7

Introduction to Refrigeration – Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification – Nomenclature – ODP & GWP.

UNIT II VAPOUR COMPRESSION REFRIGERATION SYSTEM 10

Vapor compression cycle: p-h and T-s diagrams – deviations from theoretical cycle – subcooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system – low temperature refrigeration – Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT III OTHER REFRIGERATION SYSTEMS 8

Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration – Magnetic – Vortex and Pulse tube refrigeration systems.

UNIT IV PSYCHROMETRIC PROPERTIES AND PROCESSES 8

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

UNIT V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 12

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Refrigeration and Air Conditioning course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the basic working principle of refrigeration and air conditioning systems.	K2

CO2	Explain the simple vapour compression Refrigeration cycle.	**K3**
CO3	Discuss the difference of compound compression refrigeration cycles and cascade refrigeration cycles.	**K3**
CO4	Classify the refrigerants and explain the primary and secondary refrigerants.	**K4**
CO5	Understand the lithium bromide water refrigeration system.	**K2**

TEXT BOOK:

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010.

REFERENCES:

1. Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
2. Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 1986.
3. ASHRAE Hand book, Fundamentals, 2010 4. Jones W.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2001.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name	**REFRIGERATION AND AIR CONDITIONING**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	1	2	2	2	2	-	-	3	-	-	3
CO2	-	1	2	2	2	2	-	-	3	-	-	3
CO3	3	2	1	1	2	1	-	-	-	-	-	-
CO4	-	1	2	2	2	2	-	-	3	-	-	3
CO5	1	2	3	3	3	3	-	-	1	-	-	2
Average	2	1.4	2	2	2.2	2	-	-	2.5	-	-	2.75

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**REFRIGERATION AND AIR CONDITIONING**		
CO	**PSO1**	**PSO2**	
CO1	3	3	
CO2	1	2	
CO3	3	1	
CO4	2	3	
CO5	1	1	
Average	2	2	

	WELDING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To understand the basics of welding and to know about the various types of welding processes

UNIT I INTRODUCTION **9**

Introduction- Welding as a production process – its advantages and limitations. Gas welding process, Types of fuels, Acetylene, Indane, Butane etc. Gas welding equipment, Gas welding technique. Electric arc welding – Manual metal arc welding – Power supplies, cables and other accessories for arc welding, Welding technique - atomic, hydrogen welding, Thermit welding, soldering, brazing and braze welding.

UNIT II SPECIAL WELDING PROCESS **9**

Special Welding Processes- Power sources, equipments and accessories, application, limitation and other characteristics of: (a) Gas tungsten arc (TIG) welding (b) Gas metal arc (MIG) welding (c) Submerged arc welding (d) Electro slag welding processes. Resistance welding processes- principle- Types (spot, seam, projection, percussion, flash), Equipment required for each application.

UNIT III MODERN WELDING PROCESS **9**

Modern Welding Processes-Electron beam welding, Laser beam welding, Plasma arc welding, Friction welding, Explosive welding, Ultrasonic welding, Stud welding, Under water welding, Diffusion bonding, Cold welding, Welding of dissimilar metals.

UNIT IV WELDING DEFECTS AND TESTING **9**

Weldment Testing- Defects in welding in various processes-Causes and remedies; Destructive testing of weldments - Strength, hardness, ductility, fatigue, creep properties etc. Nondestructive testing of weldments; Ultrasonic dye penetrant, magnetic particle inspection. X-ray testing procedures and identification of defects – case studies. Weld thermal cycle – Residual stressed distortion in welding stress relieving techniques.

UNIT V DESIGN OF WELDMENTS **9**

Weldability, Automation And Design in Welding- Weldability – definition. Temperature distribution in welding –heat affected zone weldability of steel, cast iron. Aluminum, Pre heating and post heating of weldments. Estimation of transition temperature. Automation in welding – Seam tracking vision and arc sensing welding robots. Design of weldments-Welding symbols positions of welding joint and groove design. Weld stress –Calculations – Design of weld size.

TOTAL: 45 Hours

COURSE OUTCOMES

After successful completion of the welding technology course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the theoretical aspects of various welding technology.	**K2**
CO2	Classify the various special types of welding process	**K3**
CO3	Study the various Modern Welding Processes.	**K4**

CO4 Identify the various welding defects and testing. **K5**

CO5 Design the various weldments. **K5**

TEXT/REFERENCE BOOKS

1. Abbott, J., & Smith, K. M. Welding Technology: Texas State Technical College Publishing.
2. Radhakrishnan.V.M. Welding Technology and Design, New Age International Pub. Ltd.,
3. Little R.L., Welding Technology Tata McGraw-Hill
4. Partner R.S.Welding Process and Technology, Khanna Publishers
5. Lancaster J.F., Metallurgy of Welding, George Allen and Unwin.
6. "AWS Welding Hand Book", Volume 1 to 4, AWS.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**WELDING TECHNOLOGY**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	2	3	2	2	-	-	-	-	1
CO2	2	1	0	0	1	0	2	-	-	-	-	0
CO3	2	3	2	2	3	2	2	-	-	-	-	1
CO4	2	1	0	0	1	0	2	-	-	-	-	0
CO5	2	3	2	2	3	2	2	-	-	-	-	1
Average	2	2.2	2	2	2.2	2	2	-	-	-	-	1

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**WELDING TECHNOLOGY**		
CO	**PSO1**		**PSO2**
CO1	2		3
CO2	2		2
CO3	3		1
CO4	3		1
CO5	1		2
Average	2.2		2

HEAT AND MASS TRANSFER

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

- To understand the mechanisms of heat transfer under steady and transient conditions.
- To understand the concepts of heat transfer through extended surfaces.
- To learn the thermal analysis and sizing of heat exchangers and to understand the basic concepts of mass transfer. (Use of standard HMT data book permitted)

UNIT I CONDUCTION 9

Basic Concepts – Mechanism of Heat Transfer – Conduction, Convection and Radiation – General Differential equation of Heat Conduction – Fourier Law of Conduction – Cartesian and Cylindrical Coordinates – One Dimensional Steady State Heat Conduction – Conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Use of Heislers Chart.

UNIT II CONVECTION 9

Basic Concepts – Convective Heat Transfer Coefficients – Boundary Layer Concept – Types of Convection – Forced Convection – Dimensional Analysis – External Flow – Flow over Plates, Cylinders and Spheres – Internal Flow – Laminar and Turbulent Flow – Combined Laminar and Turbulent – Flow over Bank of tubes – Free Convection – Dimensional Analysis – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9

Nusselts theory of condensation-pool boiling, flow boiling, correlations in boiling and condensation, Types of Heat Exchangers – LMTD Method of heat Exchanger Analysis – Effectiveness – NTU method of Heat Exchanger Analysis – Overall Heat Transfer Coefficient – Fouling Factors.

UNIT IV RADIATION 9

Basic Concepts, Laws of Radiation – surface emission properties - Stefan Boltzman Law, Kirchoff Law, Planks law, wien's displacement law –Black Body Radiation –Grey body radiation Shape Factor Algebra – Electrical Analogy – Radiation Shields –Introduction to Gas Radiation.

UNIT V MASS TRANSFER 9

Basic Concepts – Mass transfer coefficient - Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – General mass diffusion equation in stationary media - Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations

TOTAL: 45 Hours

Note: *(Use of standard heat and mass transfer data book is permitted in the University examination)*

COURSE OUTCOMES:

After successful completion of the Heat and Mass Transfer course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Understand the mechanisms of heat transfer under steady and transient conditions.	K2
CO2:	Understand the concepts of heat transfer through extended surfaces.	K2

CO3:	Learn the thermal analysis and sizing of heat exchangers and to understand the basic concepts of mass transfer.	K4
CO4:	Understand about the General Differential equation of Heat conduction.	K6
CO5:	Design heat exchangers and mass transfer systems	K2

TEXT BOOKS:

1. Sachdeva R C, "Fundamentals of Engineering Heat and Mass Transfer" New Age International, 1995.
2. Yadav R "Heat and Mass Transfer" Central Publishing House, 1995.

REFERENCES:

1. Nag P.K, " Heat Transfer", Tata McGraw-Hill, New Delhi, 2002.
2. Holman J.P "Heat and Mass Transfer" Tata McGraw-Hill, 2000.
3. Kothandaraman C.P "Fundamentals of Heat and Mass Transfer" New Age International, New Delhi, 1998
4. Frank P. Incropera and David P. DeWitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, 1998.
5. Velraj R, "Heat & Mass Transfer", Ane Books, New Delhi, 2004.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name	**HEAT AND MASS TRANSFER**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	0	0	0	0	2	--	--	--	--	0
CO2	1	2	3	3	3	3	1	--	--	--	--	2
CO3	2	3	2	2	2	2	2	--	--	--	--	1
CO4	2	3	2	2	2	2	2	--	--	--	--	1
CO5	0	1	2	2	2	2	0	--	--	--	--	3
Average	**1.75**	**2**	**2.25**	**2.25**	**2.25**	**2.25**	**1.75**	**--**	**--**	**--**	**--**	**1.75**

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**HEAT AND MASS TRANSFER**		
CO	**PSO1**	**PSO2**	
CO1	2	2	
CO2	2	1	
CO3	3	1	
CO4	2	2	
CO5	2	1	
Average	2.2	1.4	

	CRYOGENIC ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- The main aim of this course is to make the students to know and understand the cryogenic engineering's various stages.

UNIT I INTRODUCTION 9

Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Applications of cryogenics in space, Food Processing, super Conductivity, Electrical Power, Biology, Medicine, Electronics and Cutting Tool Industry.

UNIT II LIQUEFACTION CYCLES 9

Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles, Inversion Curve – Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle Dual Cycle, Helium Refrigerated Hydrogen Liquefaction Systems, Critical Components in Liquefaction Systems.

UNIT III SEPARATION OF CRYOGENIC GASES 9

Binary Mixtures, T-C and H-C Diagrams, Principle of Rectification, Rectification Column Analysis – McCabe Thiele Method, Adsorption Systems for purification.

UNIT VI CRYOGENIC REFRIGERATORS 9

Joule Thomson Cry coolers, Stirling Cycle Refrigerators, G.M.Cryocoolers, Pulse Tube Refrigerators. Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators.

UNIT V STORAGE, INSULATION AND INSTRUMENTATION 9

Cryogenic Storage vessels, Transportation, and Transfer Lines., Thermal insulation and their performance at cryogenic temperatures, Super Insulations, Vacuum insulation, Powder insulation and Cryo-pumping. Instrumentation to measure Pressure, Flow, Level and Temperature

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Cryogenic Engineering course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Understand the principles of cryogenics systems and their application.	K2
CO2:	Understand low temperature processes and techniques related issues.	K2
CO3:	Evaluate the properties of material at low temperature.	K4
CO4:	Understand different types of cryogenic insulation techniques.	K6
CO5:	Explain Liquefaction Cycle and Critical Components in Liquefaction Systems.	K2

TEXT BOOKS:

1. Randali F. Barron, Cryogenic Systems, McGraw-Hill, 1985
2. Scott R.B., Cryogenic Engineering, Van Nostrand and Co., 1962.

REFERENCES:

1. Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989
2. Guthree A, "High Vacuum Technology" New Age International Publication.
3. White G.K., "Experimental Techniques In two temp Physics ", Oxford University Press, England, 1959.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	CRYOGENIC ENGINEERING											
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	0	0	1	0	-	-	-	-	-	-
CO2	2	1	0	0	1	0	-	-	-	-	-	-
CO3	2	3	2	2	3	2	-	-	-	-	-	-
CO4	0	1	2	2	2	2	-	-	-	-	-	-
CO5	2	1	0	0	1	0	-	-	-	-	-	-
Average	2	1.4	2	2	1.6	2	-	-	-	-	-	-

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	CRYOGENIC ENGINEERING		
CO	PSO1	PSO2	
CO1	2	3	
CO2	1	2	
CO3	3	1	
CO4	2	3	
CO5	1	1	
Average	1.8	2	

	RENEWABLE ENERGY SOURCES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- At the end of the course, the students are expected to identify the new methodologies / technologies for effective utilization of renewable energy sources.

UNIT I SOLAR ENERGY **9**

Solar Radiation – Measurements of solar Radiation and sunshine – Solar Thermal Collectors – Flat Plate and Concentrating Collectors – Solar Applications – fundamentals of photo Voltaic Conversion – solar Cells – PV Systems – PV Applications.

UNIT II WIND ENERGY **9**

Wind Data and Energy Estimation – wind Energy Conversion Systems – Wind Energy generators and its performance – Wind Energy Storage – Applications – Hybrid systems.

UNIT III BIO – ENERGY **9**

Biomass, Biogas, Source, Composition, Technology for utilization – Biomass direct combustion – Biomass gasifier – Biogas plant – Digesters – Ethanol production – Bio diesel production and economics.

UNIT IV OTEC, TIDAL, GEOTHERMAL AND HYDEL ENERGY **9**

Tidal energy – Wave energy – Data, Technology options – Open and closed OTEC Cycles – Small hydro, turbines – Geothermal energy sources, power plant and environmental issues.

UNIT V NEW ENERGY SOURCES **9**

Hydrogen, generation, storage, transport and utilisation, Applications: power generation, transport – Fuel cells – technologies, types – economics and the power generation.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Renewable Energy Sources course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the basic concepts of energy conversions.	**K2**
CO2	Understand the various wind energy generators and its performance.	**K2**
CO3	Understand the chronological evaluation of Wind energy system and understand the function and process involved in the Hydel energy system.	**K2**
CO4	Understand the function and process involved in the Geo thermal energy system and explain the working principle of the Ocean thermal power plant.	**K2**
CO5	Analyze and explain actual load of the power system and the central reserve system.	**K5**

TEXT BOOKS:

1. Rai G.D., Non-Conventional Energy Sources, Khanna Publishers, New Delhi, 1999.
2. Sukhatme S.P., Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.

REFERENCES:

1. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K., 1996.
2. Twidell, J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 1986.
3. Tiwari G.N., Solar Energy – Fundamentals Design, Modeling and applications, Narosa Publishing House, New Delhi, 2002
4. Freris L.L., Wind Energy Conversion systems, Prentice Hall, UK, 1990.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**Renewable Energy Sources**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	2	3	3	3	3	1	-	-	-	2	2
CO2	1	2	3	3	3	3	1	-	-	-	2	2
CO3	2	3	2	2	3	2	2	-	-	-	1	1
CO4	1	2	3	3	3	3	1	-	-	-	2	2
CO5	1	2	3	3	3	3	1	-	-	-	2	2
Average	1.2	2.2	2.8	2.8	3	2.8	1.2	-	-	-	1.8	1.8

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**Renewable Energy Sources**		
CO	**PSO1**	**PSO2**	
CO1	2	3	
CO2	1	2	
CO3	3	1	
CO4	2	3	
CO5	1	1	
Average	1.8	2	

	Composite Materials and Mechanics	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the fundamentals of composite material strength and its mechanical behavior.
- Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
- Thermo-mechanical behavior and study of residual stresses in Laminates during processing. Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.

UNIT I COMPOSITE MATERIALS AND THEIR APPLICATIONS 9

Composite materials, Introduction Fibers Matrix materials Material forms and various stages, Fibers Matrix materials Material fabrication methods Current applications.

UNIT II CONCEPTS OF SOLID MECHANICS 9

Tensors Stress and strain Plane stress and plane strain energy density Generalized Hooke's Law Material symmetry Engineering constants 3 Coordinate transformations Thermal effects, Moisture effects Chemical aging, flammability.

UNIT III CONCEPTS OF MICROMECHANICS 9

Effective properties Survey and model comparison from strength of materials approximations, continuum mechanics approaches.

UNIT IV Stress-Strain for an Orthotropic Lamina And Aminate Analysis 9

Orthotropic properties in plane stress, Deformation due to extension/shear and bending/torsion A, B, D matrices hydrothermal behavior Special laminates Average stress-strain properties.

UNIT V CONCEPTS OF FAILURE OF LAMINATES AND SHAFTS 9

Tensile failure of fiber composites Compressive failure of fiber composites Effect of multi axial stresses (failure criteria by Tsai-Wu, Hashin, etc.) Edge effects, Effective stiffness of beams Effective stiffness of shafts

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Composite Materials and Mechanics course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Understand the fundamentals of composite material strength and its mechanical behavior.	K2
CO2:	Understand the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.	K3

CO3:	Understand Thermo-mechanical behavior and study of residual stresses in Laminates during processing.	K4
CO4:	Implement Classical Laminate Theory (CLT) to study and analysis of residual stresses in an isotropic layered structure such as electronic chips.	K3
CO5:	Study the concepts of polymer, Graphite, ceramic and metal matrices	K5

TEXT BOOKS:

1. Carl T. Herakovich, Mechanics of Fibrous Composites, 1997,
2. Stephen R. Swanson, Introduction to Design and Analysis with Advanced Composite Materials, Prentice-Hall, 1997.

REFERENCES:

1. HyerM. W., Stress Analysis of Fiber-Reinforced Composite Materials, McGraw-Hill, 1997
2. GibsonR. F., Principles of Composite Material Mechanics, 2nd edition, CRC Press.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name	**Composite Materials and Mechanics**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	0	0	0	0	2	--	--	--	--	0
CO2	2	3	2	2	2	2	2	--	--	--	--	1
CO3	2	3	2	2	2	2	2	--	--	--	--	1
CO4	3	2	1	1	1	1	3	--	--	--	--	0
CO5	0	1	2	2	2	2	0	--	--	--	--	3
Average	**2.25**	**2**	**1.75**	**1.75**	**1.75**	**1.75**	**2.25**	**--**	**--**	**--**	**--**	**1.66**

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**Composite Materials and Mechanics**		
CO	**PSO1**	**PSO2**	
CO1	2	2	
CO2	2	1	
CO3	3	1	
CO4	2	2	
CO5	2	1	
Average	2.2	1.4	

	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the construction and working principle of various parts of an automobile.
- To have the practice for assembling and dismantling of engine parts and transmission system.

UNIT I VEHICLE STRUCTURE AND ENGINES 9

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines –components-functions and materials, variable valve timing (VVT).

UNIT II ENGINE AUXILIARY SYSTEMS 9

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system.

UNIT III TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT IV STEERING, BRAKES AND SUSPENSION SYSTEMS 9

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS) and Traction Control

UNIT V ALTERNATIVE ENERGY SOURCES 9

Use of Natural Gas, Liquefied Petroleum Gas. Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell.

Note: *Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.*

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Automobile Engineering course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Explain the vehicle construction and engines in automobiles.	**K5**
CO2	Demonstrate the fuel injection, ignition systems and starting systems.	**K3**
CO3	Function of the transmission and cooling systems.	**K4**
CO4	Discuss the steering systems, braking systems and suspension systems.	**K6**

CO5	Discuss the IC engine emissions and alternative fuels and their conversion kits used in automobile.	**K4**

TEXT BOOKS:

1. Kirpal Singh, "Automobile Engineering Vol 1 & 2 ", Standard Publishers, Seventh Edition, 1997, New Delhi
2. Jain,K.K., and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002

REFERENCES:

1. Newton, Steeds and Garet, "Motor Vehicles", Butterworth Publishers, 1989.
2. Joseph Heitner, "Automotive Mechanics", Second Edition, East-West Press, 1999.
3. Martin W. Stockel and Martin T Stockle, "Automotive Mechanics Fundamentals", The Good heart – Will Cox Company Inc, USA, 1978.
4. Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 1998.
5. R. Pugazhenthi, et.al., "Automobile Engineering", sams publications, 2015.
6. Ganesan V." Internal Combustion Engines", Third Edition, Tata Mcgraw-Hill, 2007.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code				Semester							
Subject Name	**Automobile Engineering**										
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	2	3	3	3	3	1	-	2	-	2	2
CO2	3	2	1	1	2	1	3	-	-	-	-	-
CO3	2	3	2	2	3	2	2	-	1	-	1	1
CO4	-	1	2	2	2	2	-	-	3	-	3	3
CO5	-	1	2	2	2	2	-	-	3	-	3	3
Average	2	1.8	2	2	2.4	2	2	-	2.2	-	2.2	2.2

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**Automobile Engineering**		
CO	**PSO1**	**PSO2**	
CO1	3	3	
CO2	3	3	
CO3	2	3	
CO4	1	2	
CO5	3	2	
Average	2.4	2.6	

	DESIGN OF PRESSURE VESSELS AND PIPING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the different types of stresses and their effects in pressure vessel.
- To understand the piping layout and the stresses acting on it.

UNIT I CYLINDRICAL SHELL AND VARIOUS CLOSURES 9

Membrane theory for thin shells, stresses in cylindrical, spherical and conical shells, dilation of above shells, general theory of membrane stresses in vessel under internal pressure and its application to ellipsoidal and torispherical end closures. Bending of circular plates and determination of stresses in simply supported and clamped circular plate. Introduction to ASME code and formulae.

UNIT II JUNCTION STRESSES, OPENING AND REINFORCEMENTS 9

Discontinuity stresses. Stress concentration in plate having circular hole due to bi-axial loading. Theory of reinforced opening and reinforcement limits.

UNIT III SUPPORT DESIGN 9

Supports for vertical & horizontal vessels. Design of base plate and support lugs. Types of anchor bolt, its material and allowable stresses. Design of saddle supports.

UNIT IV BUCKLING IN VESSELSB 9

Buckling of vessels under external pressure. Elastic buckling of long cylinders, buckling modes, Collapse under external pressure. Design for stiffening rings. Buckling under combined external pressure and axial loading.

UNIT V PIPING STRESS ANALYSIS 9

Flow diagram, Piping layout and piping stress analysis. Flexibility factor and stress intensification factor. Design of piping system as per B31.1 piping code. Piping components – bends, tees, bellows and valves. Types of piping supports and their behavior.

TOTAL: 45 Hours

TEXT BOOKS:

1. Harvey J F, ‘Pressure vessel design’ CBS publication
2. Brownell. L. E & Young. E. D, ‘Process equipment design’, Wiley Eastern Ltd., India

REFERENCES:

1. ASME Pressure Vessel and Boiler code, Section VIII Div 1 & 2, 2003
2. American standard code for pressure piping , B 31.1
3. Henry H Bednar, Pressure vessel Design Hand book, CBS publishers and distributors Stanley M Wales, Chemical Process equipment, selection and design, Butter worths, series in Chemical Engineering,1988
4. William.j.,Bees,"Approximate methods in the Design and Analysis of pressurevessels and piping", ASME Pressure vessels and piping conference,1997.

COURSE OUTCOMES:

After successful completion of the Design of Pressure Vessels and Piping course, the student with able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Do heat transfer analysis using LMTD or NTU method.	K2
CO2:	Identify the nature of problems with the available data.	K2
CO3:	Understand the ASME code and formulae for thermal design of heat exchangers.	K2
CO4:	Understand and Analyze thin plates and shells of various types of stresses, opening and reinforcement.	K2
CO5:	Design shells, end closures and nozzles of pressure vessels using ASME codes.	K2

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name	**DESIGN OF PRESSURE VESSELS AND PIPING**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	1	2	2	2	2	-	-	-	-	-	3
CO2	2	3	2	2	3	2	2	-	-	-	-	1
CO3	-	1	2	2	2	2	-	-	-	-	-	3
CO4	-	1	2	2	2	2	-	-	-	-	-	3
CO5	-	1	2	2	2	2	-	-	-	-	-	3
Average	2	1.4	2	2	2.2	2	2	--	--	--	--	2.6

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**DESIGN OF PRESSURE VESSELS AND PIPING**		
CO	**PSO1**	**PSO2**	
CO1	2	2	
CO2	2	1	
CO3	3	1	
CO4	2	2	
CO5	2	1	
Average	2.2	1.4	

	VIBRATION AND NOISE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To familiarize the students with the sources of vibration and noise in machines and make design modifications to reduce the vibration and noise and improve the life of the components.

UNIT I INTRODUCTION 9

Relevance of and need for vibrational analysis, Mathematical modeling of vibrating systems-discrete and continuous systems-single-degree of freedom systems, free and forced vibrations, various damping models.

UNIT II TWO DEGREES OF FREEDOM SYSTEMS 9

Generalized co-ordinates, principal co-ordinates, derivation of equations of motion, co-ordinate coupling, and Lagrange's equation.

UNIT III MULTI DEGREES OF FREEDOM SYSTEMS 9

Derivation of equations of motion, influence coefficients, orthogonality principle, calculation of natural frequencies by Raleigh, Stodala, Dunkerley, Holzer and matrix iteration methods, branched system, geared system.

UNIT IV VIBRATION MEASUREMENT AND CONTROL 9

Measurement of vibration, FFT analyzer, Methods of vibration control - excitation reduction at source, balancing of rigid, flexible and variable mass rotors. Dynamic properties and selection of structural materials-viscoelastic polymers, vibration absorbers- tuned absorber, tuned and damped absorber (qualitative treatment only), unturned viscous damper, vibration isolation.

UNIT V TRANSIENT VIBRATION AND NOISE 9

Impulse and arbitrary excitation, base excitation, Laplace transform formulation, response spectrum, Properties of sound – sound level meter, Sound isolation- machine enclosures, silencers and mufflers.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Vibration and Noise Engineering course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Identify the sources of vibration and noise in machines.	K2
CO2:	Make the design modifications to reduce the vibration and noise from the components to improve the life.	K2
CO3:	Identify the vibration analysis in machinery to safeguard the mechanism.	K2
CO4:	Create Mathematical modeling of single degree of freedom system.	K2
CO5:	Understand the difference between free and forced vibrations.	K2

TEXT BOOKS:

1. Thomson W T, "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990.
2. Ashok Kumar Mallik, “Principles of Vibration Control”, Affiliated East-West Press Pvt. Ltd., New Delhi Press, 1990.

REFERENCES:

1. Ambekar A.G., “Mechanical Vibrations and Noise Engineering”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2006.
2. Lewis H Bell, “Industrial Noise Control Fundamentals and Applications”, Marcel Dekker, New York, 1982.
3. Rao S S, "Mechanical Vibrations", Addison Wesley, USA, 1995.
4. Tse Morse and Hinkle, “Mechanical Vibration”, Prentice Hall, New Delhi, 1987.
5. Grover G K, "Mechanical Vibrations ", New Chand and Brothers, Roorkey, 1989.
6. Seto, “Mechanical Vibrations ", Schaum Outline Series, McGraw Hill Inc., New York, 1990.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name												
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1	2	2	3	-	0	0	0	0
CO2	2	3	2	2	2	2	2	-	1	1	1	1
CO3	2	1	0	0	0	0	0	-	1	1	1	1
CO4	2	3	2	2	2	2	2	-	1	1	1	1
CO5	0	1	2	1	2	1	2	-	3	3	3	3
Average	1.8	2	1.4	1.2	1.6	1.4	1.8	-	1.2	1.2	1.2	1.1

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**VIBRATIONS AND NOISE ENGINEERING**		
CO	**PSO1**		**PSO2**
CO1	2		3
CO2	1		2
CO3	3		1
CO4	2		3
CO5	1		1
Average	1.8		2

	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the basic difference between incompressible and compressible flow.
- To understand the phenomenon of shock waves and its effect on flow.
- To gain some basic knowledge about jet propulsion and Rocket Propulsion.

(Use of Standard Gas Tables permitted)

UNIT I COMPRESSIBLE FLOW – FUNDAMENTALS 9

Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility.

UNIT II FLOW THROUGH VARIABLE AREA DUCTS 9

Isentropic flow through variable area ducts, Nozzle flow - T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, chocked mass flow rate of the nozzle - effect of friction in flow through nozzles.

UNIT III FLOW THROUGH CONSTANT AREA DUCTS 9

Flow in constant area ducts with friction – Fanno curves and Fanno flow equation, variation of flow properties, variation of Mach number with duct length. Isothermal flow with friction in constant area ducts. Flow in constant area ducts with heat transfer, Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer.

UNIT IV NORMAL SHOCK 9

Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock, Prandtl - Meyer equation, impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with shock, normal shock in Fanno and Rayleigh flows, flow with oblique shock.

UNIT V PROPULSION 9

Aircraft propulsion – types of jet engines – energy flow through jet engines, study of turbojet engine components – diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbo jet engines – thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbo jet engine, ram jet and pulse jet engines. Rocket propulsion – rocket engines thrust equation – effective jet velocity specific impulse – rocket engine performance, solid and liquid propellants, comparison of different propulsion systems.

TOTAL: 45 Hours

Note: ***(Use of approved gas tables is permitted in the University examination)***

TEXT BOOKS:

1. Yahya. S.M., "Fundamental of compressible flow", New Age International (p) Ltd., New Delhi, 1996.
2. Patrich.H. Oosthvizen, William E. Carscallen, "Compressible fluid flow", McGraw-Hill, 1997.

REFERENCES:

1. Cohen. H., Rogers R.E.C and Sravanamutoo, "Gas turbine theory", Addison Wesley Ltd., 1987.
2. Ganesan. V., "Gas Turbines", Tata McGraw-Hill, New Delhi, 1999.
3. Rathakrishnan. E, "Gas Dynamics", Prentice Hall of India, New Delhi, 2001.

COURSE OUTCOMES:

After successful completion of the Gas Dynamics and Jet Propulsion course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the basic difference between incompressible and compressible flow.	**K2**
CO2	Understand the phenomenon of shockwaves and effect on flow.	**K2**
CO3	Study the basic concepts and isentropic flows.	**K2**
CO4	Study the flow through constant area and variable area duct.	**K2**
CO5	Identify the effect of friction in flow through nozzles.	**K2**

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name	**GAS DYNAMICS AND JET PROPULSION**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	0	0	1	0	-	-	-	-	-	-
CO2	2	1	0	0	1	0	-	-	-	-	-	-
CO3	2	3	2	2	3	2	-	-	-	-	-	-
CO4	0	1	2	2	2	2	-	-	-	-	-	-
CO5	2	1	0	0	1	0	-	-	-	-	-	-
Average	2	1.4	2	2	1.6	2	-	-	-	-	-	-

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**GAS DYNAMICS AND JET PROPULSION**		
CO	**PSO1**	**PSO2**	
CO1	2	3	
CO2	1	2	
CO3	3	1	
CO4	2	3	
CO5	1	1	
Average	1.8	2	

DESIGN OF JIGS, FIXTURES AND PRESS TOOLS

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

- To understand the functions and design principles of Jigs, fixtures and press tools
- To gain proficiency in the development of required views of the final design.

UNIT I LOCATING AND CLAMPING PRINCIPLES 8

COURSE OBJECTIVE of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping –Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

UNIT II JIGS AND FIXTURES 10

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

UNIT III PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING 10

Press Working Terminologies - operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.

UNIT IV BENDING AND DRAWING DIES 10

Difference between bending and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads –Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads ironing– Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.

UNIT V OTHER FORMING TECHNIQUES 7

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke.

TOTAL: 45 Hours

Note: (Use of P S G Design Data Book is permitted in the University examination)

COURSE OUTCOMES:

After successful completion of the Design of Jigs, Fixtures and Press Tools course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Understand the principles of designing jigs, fixtures and press tools.	K2

CO2: Understand the parts in various designs. k3

CO3: Adopt a standard procedure for the design of Jigs. K5

CO4: Understand the fixtures and press tools. K6

CO5: Understand the press working terminologies and elements of cutting dies. K4

TEXT BOOKS:

1. Joshi, P.H. "Jigs and Fixtures", Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
2. Joshi P.H "Press tools - Design and Construction", wheels publishing, 1996.

REFERENCES:

1. Venkataraman. K., "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, 2005.
2. Donaldson, Lecain and Goold "Tool Design", 3rd Edition, Tata McGraw Hill, 2000.
3. Kempster, "Jigs and Fixture Design", Third Edition, Hoddes and Stoughton, 1974.
4. Hoffman "Jigs and Fixture Design", Thomson Delmar Learning, Singapore, 2004.
5. ASTME Fundamentals of Tool Design Prentice Hall of India.
6. Design Data Hand Book, PSG College of Technology, Coimbatore.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS											
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	0	0	1	0	2	-	0	-	-	0
CO2	3	2	1	1	1	1	3	-	0	-	-	0
CO3	1	2	3	3	3	3	1	-	2	-	-	2
CO4	1	2	2	2	2	2	0	-	3	-	-	3
CO5	2	3	2	2	2	2	2	-	1	-	-	1
Average	1.8	2	2	2	1.8	2	2	-	2	-	-	2

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS		
CO	PSO1	PSO2	
CO1	1	2	
CO2	2	1	
CO3	1	2	
CO4	2	1	
CO5	1	2	
Average	1.4	1.6	

	INDUSTRIAL AUTOMATION, CNC AND ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the functions of the basic components of a Robot.
- To study the use of various types of End of Effectors and Sensors
- To impart knowledge in Robot Kinematics and Programming
- To learn Robot safety issues and economics.

UNIT I AUTOMATION 9

Basic principles of automation; Hard Automation, Flexible Automation extending the capabilities of conventional machines through improved devices and manipulators; Transfer Machines for Assembly, Multi spindle Automatics.

UNIT II CNC 9

Basic principles of numerical control; Methods of coding and programming; CNC, DNC and Machining Centres; Manual Programming, Computer Aided (APT) programming; Adaptive control; Economics of numerical control.

UNIT III FUNDAMENTALS OF ROBOT 9

Robot – Definition – Robot Anatomy – Co-ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and Functions – Need for Robots – Different Applications.

UNIT IV ROBOT DRIVE SYSTEMS AND END EFFECTORS 9

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of Drives End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT V SENSORS AND MACHINE VISION 9

Requirements of a sensor, Principles and Applications of the following types of sensors – Position of sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, Pneumatic Position Sensors), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Time of Flight Range Finders, Laser Range Meters), Proximity Sensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors), Touch Sensors, (Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors, Slip Sensors. Camera, Frame Grabber, Sensing and Digitizing Image Data – Signal Conversion, Image Storage, Lighting Techniques. Image Processing and Analysis – Data Reduction: Edge detection, Feature Extraction and Object Recognition.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Automation, CNC and Robotics course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Explain the principles of automation	**K2**
CO2	Applying the programming knowledge on CNC machining.	**K3**
CO3	Design and development of robot anatomy model and its structure.	**K4**
CO4	Construction of Robot End effectors and drive system.	**K4**
CO5	Measure the sensors data and explain the machine vision system to robotics.	**K3**

TEXT BOOK:

1. M.P.Groover, "Industrial Robotics – Technology, Programming and Applications", McGraw-Hill, 2001.

REFERENCES:

1. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw-Hill Book Co., 1987.
2. YoramKoren, "Robotics for Engineers", McGraw-Hill Book Co., 1992.
3. Janakiraman.P.A., "Robotics and Image Processing", Tata McGraw-Hill, 1995.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**INDUSTRIAL AUTOMATION, CNC AND ROBOTICS**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	1	-	-	-	-	-	-	-
CO2	3	2	1	1	2	1	-	-	-	-	-	-
CO3	-	1	2	2	2	2	-	-	-	-	-	3
CO4	-	1	2	2	2	2	-	-	-	-	-	3
CO5	1	2	3	3	3	3	-	-	-	-	-	2
Average	2	1.4	2	2	2	2	-	-	-	-	-	2.6

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**INDUSTRIAL AUTOMATION, CNC AND ROBOTICS**		
CO	**PSO1**	**PSO2**	
CO1	3	2	
CO2	2	1	
CO3	3	3	
CO4	3	2	
CO5	2	1	
Average	2.6	1.8	

	UNCONVENTIONAL MACHINING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To learn about various unconventional machining processes, the various process parameters and their influence on performance and their applications.

UNIT I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Unconventional machining Process – Need – classification – merits, demerits and applications. Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining - Ultrasonic Machining. (AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters – MRR- Applications.

UNIT II THERMAL AND ELECTRICAL ENERGY BASED PROCESSES 9

Electric Discharge Machining (EDM) – Wire cut EDM – Working Principle-equipments-Process Parameters-Surface Finish and MRR- electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing – – Applications. Laser Beam machining and drilling, (LBM), plasma, Arc machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types - Beam control techniques – Applications.

UNIT III CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES 9

Chemical machining and Electro-Chemical machining (CHM and ECM)- Etchants – Maskant - techniques of applying maskants - Process Parameters – Surface finish and MRR-Applications. Principles of ECM-equipments-Surface Roughness and MRR Electrical circuit-Process Parameters- ECG and ECH - Applications.

UNIT IV ADVANCED NANO FINISHING PROCESSES 9

Abrasive flow machining, chemo-mechanical polishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheological abrasive flow finishing their working principles, equipments, effect of process parameters, applications, advantages and limitations.

UNIT V RECENT TRENDS IN NON-TRADITIONAL MACHINING PROCESSES 9

Recent developments in non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Comparison of non-traditional machining processes.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Unconventional Machining Processes course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Formulate different types of non-traditional machining processes and evaluate mechanical energy based non-traditional machining processes	**K2**
CO2	Illustrate chemical and electro chemical energy-based processes	**K3**
CO3	Evaluate thermo-electric energy-based processes	**K3**
CO4	Interpret nano finishing processes	**K3**
CO5	Analyse hybrid non-traditional machining processes and differentiate nontraditional machining processes	**K4**

TEXT / REFERENCES BOOKS:

1. Vijay.K. Jain “Advanced Machining Processes” Allied Publishers Pvt. Ltd., New Delhi, 2002.
2. Benedict. G.F., “Nontraditional Manufacturing Processes” Marcel Dekker Inc., New York, 1987.
3. Pandey P.C. and Shan H.S. “Modern Machining Processes”, Tata McGraw-Hill, New Delhi. 1980.
4. McGeough, “Advanced Methods of Machining”, Chapman and Hall, London, 1998.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**Unconventional Machining**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	1	1	3	0	0	0	0	0	0	3
CO2	2	2	1	2	3	0	0	0	0	0	0	3
CO3	2	2	2	3	3	0	0	0	0	0	0	3
CO4	2	2	2	3	3	0	0	0	0	0	0	3
CO5	2	2	2	2	3	0	0	0	0	0	0	3
Average	2	2	1.6	2.2	3	0	0	0	0	0	0	3

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**Unconventional Machining**		
CO	**PSO1**	**PSO2**	
CO1	2	1	
CO2	2	3	
CO3	3	2	
CO4	2	2	
CO5	2	2	
Average	2.2	2	

	MANUFACTURE OF AUTOMOTIVE COMPONENTS	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVE:

- To understand the various forms of manufacturing processes used in the automobile components.
- To familiarize the students with the forging, extrusion, casting, machining process and recent trends in manufacturing of auto components.

UNIT I MANUFACTURE OF ENGINE & ENGINE COMPONENTS 9

Introduction - Casting of engine block - drilling of cylinder holes - water cooling passages - Preparation of casting for cylinder heads - design of cores. Forging of crankshafts and connecting rod, casting piston and drilling of oil holes - Upset forging of valves. Heat treatment of crankshafts and connecting rod. Drilling of oil holes and grinding of crank shafts. Forging and heat treatment of camshafts.

UNIT II MANUFACTURE OF CLUTCH, GEAR BOX AND PROPELLER SHAFT 9

Manufacturing friction plates - manufacture of composite friction lining - Composite moulding of phenol formaldehyde lining, Casting of gear box casing - Introduction to gear milling - hobbling - manufacturing and inspection of gears, Casting of propeller shaft, Extrusion of propeller shaft - extrusion dies - heat treatment and surface hardening of propeller shaft.

UNIT III MANUFACTURE OF AXLES & SPRINGS AND BODY PANELS 9

Forging of axles, Casting of front and rear axles - Provision of KPI. Wrap forming of coil springs. Introduction to the thermoforming and hydro-forming, Press-forming, Welding of body panels - resistance welding and other welding processes.

UNIT IV MANUFACTURE OF AUTOMOTIVE PLASTIC COMPONENTS 9

Introduction - Principle of injection moulding- injection moulding of instrument panel- moulding of bumpers - tooling and tooling requirements - hand lay-up process for making composite panels - Filament winding of automotive spring and propeller shaft. Manufacture of metal/Polymer/Metal panels.

UNIT V Manufacture of Engine Components Using Ceramic Matrix Composites 9

Introduction, Ceramic matrix piston rings, Chemical vapour deposition, Cryogenic grinding of powders, Sol-gel processing. Machining concepts using NC, generation of numerical control codes using Pro-E and IDEAS package, interfacing the CNC machine and manufacturing package. Introduction to rapid prototyping - rapid prototyping of using resins.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Manufacture of Automotive Components course, the student will able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Understand the various forms of manufacturing processes used in the automobile components.	K2
CO2:	Explain forging, extrusion, casting and other machining process used for manufacturing the auto components.	k3
CO3:	Understand manufacturing methods for engine and engine components	K5

CO4: Identify various manufacturing methods and materials used for the clutch. K6

CO5: Identify various manufacturing methods and materials used for the gear box. K4

TEXT BOOKS:

1. SeropeKalpakjian, “Manufacturing Engineering and Technology”, Prentice Hall, Singapore, 5th Edition, 2006.
2. Haslehurst.S.E., “Manufacturing Technology ", ELBS, London, 1990.

REFERENCES:

1. Waters T F and Waters F “Fundamentals of Manufacturing for Engineers”, Taylor & Francis, First Edition, 1996.
2. Heldt.P.M., " High Speed Combustion Engines ", Oxford Publishing Co., New York, 1990.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	Manufacture of Automotive Components											
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	0	0	1	0	2	-	0	-	-	0
CO2	3	2	1	1	1	1	3	-	0	-	-	0
CO3	1	2	3	3	3	3	1	-	2	-	-	2
CO4	1	2	2	2	2	2	0	-	3	-	-	3
CO5	2	3	2	2	2	2	2	-	1	-	-	1
Average	1.8	2	2	2	1.8	2	2	-	2	-	-	2

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	Manufacture of Automotive Components		
CO	PSO1	PSO2	
CO1	3	0	
CO2	2	1	
CO3	1	2	
CO4	1	2	
CO5	2	1	
Average	1.8	1.2	

	DESIGN OF HEAT EXCHANGERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To learn the thermal and stress analysis on various parts of the heat exchangers
- To analyze the sizing and rating of the heat exchangers for various applications

UNIT I DIFFERENT CLASSIFICATION OF HEAT EXCHANGERS 9

Parallel flow, counter flow and cross flow; shell and tube and plate type; single pass and multi-pass; once through steam generators etc.

UNIT II PROCESS DESIGN OF HEAT EXCHANGERS 9

Heat transfer correlations, Overall heat transfer coefficient, LMTD, sizing of finned tube heat exchangers, U tube heat exchangers, fouling factors, pressure drop calculations.

UNIT III MECHANICAL DESIGN OF SHELL AND TUBE TYPE 9

Thickness calculation, Tube sheet design using TEMA formula, concept of equivalent plate for analysing perforated analysis, flow induced vibration risks including acoustic issues and remedies, tube to tube sheet joint design, buckling of tubes, thermal stresses.

UNIT IV COMPACT AND PLATE HEAT EXCHANGER 9

Types – Merits and Demerits – Design of compact heat exchangers, plate heat exchangers, performance influencing parameters, limitations.

UNIT V CONDENSORS AND COOLING TOWERS 9

Design of surface and evaporative condensers – cooling tower –performance Characteristics

TOTAL: 45 hours

COURSE OUTCOMES:

After successful completion of the design of heat exchangers course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Understand the basic principles of heat exchangers systems and their application.	K2
CO2:	Explain the different classification of heat exchangers.	k3
CO3:	Differentiate the Parallel flow, counter flow and cross flow for heat exchangers.	K5
CO4:	Understand the thermal and stress analysis on various parts of the heat exchangers.	K6
CO5:	Calculate the Heat transfer correlations, Overall heat transfer coefficient, LMTD, *etc.*	K4

TEXT BOOKS:

1. TaborekT., Hewitt G.F and AfganN., Heat Exchangers, Theory and Practice, McGraw-Hill Book Co.1980.

2. Walker, Industrial Heat Exchangers- A Basic Guide, McGraw Hill Book Co. 1980.

REFERENCES:

1. Nicholas Cheremistoff, Cooling Tower, Ann Arbor Science Pub, 1981.
2. Arthur, FrassP., Heat Exchanger Design, John Wiley and Sons, 1988.
3. GuptaJ.P., Fundamentals of heat exchangers and pressure vessel technology, Hemisphere Publishing Corporation, Springer-Verlag, 1986.
4. Donald Q. Kern and Alban D. Kraus, "Extended surface hear transfer", McGrawHillBook Co., 1972
5. Sanders E.A.D., Heat Exchangers, Selection Design and Construction, Layman Scientific & Technical co, John Wiley & sons, 1988.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code				**Semester**							
Subject Name	**DESIGN OF HEAT EXCHANGERS**										
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	0	0	0	0	2	--	--	--	--	0
CO2	1	2	3	3	3	3	1	--	--	--	--	2
CO3	2	3	2	2	2	2	2	--	--	--	--	1
CO4	2	3	2	2	2	2	2	--	--	--	--	1
CO5	0	1	2	2	2	2	0	--	--	--	--	3
Average	**1.75**	**2**	**2.25**	**2.25**	**2.25**	**2.25**	**1.75**	**--**	**--**	**--**	**--**	**1.75**

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**DESIGN OF HEAT EXCHANGERS**		
CO	**PSO1**	**PSO2**	
CO1	2	2	
CO2	2	1	
CO3	3	1	
CO4	2	2	
CO5	2	1	
Average	2.2	1.4	

	ADDITIVE MANUFACTURING	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVE:

- To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies.
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.

UNIT I INTRODUCTION 9

Overview – History - Need-Classification -Additive Manufacturing Technology in product development- Materials for Additive Manufacturing Technology – Tooling - Applications.

UNIT II CAD & REVERSE ENGINEERING 9

Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation – Model Slicing –Tool path Generation – Softwares for Additive Manufacturing Technology: MIMICS, MAGICS.

UNIT III Liquid Based and Solid Based Additive Manufacturing Systems 9

Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications - Solid based system –Fused Deposition Modeling - Principle, process, advantages and applications, Laminated Object Manufacturing.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 9

Selective Laser Sintering – Principles of SLS process - Process, advantages and applications, Three Dimensional Printing - Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting.

UNIT V MEDICAL AND BIO-ADDITIVE MANUFACTURING 9

Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE) – Case studies.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Additive Manufacturing course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Understand why the Advanced/Additive manufacturing (AM) has become one of the most important technology trends in decades of product development and innovation.	K2
CO2:	Understand the comprehensive knowledge of the broad range of AM processes, devices, Capabilities and materials available.	K3
CO3:	Understand the various software tools and reverse engineering techniques.	K4
CO4:	Know how to create liquid based and solid based additive manufacturing system and additive manufacturing devices and processes.	K3

CO5:	Understand the powder based additive manufacturing system.	K3

TEXT BOOKS:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.

REFERENCES:

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name	Additive manufacturing											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	0	0	1	0	2	0	0	0	0	0
CO2	3	2	1	1	2	1	3	1	0	0	0	0
CO3	2	3	2	1	3	2	2	2	1	1	1	1
CO4	0	1	2	2	1	2	0	2	3	3	3	3
CO5	1	2	3	3	2	3	1	3	2	2	2	2
Average	1.6	1.8	1.6	1.4	1.8	1.4	1.8	1.4	1.2	1.2	1.2	1.2

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	Additive manufacturing		
CO	**PSO1**		**PSO2**
CO1	2		1
CO2	1		2
CO3	2		1
CO4	2		3
CO5	1		1
Average	1.6		1.8

		L	**T**	**P**	**C**

	RAPID PROTOTYPING, TOOLING AND MANUFACTURE	3	0	0	3

COURSE OBJECTIVE:

- To develop the ability to understand the advanced manufacturing techniques of rapid prototyping, tooling and manufacture.

UNIT I INTRODUCTION 9

History – Development of RP systems – Applications in Product Development, Reverse Engineering, Rapid Tooling, Rapid Manufacturing- Principle –Fundamental – File format –Other translators – medical applications of RP – On demand manufacturing – Direct material deposition - Shape Deposition Manufacturing.

UNIT II LIQUID BASED AND SOLID BASED RAPID PROTOTYPINGSYSTEMS 9

Classification – Liquid based system – Stereo-lithography Apparatus (SLA), details of SL process, products, Advantages, Limitations, Applications and Uses. Solid based system -Fused Deposition Modeling, principle, process, products, advantages, applications and uses -Laminated Object Manufacturing.

UNIT III POWDER BASED RAPID PROTOTYPING SYSTEMS 9

Selective Laser Sintering – principles of SLS process, principle of sinter bonding process, Laser sintering materials, products, advantages, limitations, applications and uses. Three Dimensional Printing – process, major applications, research and development. Direct shell production casting – key strengths, process, applications and uses, case studies, research and development. Laser Sintering System, manufacturing using Laser sintering, customized plastic parts, customized metal parts, e-manufacturing - Laser Engineered Net Shaping(LENS).

UNIT IV MATERIALS FOR RAPID PROTOTYPING SYSTEMS 9

Nature of material – type of material – polymers, metals, ceramics and composites liquid based materials, photo polymer development – solid based materials, powder based materials – case study.

UNIT V REVERSE ENGINEERING AND NEW TECHNOLOGIES 9

Introduction, measuring device- contact type and non-contact type, CAD model creation from point clouds-preprocessing, point clouds to surface model creation, medical data processing -types of medical imaging, software for making medical models, medical materials, other applications - Case study.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Rapid Prototyping, Tooling and Manufacture course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Understand advanced manufacturing technologies	K2
CO2:	Get the knowledge on development of rapid prototyping system	k3
CO3:	Apply rapid prototyping methods for medical applications	K3

CO4:	Known Liquid based rapid prototyping system	K3
CO5:	Known Solid based rapid prototyping system	K4

TEXT BOOKS:

1. Rafiq I. Noorani, Rapid Prototyping – Principles and Applications, Wiley & Sons,2006.
2. Chua C.K, Leong K.F and Lim C.S, Rapid Prototyping: Principles and Applications, second edition, World Scientific, 2003.

REFERENCE BOOKS:

1. HopkinsonN., Hauge R.J.M,,DickensP.M, "Rapid Manufacturing – An Industrial revolution for the digitalage", Wiley, 2006.
2. Ian Gibson, "Advanced Manufacturing Technology for Medical applications: Reverse Engineering, Software conversion and Rapid Prototyping", Wiley, 2006.
3. Paul F.Jacobs, Rapid Prototyping and Manufacturing, "Fundamentals of Stereolithography", McGrawHill, 1993.
4. Pham. D.T and Dimov S.S., "Rapid Manufacturing", Springer Verlog, 2001.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**RAPID PROTOTYPING, TOOLING AND MANUFACTURE**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	1	-	2	-	-	-	-	-
CO2	3	2	1	-	2	1	3	-	-	-	-	-
CO3	1	2	3	-	3	3	1	-	-	-	-	2
CO4	-	1	2	-	2	2	-	-	-	-	-	3
CO5	2	3	2	-	3	2	2	-	-	-	-	1
Average	2	1.8	2	-	2.2	2	2	-	-	-	-	2

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**RAPID PROTOTYPING, TOOLING AND MANUFACTURE**		
CO	**PSO1**	**PSO2**	
CO1	3	1	
CO2	3	3	
CO3	2	2	
CO4	1	2	
CO5	3	3	
Average	2.4	2.2	

18DBME74	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the application of computers in various aspects of manufacturing viz., design, proper planning, manufacturing cost, layout & material handling system.

UNIT I COMPUTER AIDED DESIGN 9

Concept of CAD as drafting and designing facility, desirable features of CAD package, drawing features in CAD – Scaling, rotation, translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate, typical CAD command structure, wire frame modeling, surface modeling and solid modeling (concepts only) in relation to popular CAD packages.

UNIT II COMPONENTS OF CIM 9

CIM as a concept and a technology, CASA/SME model of CIM, CIM II, benefits of CIM, communication matrix in CIM, fundamentals of computer communication in CIM – CIM data transmission methods – serial, parallel, asynchronous, synchronous, modulation, demodulation, simplex and duplex. Types of communication in CIM – point to point (PTP), star and multiplexing. Computer networking in CIM – the seven layer OSI model, LAN model, MAP model, network topologies – star, ring and bus, advantages of networks in CIM.

UNIT III GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING 9

History Of Group Technology – role of G.T in CAD/CAM Integration – part families- classification and coding – DCLASS and MCLASS and OPTIZ coding systems – facility design using G.T – benefits of G.T – cellular manufacturing. Process planning - role of process planning in CAD/CAM Integration – approaches to computer aided process planning – variant approach and generative approaches – CAPP and CMPP systems.

UNIT IV SHOP FLOOR CONTROL AND INTRODUCTION TO FMS 9

Shop floor control – phases – factory data collection system – automatic identification methods – Bar code technology – automated data collection system.

FMS – components of FMS – types – FMS workstation – material handling and storage system –FMS layout- computer control systems – applications and benefits.

UNIT V COMPUTER AIDED PLANNING AND CONTROL AND COMPUTER MONITORING 9

Production planning and control – cost planning and control – inventory management – material requirements planning (MRP) – shop floor control, Lean and Agile Manufacturing. Types of production monitoring systems – structure model of manufacturing – process control and strategies – direct digital control.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Computer Integrated Manufacturing course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the basic Concepts of drafting, designing facility of CAD package and CAD drawing command structure i.e. Scaling, rotation,	K2

	translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate.	
CO2	Identify and classify the various communication system used in Computer integrated manufacturing.	**K3**
CO3	Explain various coding systems, process planning and new technologies used in the computer integrated manufacturing environment.	**K3**
CO4	Explain shop floor control and flexible manufacturing system.	**K3**
CO5	Estimate the cost planning and control in production environment.	**K3**

TEXT BOOK:

1. Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education 2001.

REFERENCE BOOKS:

1. Mikell. P. Groover and Emory Zimmers Jr., "CAD/CAM", Pearson Education India, 2006
2. James A. Regh and Henry W. Kreabber, "Computer Integrated Manufacturing", Pearson Education second edition, 2005.
3. Chris McMahon and Jimmie Browne, "CAD CAM Principles, Practice and Manufacturing Management", Pearson Education second edition, 2005.
4. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice hall of India Pvt. Ltd., 2005.
5. YoremKoren, "Computer Integrated Manufacturing", McGraw Hill, 2005.
6. P N Rao, "CAD/CAM Principles and Applications", TMH Publications, 2007.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code	**18DBME74**				Semester							
Subject Name	**Computer Integrated Manufacturing**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	1	-	-	-	-	-	-	-
CO2	3	2	1	1	2	-	-	-	-	-	-	-
CO3	1	2	3	3	3	-	-	-	-	-	-	2
CO4	1	2	3	3	3	-	-	-	-	-	-	2
CO5	-	1	2	2	2	-	-	-	-	-	-	3
Average	1.7	1.6	2.2	2.2	2.2	-	-	-	-	-	-	2.3

PSOs matrices of courses selected

Subject Code	**18DBME74**	Semester	
Subject Name	**Computer Integrated Manufacturing**		
CO	**PSO1**	**PSO2**	
CO1	2	2	
CO2	2	2	
CO3	2	2	
CO4	2	2	
CO5	2	2	
Average	2	2	

	POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- Providing an overview of Power Plants and detailing the role of Mechanical Engineers in their operation and maintenance.

UNIT I INTRODUCTION TO POWER PLANTS AND BOILERS 9

Layout of Steam, Hydel , Diesel , MHD, Nuclear and Gas turbine Power Plants Combined Power cycles – comparison and selection , Load duration Curves Steam boilers and cycles – High pressure and Super Critical Boilers – Fluidized Bed Boilers.

UNIT II STEAM POWER PLANT 9

Rankine Cycle: Classification – Reheat cycle – Regenerative cycle – Reheat – regenerative cycle. Fuel and ash handling, Combustion Equipment for burning coal, Mechanical Stokers. Pulveriser, Electrostatic Precipitator, Draught- Different Types, Surface condenser types, cooling Towers.

UNIT III NUCLEAR AND HYDEL POWER PLANTS 9

Nuclear Energy-Fission , Fusion Reaction, Types of Reactors, Pressurized water reactor ,Boiling water reactor, Waste disposal and safety Hydel Power plant- Essential elements, Selection of turbines, governing of Turbines- Micro hydel developments.

UNIT IV DIESEL AND GAS TURBINE POWER PLANT 9

Types of diesel plants, components, Selection of Engine type, applications- Gas turbine plant cycle – classification – simple cycle – regenerative cycle – reheat cycle – regenerative – reheat cycle – inter-cooling. Steam and gas turbine Power plants – cycle analysis.

UNIT V OTHER POWER PLANTS AND ECONOMICS OF POWER PLANTS 9

Geo thermal- OTEC- Tidel- Pumped storage –Solar central receiver system Cost of electric Energy-Fixed and operating costs-Energy rates- Types tariffs- Economics of load sharing, comparison of various power plants.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Power Plant Engineering course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the functions of the component of power plant , modern boilers & subsystems of power plants	**K4**
CO2	Solve problems based on rankine cycle and binary cycle and explain the subsystems of steam power plant	**K3**
CO3	Evaluate the design layout and working of Nuclear and hydroelectric power plants.	**K5**
CO4	Construct diesel and gas turbine power plant	**K3**
CO5	Analyze other power plants and Evaluate economic feasibility and its implications on power generating units.	**K5**

TEXT / REFERENCE BOOKS:

1. EI-Wakil M.M, Power "Plant Technology," Tata McGraw-Hill 1984.
2. Nag P. K, "Power Plant Engineering", Third edition Tata McGraw- Hill, 2007.
3. Arora S.C and Domkundwar S, "A Course in Power Plant Engineering", DhanpatRai , 2001.
4. K. K. Ramalingam, "Power Plant Engineering", Scitech Publications, 2002.
5. G. R. Nagpal, "Power Plant Engineering", Khanna Publishers, 1998.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**Power Plant Engineering**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	2	3	-	2	-	-	-	1	1
CO2	3	2	1	1	2	-	3	-	-	-	-	-
CO3	1	2	3	3	3	-	1	-	-	-	2	2
CO4	-	1	2	2	2	-	-	-	-	-	3	3
CO5	1	2	3	3	3	-	1	-	-	-	2	2
Average	1.7	2	2.2	2.2	2.6	-	1.7	-	-	-	2	2

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**Power Plant Engineering**		
CO	**PSO1**	**PSO2**	
CO1	2	1	
CO2	2	2	
CO3	3	1	
CO4	1	1	
CO5	3	1	
Average	2.2	2	

	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- The objective of the course is to learn how to solve the Navier-Stokes and Euler equations for engineering problems using computational algorithms and programming. Various numerical solution techniques will be introduced and applied to several course projects.

UNIT I FINITE DIFFERENCE METHODS **9**

Governing Differential Equations and Finite Difference Method- Classification of PDEs - Initial and Boundary conditions - Initial and Boundary value problems - Finite difference method - Central, Forward, Backward difference for a uniform grid – Central difference expressions for a non-uniform grid - Numerical error - Accuracy of solution – Grid independence test.

UNIT II CONDUCTION HEAT TRANSFER **9**

Conduction Heat Transfer- Applications of Heat conduction - Steady and Unsteady conductions - One dimensional steady state problems - Two dimensional steady state problems - Three dimensional steady state problems - Transient one dimensional problems.

UNIT III CONVECTION HEAT TRANSFER **9**

Convection Heat Transfer- Introduction - Steady one dimensional Convection Diffusion - Unsteady one. Dimensional Convection – Diffusion – Unsteady two dimensional Convection - Diffusion.

UNIT IV INCOMPRESSIBLE FLUID FLOW **9**

Incompressible Fluid Flow- Introduction - Governing equations - Difficulties in solving Navier- Stokes equation - Stream function - Vorticity method - In viscid flow (steady) - Determination of pressure for viscous flow.

UNIT V APPLICATIONS OF COMPUTATIONAL FLUID DYNAMICS **9**

Applications of Computational Fluid Dynamics- Computer graphics in CFD - Future of CFD - Enhancing the design process - understanding - Applications - Automobile, Engine, Industrial, Civil, Environmental.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the computational fluid dynamics course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand basic properties of computational methods – accuracy of solutions, stability, and consistency.	**K2**
CO2	Classification of computational solution techniques for time integration of ordinary differential equations.	**K4**
CO3	Understand the computational solution techniques for various types of partial differential equations.	**K2**
CO4	Solve the Euler and Navier-Stokes equations computationally.	**K3**
CO5	Develop the basic programming and graphic skills to conduct the flow field calculations and data analysis.	**K3**

TEXT/REFERENCE BOOKS:

1. Muralidhar, K., and Sundararajan, T., “Computational Fluid flow and Heat Transfer", Narosa Publishing House,
2. Ghoshdasdidar, P.S., “Computer simulation of flow and heat transfer", Tata McGraw – Hill, New Delhi
3. Anderson, D. A., Tannehill, J. L, and Pletcher, R.H., “Computational fluid mechanics and Heat Transfer", Hemisphere Publishing Corporation,
4. John David Anderson, "Computational Fluid Dynamics: The Basics with Applications", McGraw Hill, New York.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name	**COMPUTATIONAL FLUID DYNAMICS**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	0	0	1	0	2	-	-	-	0	0
CO2	2	1	0	0	1	0	2	-	-	-	0	0
CO3	2	3	2	2	2	2	2	-	-	-	1	1
CO4	0	1	2	2	1	2	0	-	-	-	3	3
CO5	2	3	2	2	2	2	2	-	-	-	1	1
Average	2	1.8	2	2	1.4	2	2	-	-	-	2	2

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**COMPUTATIONAL FLUID DYNAMICS**		
CO	**PSO1**	**PSO2**	
CO1	3	2	
CO2	2	2	
CO3	2	2	
CO4	3	3	
CO5	3	2	
Average	2.6	2.2	

COURSE OBJECTIVE:

ADVANCED I.C. ENGINES

L	T	P	C
3	0	0	3

- To understand the underlying principles of operation of different IC Engines and components.
- To provide knowledge on pollutant formation, control, alternate fuel etc.

UNIT I SPARK IGNITION ENGINES **9**

Mixture requirements – Fuel injection systems – Mono point, Multipoint & Direct injection - Stages of combustion – Normal and Abnormal combustion – Knock - Factors affecting knock – Combustion chambers.

UNIT II COMPRESSION IGNITION ENGINES **9**

Diesel Fuel Injection Systems - Stages of combustion – Knocking – Factors affecting knock – Direct and Indirect injection systems – Combustion chambers – Fuel Spray behavior – Spray structure and spray penetration – Air motion - Introduction to Turbocharging.

UNIT III POLLUTANT FORMATION AND CONTROL **9**

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – Emission norms and Driving cycles.

UNIT IV ALTERNATIVE FUELS **9**

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - Properties, Suitability, Merits and Demerits - Engine Modifications.

UNIT V RECENT TRENDS **9**

Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometry turbochargers – Common Rail Direct Injection Systems - Hybrid Electric Vehicles – NOx Adsorbers - Onboard Diagnostics.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Advanced I.C Engine course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Analyze and understand the reasons for differences among operating characteristics of different engine types and designs.	**K4**
CO2	Predict the concentration of Primary exhaust pollutants based on an in-depth analysis of the combustion process.	**K3**
CO3	Analyze the skills to run engine dynamometer experiments and alternative fuels	**K4**
CO4	Compare and contrast experimental results with theoretical trends.	**K4**
CO5	Develop the ability to optimize future engine designs for specific sets of constraints fuel economy, performance and emissions.	**K3**

TEXT / REFERENCE BOOKS:

1. Ramalingam. K.K., "Internal Combustion Engine Fundamentals", Scitech Publications, 2002.
2. Ganesan, "Internal Combustion Engines", II Edition, TMH, 2002.
3. Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines".,DhanpatRai& Sons 2007.
4. Duffy Smith, "Auto Fuel Systems", The Good Heart Willcox Company, Inc., 1987.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**Advanced I.C. Engines**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	2	3	2	2	-	-	-	1	1
CO2	-	1	2	2	2	2	-	-	-	-	3	3
CO3	2	3	2	2	3	2	2	-	-	-	1	1
CO4	2	3	2	2	3	2	2	-	-	-	1	1
CO5	3	2	1	1	2	1	3	-	-	-	-	-
Average	2.2	2.4	1.8	1.8	2.6	1.8	2.2	-	-	-	1.5	1.5

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**Advanced I.C. Engines**		
CO	**PSO1**		**PSO2**
CO1	3		1
CO2	3		3
CO3	2		2
CO4	1		2
CO5	3		3
Average	2.4		2.2

	FUNDAMENTAL OF NANOSCIENCE	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVE:

- To understand the different types of stresses and their effects in pressure vessel.
- To understand the piping layout and the stresses acting on it.

UNIT I INTRODUCTION **9**

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering classifications of nanostructured materials- nano particles- quantum dots, nano wires-ultra-thin films ultilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, ptical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II PREPARATION METHODS **9**

Bottom-up Synthesis-Top-down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III PATTERNING AND LITHOGRAPHY FOR NANOSCALE DEVICES **9**

Introduction to optical/UV electron beam and X-ray Lithography systems and processes, Wetetching, dry (Plasma /reactive ion) etching, Etch resists-dip pen lithography.

UNIT IV PREPARATION ENVIRONMENTS **9**

Clean rooms: specifications and design, air and water purity, requirements for particular processes, Vibration free environments: Services and facilities required. Working practices, sample cleaning, Chemical purification, chemical and biological on tamination, Safety issues, flammable and toxichazards, biohazards.

UNIT V CHARACTERIZATION TECHNIQUES **9**

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM,STM, SNOM, ESCA, SIMS-Nano indentation.

TOTAL : 45 Hours

COURSE OUTCOMES:

After successful completion of the Product Development and Manufacture course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the principles and industrial applications of nanotechnology	**K2**
CO2	Develop the Nano-scale paradigm in terms of properties at the Nano-scale dimensions.	**K3**
CO3	Explain the nanotechnology concepts in materials science, chemistry, physics, biology and engineering.	**K5**
CO4	Design the environment for preparing nanomaterial.	**K5**
CO5	Classify various characterization techniques in nano materials	**K4**

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., Nano materials: Synthesis, Properties and Applications, (Institute of Physics Publishing, Bristol and Philadelphia, 1996)
2. N John Dinardo, Nano scale charecterisation of surfaces & Interfaces, Second edition, Weinheim Cambridge, Wiley-VCH, 2000

REFERENCE BOOKS:

1. G Timp (Editor), Nanotechnology, AIP press/Springer, 1999.
2. Akhlesh Lakhtakia (Editor) The Hand Book of Nano Technology, "NanometerStructure", Theory, Modeling and Simulations. Prentice-Hall of India (P) Ltd, NewDelhi, 2007.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	FUNDAMENTAL OF NANOSCIENCE											
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	0	0	0	0	2	--	--	--	--	0
CO2	1	2	3	3	3	3	1	--	--	--	--	2
CO3	2	3	2	2	2	2	2	--	--	--	--	1
CO4	2	3	2	2	2	2	2	--	--	--	--	1
CO5	0	1	2	2	2	2	0	--	--	--	--	3
Average	1.75	2	2.25	2.25	2.25	2.25	1.75	--	--	--	--	1.75

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	FUNDAMENTAL OF NANOSCIENCE		
CO	PSO1	PSO2	
CO1	2	2	
CO2	2	1	
CO3	3	1	
CO4	2	2	
CO5	2	1	
Average	2.2	1.4	

	PRODUCT DEVELOPMENT AND MANUFACTURE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To introduce the various concepts of product design tools and techniques while designing a product.

UNIT I INTRODUCTION **9**

Product Development process – Product development organizations, Gather raw data –Interpret raw data- organize the needs into a hierarchy – Relative importance of the needs. Product life cycle management - concepts, benefits, value addition to customer. Lifecycle Models- creation of **18DBME83**projects and roles, users and project management, system administration, Access control and its use in life cycle.

UNIT II PRODUCT SPECIFICATIONS **9**

Establishing the product specifications– Target specifications – Refining specifications, concept, Generation-Clarify the problem – Search internally – Search externally – Explore systematically.

UNIT III PRODUCT ARCHITECTURE **9**

Concept selection- Screening – scoring, Product architecture – Implication of architecture –Establishing the architecture – Related system level design issues.

UNIT IV INDUSTRIAL DESIGN **9**

Need for industrial design – Impact of industrial design – Industrial design process –Management of industrial design process – Assessing the quality of industrial design, design for Manufacturing- cost considerations, Impact of DFM decisions on other factors.

UNIT V PRINCIPLES OF PROTOTYPING AND ECONOMIC ANALYSIS **9**

Principles of prototyping – Planning for prototypes, economics of product development projects, Elements of economic analysis – Base – Case financial model – Sensitivity analysis – Influence of the quantitative factors.

TOTAL: 45 Hours

COURSE OUTCOMES

After successful completion of the Product Development and Manufacture course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the new product management through the manufacturing area.	**K4**
CO2	Introduce the various concepts of product design tools.	**K6**
CO3	Identification of design criteria which are used in designing a product.	**K4**
CO4	Gathering and interpreting and organizing of raw data.	**K4**
CO5	Understand Product lifecycle management (PLM) and Product Data Management (PDM).	**K3**

TEXT BOOKS:

1. Karal, T. Ulrich Steven D. Eppinger, Product Design and Development, McGraw Hill, International Editions, 2003.
2. Stephan C. Wheelwright, Kim B. Clark, Managing New Product and Process Development: Text and Cases, Free Press, 1992.

REFERENCE BOOKS:

1. RosenthalS., Effective Product Design and Development, Irwin, 1992.
2. Charles Gevirtz Developing New products with TQM, McGraw Hill International Editions, 1994

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	PRODUCT DEVELOPMENT AND MANUFACTURE											
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	-	1	2	2	2	2	-	-	-	-	-	3
CO1	2	3	2	2	3	2	2	-	-	-	-	1
CO2	-	1	2	2	2	2	-	-	-	-	-	3
CO3	-	1	2	2	2	2	-	-	-	-	-	3
CO4	-	1	2	2	2	2	-	-	-	-	-	3
Average	2	1.4	2	2	2.2	2	2	--	--	--	--	2.6

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	PRODUCT DEVELOPMENT AND MANUFACTURE		
CO	PSO1	PSO2	
CO	2	2	
CO1	2	1	
CO2	3	1	
CO3	2	2	
CO4	2	1	
Average	2.2	1.4	

NON DESTRUCTIVE TESTING AND MATERIALS **L T P C**

3 0 0 3

COURSE OBJECTIVE:

- To stress the importance of NDT in engineering.
- To introduce all types of NNDT and their applications in Engineering.

UNIT I OVERVIEW OF NDT **9**

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT, Visual inspection – Unaided and aided.

UNIT II SURFACE NDE METHODS **9**

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT III THERMOGRAPHY AND EDDY CURRENT TESTING (ET) **9**

Thermography- Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

UNIT IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) **9**

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique –Principle, AE parameters, Applications.

UNIT V RADIOGRAPHY (RT) **9**

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radio graphic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography.

TOTAL : 45 Hours

COURSE OUTCOMES:

After successful completion of the Non-Destructive Testing and Materials course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO 1	Understand the NDT versus mechanical testing.	K2
CO 2	Analyze Liquid Penetrant Testing and its properties and , Principles and methods of demagnetization	K4
CO 3	Determine thermography principles and eddy current testing	K5
CO 4	Classify ultrasonic testing principles and acoustic emission technique	K4

CO 5	Discuss and understand the principle of radiography and film techniques.	**K4**

TEXT BOOKS:

1. Baldev Raj, T. Jayakumar, M. Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

REFERENCE BOOKS:

1. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005
3. Charles, J. Hellier, "Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.
4. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Hand book,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol.7, Ultrasonic Test.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**NON DESTRUCTIVE TESTING AND MATERIALS**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	1	-	2	-	-	-	-	-
CO2	2	3	2	2	3	2	2	-	-	-	-	-
CO3	1	2	3	3	3	3	1	-	-	-	-	-
CO4	2	3	2	2	3	2	2	-	-	-	-	-
CO5	-	1	2	2	2	2	-	-	-	-	-	-
Average	1.75	2	2.2	2.2	2.4	2.2	1.7	-	-	-	-	-

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**NON DESTRUCTIVE TESTING AND MATERIALS**		
CO	**PSO1**	**PSO2**	
CO1	2	3	
CO2	2	3	
CO3	3	2	
CO4	3	1	
CO5	2	2	
Average	2.4	2.2	

	ADVANCED COMPUTER INTEGRATED MANUFACTURING	**L**	**T**	**P**	**C**

		3	**0**	**0**	**3**

COURSE OBJECTIVE:

- To understand the application of computers in various aspects of manufacturing viz., design, proper planning, manufacturing cost, layout & material handling system.

UNIT I INTRODUCTION **9**

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerised elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

UNIT II PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING **9**

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.

UNIT III CELLULAR MANUFACTURING **9**

Group Technology(GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

UNIT IV FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) **9**

Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

UNIT V INDUSTRIAL ROBOTICS **9**

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Computer Integrated Manufacturing course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the basic Concepts of drafting, designing facility of CAD package and CAD drawing command structure i.e. Scaling, rotation, translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate.	**K2**

CO2	Identify and classify the various communication system used in Computer integrated manufacturing.	**K3**
CO3	Explain various coding systems, process planning and new technologies used in the computer integrated manufacturing environment.	**K5**
CO4	Explain shop floor control and flexible manufacturing system.	**K5**
CO5	Estimate the cost planning and control in production environment.	**K4**

REFERENCE BOOKS:

1. Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.
2. Radhakrishnan P, Subramanyan S.and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.
3. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India,2003.
4. Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach" Chapman & Hall, London, 1995.
5. Rao. P, N Tewari &T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill Publishing Company, 2000.
6. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill Publishing Co.2007.
7. Chris McMahon and Jimmie Browne "CAD/CAM Principles", "Practice and Manufacturing management " Second Edition, Pearson Education, 1999.
8. Bradley D.A, Dawson D, Buru N.C and Loader A.J, "Mechatronics", Chapman and Hall, 1993.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**Advanced Computer Integrated Manufacturing**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	1	-	-	-	-	-	-	-
CO2	3	2	1	1	2	-	-	-	-	-	-	-
CO3	1	2	3	3	3	-	-	-	-	-	-	2
CO4	1	2	3	3	3	-	-	-	-	-	-	2
CO5	-	1	2	2	2	-	-	-	-	-	-	3
Average	1.7	1.6	2.2	2.2	2.2	-	-	-	-	-	-	2.3

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**Advance Computer Integrated Manufacturing**		
CO	**PSO1**	**PSO2**	
CO1	2	2	
CO2	2	2	
CO3	2	2	
CO4	2	2	
CO5	2	2	
Average	2	2	

COURSE OBJECTIVE:

	ROBOTICS AND AUTOMATION	L	T	P	C
		3	0	0	3

- The objective of the course is to provide a mathematical introduction to the mechanics and control of robots that can be modeled as kinematic chains.

UNIT I INTRODUCTION **9**

Introduction to Robotics- Robot, Robotics, Types of Robot, Robot classification, Types of Robot, Degrees of freedom.

UNIT II KINEMATICS AND DYNAMICS OF ROBOTIC LINKS **9**

Kinematics and Dynamics of Robotic linkages (open ended type manipulators)- Frames, Transformations: Translation and rotation, Denavit-Hartenberg parameters, Forward and Inverse Kinematics, Jacobian, Dynamics: Equations of motion, Newton-Euler formulation.

UNIT III SENSORS AND ACTUATORS **9**

Sensors and actuators- Strain gauge, resistive potentiometers, Tactile and force sensors, tachometers, LVDT, Piezoelectric accelerometer, Hall effect sensors, Optical Encoders, Pneumatic and Hydraulic actuators, servo valves, DC motor, stepper motor, drives.

UNIT IV CONTROLLERS **9**

Control of Manipulators- Feedback control of II order linear systems, Joint control, Trajectory control, Controllers, PID control.

UNIT V ROBOT PROGRAMMING **9**

Robot Programming-Language-overview, commands for elementary operations.

TOTAL: 45 Hours

COURSE OUTCOMES

After successful completion of the robotics and automation course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Identify the electrical, electronic and mechanical components and use of them design or machine elements and transmission system.	**K3**
CO2	Understand the features and operation of automation products.	**K2**
CO3	Identify the various sensors and actuators using in the manufacturing cells with robotic control.	**K3**
CO4	Understand the various controllers' manipulators using in industrial robotics.	**K2**
CO5	Write the programming for the industrial robotics.	**K1**

TEXT/REFERENCE BOOKS:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, Addison-Wesley.
2. Tsuneo Yoshikawa, Foundations of Robotics, MIT Press.
3. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Pearson Education Inc.
4. Spong M. W., and Vidyasagar M., Robot Dynamics and Control, John Wiley & Sons.
5. Murray R. M., et al, A Mathematical Introduction to Robotic Manipulation, CRC Press
6. Waldron K. J., and Kinzel G. L., Kinematics, Dynamics and Design of Machinery, John Wiley

7. Eronini Umez-Eronini, System Dynamics & Control, Brooks/ Cole Publishing Company.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**ROBOTICS AND AUTOMATION**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	1	-	-	-	-	-	-	-
CO2	3	2	1	1	2	1	-	-	-	-	-	-
CO3	-	1	2	2	2	2	-	-	-	-	-	3
CO4	-	1	2	2	2	2	-	-	-	-	-	3
CO5	1	2	3	3	3	3	-	-	-	-	-	2
Average	2	1.4	2	2	2	2	-	-	-	-	-	2.6

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**ROBOTICS AND AUTOMATION**		
CO	**PSO1**	**PSO2**	
CO1	3	2	
CO2	2	1	
CO3	3	3	
CO4	3	2	
CO5	2	1	
Average	2.6	1.8	

	BIO MATERIALS	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVE:

- Learn characteristics and classification of Biomaterials
- Understand different metals, ceramics and its nanomaterials characteristics as biomaterials
- Learn polymeric materials and its combinations that could be used as a tissue replacement implants
- Get familiarized with the concepts of Nano Science and Technology
- Understand the concept of biocompatibility and the methods for biomaterials testing

UNIT I INTRODUCTION TO BIO MATERIALS 9

Introduction: Definition of biomaterials, requirements & classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.

UNIT II METALLIC AND CERAMIC MATERIALS 9

Metallic implant materials: Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.

UNIT III POLYMERIC IMPLANT MATERIALS 9

Polyolefin's, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. (Classification according to thermo sets, thermoplastics and elastomers).Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives (processing aids), aging and environmental stress cracking. Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.

UNIT IV CERAMIC IMPLANT MATERIALS 9

Definition of bio ceramics. Common types of bio ceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).

Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions.

UNIT V Biocompatibility & Toxicological Screening of Biomaterials 9

Definition of Biocompatibility, blood compatibility and tissue compatibility tests, Toxicity tests: acute and chronic toxicity studies (in situimplantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.

TOTAL:45 Hours

COURSE OUTCOMES:

After successful completion of the Bio Materials course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Describe and discuss fundamental concepts of human biomechanical systems and the interaction between the human body and biomaterials, by applying the knowledge of Biological Sciences.	**K2**
CO2:	Identify the various metals and ceramic materials applications to various biomedical usages.	**K3**
CO3:	Translate representative biological problems into tractable biomechanical questions and produce quantitative solutions using relevant engineering methods in solid and fluid mechanics.	**K4**
CO4:	Apply critical judgement to the selection of different classes of biomaterials in biomedical applications.	**K4**
CO5:	Apply standards, regulations and ethical responsibilities in the process of developing biomaterials and medical devices, and design strategies to deal with possible hurdles in bringing a product to market.	**K4**

TEXTBOOK:

1. Sujata V. Bhatt, Biomaterials, Second Edition, Narosa Publishing House, 2005.
2. Sreeram Ramakrishna, MuruganRamalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, Biomaterials: A Nano Approach, CRC Press, 2010.

REFERENCES:

1. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill, 2003
2. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, Introduction to Biomedical Engineering, Elsevier, 2005.
3. Park J.B., Biomaterials Science and Engineering, Plenum Press, 1984.
4. A.C Anand, J F Kennedy, M.Miraftab, S.Rajendran,Woodhead Medical Textiles and Biomaterials for Healthcare, Publishing Limited 2006.
5. D F Williams, Materials Science and Technology: Volume 14, Medical and Dental Materials: A comprehensive Treatment Volume, VCH Publishers 1992.
6. Monika Saini, Yashpal Singh, Pooja Arora, Vipin Arora, and KratiJain. Implant biomaterials: A comprehensive review, World Journal of Clinical Cases, 2015

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**BIO MATERIALS**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	1	-	2	-	-	-	-	-
CO2	3	2	1	-	2	1	3	-	-	-	-	-
CO3	1	2	3	-	3	3	1	-	-	-	-	2
CO4	-	1	2	-	2	2	-	-	-	-	-	3
CO5	2	3	2	-	3	2	2	-	-	-	-	1
Average	2	1.8	2	-	2.2	2	2	-	-	-	-	2

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**BIO MATERIALS**		
CO	**PSO1**	**PSO2**	
CO1	3	1	
CO2	3	3	
CO3	2	2	
CO4	1	2	
CO5	3	3	
Average	2.4	2.2	

	MICRO ELECTRO MECHANICAL SYSTEMS	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVE:

- To study about MEMS and parts of MEMS
- To study the design methodology of MEMS for various mechanics.
- To study about actuators in MEMS.
- To study about MEMS based circuits.
- To study about optical and RF based MEMS.

UNIT I INTRODUCTION TO MEMS 9

MEM Sand Micro systems, Miniaturization, Typical products, Micro Sensors, Micro actuation, MEMS with micro actuators, Micro accelerometers and Micro fluidics, MEMS materials, Micro Fabrication

UNIT II MECHANICS FOR MEMS DESIGN 9

Elasticity, Stress, strain and material properties, Bending of thin plates, Spring configurations, tensional deflection, Mechanical vibration, Resonance, Thermo mechanics –actuators, force and response time, Fracture and thin film mechanics, material, physical aporde position(PVD), chemical mechanical polishing(CMP)

UNIT III ELECTROSTATIC DESIGN 9

Electro statics: basic theory, electrostatic in stability, Surface tension, gap and finger pull up, Electro static actuators, Comb generators, gap closers, rotary motors, inchworms, Electromagnetic actuators, bi-stable actuators.

UNIT IV CIRCUIT AND SYSTEM ISSUES 9

Electronic interfaces, Feedback systems, Noise, Circuit and system issues, Case studies –Capacitive accelerometer, Piezo electric pressure sensor, Thermal sensors, radiation sensors, mechanical sensors, bio-chemical sensors Modeling of MEMS systems, CAD for MEMS.

UNIT V INTRODUCTION TO OPTICAL AND RF-MEMS 9

Optical MEMS, system design basics – Gaussian optics, matrix operations, Resolution, Case studies, MEMS scanners and retinal scanning, display, Digital Micro mirror devices, RF Memes– design basics, case study–Capacitive RFMEMS switch, Performance issue.

TOTAL:45 Hours

COURSE OUTCOMES:

After successful completion of the Micro Electro Mechanical Systems course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Understand the operational theory of common MEMS sensors and MEMS actuators.	K2
CO2:	Identify situations where MEMS sensors and actuators would be ideal for applications to various products.	K3
CO3:	Apply the scaling laws to determine that MEMS devices would perform better than existing Non micro scale devices.	K4

CO4:	Analyze the engineering, science and physics of MEMS devices at the micro scale level including electrostatics, thermodynamics, piezoresistive, piezoelectric, magnetism, micro fluidics and optics.	K4
CO5:	Understand the fabrication methods used to build/construct MEMS.	K4

TEXTBOOK:

1. Stephen Santeria,"Micro systems Design", Kluwer publishers, 2000.
2. Tai–Ran Hsu – 'Mems & Microsystems Design and Manufacturing' – John Wiley & Sons – 2008 – 2nd Edition.

REFERENCES:

1. Nadim Maluf," An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.
2. Mohamed Gad-el-Hak, editor, " The MEMS Handbook", CRC press Baco Raton, 2001.
3. Julian w. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & Son LTD, 2002.
4. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.
5. Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer, 2010.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code				**Semester**							
Subject Name	**MICRO ELECTRO MECHANICAL SYSTEMS**										
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	1	2	1	-	-	-	-	-	-
CO3	2	3	2	2	3	2	1	-	-	-	-	1
CO4	-	1	2	2	2	2	3	-	-	-	-	3
CO5	1	2	3	3	3	3	2	-	-	-	-	2
Average	2	1.8	2	2	2.2	2.5	2	-	-	-	-	2

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**MICRO ELECTRO MECHANICAL SYSTEMS**		
CO	**PSO1**	**PSO2**	
CO1	3	3	
CO2	1	2	
CO3	3	1	
CO4	2	3	
CO5	1	1	
Average	2	2	

	FLEXIBLE MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To introduce the various Modern manufacturing systems.
- To understand the concepts and applications of flexible manufacturing systems

UNIT I PLANNING, SCHEDULING AND CONTROL OF FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction to FMS– development of manufacturing systems – benefits – major elements – types of flexibility – FMS application and flexibility –single product, single batch, n – batch scheduling problem – knowledge based scheduling system.

UNIT II COMPUTER CONTROL AND SOFTWARE FOR FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction – composition of FMS– hierarchy of computer control –computer control of work center and assembly lines – FMS supervisory computer control – types of software specification and selection – trends.

UNIT III FMS SIMULATION AND DATA BASE 9

Application of simulation – model of FMS– simulation software – limitation – manufacturing data systems – data flow – FMS database systems – planning for FMS database.

UNIT IV GROUP TECHNOLOGY AND JUSTIFICATION OF FMS 9

Introduction – matrix formulation – mathematical programming formulation –graph formulation – knowledge based system for group technology – economic justification of FMS- application of possibility distributions in FMS systems justification.

UNIT V APPLICATIONS OF FMS AND FACTORY OF THE FUTURE 9

FMS application in machining, sheet metal fabrication, prismatic component production – aerospace application – FMS development towards factories of the future – artificial intelligence and expert systems in FMS – design philosophy and characteristics for future.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Product Development and Manufacture course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the Perform Planning, Scheduling and control of Flexible Manufacturing systems.	**K2**
CO2	Build the simulation skills on software's use of group technology to product classification.	**K3**
CO3	Develop the prototype of a FMS simulation and data base.	**K3**
CO4	Determine Group Technology and justification of FMS layout.	**K5**
CO5	Identify the applications of FMS and factory of the future.	**K3**

TEXT BOOKS:

1. Jha, N.K. “Handbook of flexible manufacturing systems”, Academic Press Inc., 1991.
2. DR. H.K. Shivanand, M.M. Benal, V. Koti, “Flexible Manufacturing Systems”, New Age International (P) Limited, Publishers, 2006.

REFERENCES:

1. Radhakrishnan P. and Subramanyan S., “CAD/CAM/CIM”, Wiley Eastern Ltd., New Age International Ltd., 1994.
2. Raouf, A. and Ben-Daya, M., Editors, “Flexible manufacturing systems: recent development”, Elsevier Science, 1995.
3. Groover M.P., “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India Pvt., New Delhi, 1996.
4. Kalpakjian, “Manufacturing Engineering and Technology”, Addison-Wesley Publishsing Co., 1995.
5. TaiichiOhno, “Toyota Production System: Beyond large-scale Production”, Productivity Press (India) Pvt. Ltd. 1992.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**FLEXIBLE MANUFACTURING SYSTEMS**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	1	-	-	-	-	-	-	-
CO2	3	2	1	1	2	-	-	-	-	-	-	-
CO3	1	2	3	3	3	-	-	-	-	-	-	2
CO4	1	2	3	3	3	-	-	-	-	-	-	2
CO5	-	1	2	2	2	-	-	-	-	-	-	3
Average	1.7	1.6	2.2	2.2	2.2	-	-	-	-	-	-	2.3

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**FLEXIBLE MANUFACTURING SYSTEMS**		
CO	**PSO1**	**PSO2**	
CO1	2	2	
CO2	2	2	
CO3	2	2	
CO4	2	2	
CO5	2	2	
Average	2	2	

OPEN ELECTIVE COURSES

	PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the students to study the evolution of Management, to study the functions and principles of management and to learn the application of the principles in an organization.
- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers - managerial roles and skills – Evolution of Management – Scientific, human relations , system and contingency approaches – Types of Business organization - Sole proprietorship, partnership, company-public and private sector enterprises - Organization culture and Environment – Current trends and issues in Management.

UNIT II PLANNING 9

Nature and purpose of planning and Organizing - Planning process - Types of plans – Managing by objective (MBO) Strategies - Types of strategies - Policies - Decision Making - Types of decision - Decision Making Process.

UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization – organization chart – organization structure –types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management , Career planning and management.

UNIT IV DIRECTING 9

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication – communication and IT.

UNIT V CONTROLLING 9

System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Principles of Management course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Discuss the management roles and skills and evolution of the management.	**K4**
CO2	Analyze the planning and organizing system of the management.	**K4**
CO3	Discuss directing and controlling system of the management	**K3**
CO4	Develop engineering ethics and improve human values	**K3**
CO5	Explain safety responsibilities and environmental ethics	**K5**

TEXT BOOKS:

1. Stephen P. Robbins and Mary Coulter, 'Management', Prentice Hall of India, 8th edition.
2. Charles W L Hill, Steven L McShane, 'Principles of Management', Mcgraw Hill Education, Special Indian Edition, 2007.
3. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.

REFERENCE BOOKS:

1. Hellriegel, Slocum & Jackson, ' Management - A Competency Based Approach', Thomson South Western, 10th edition, 2007.
2. Harold Koontz, Heinz Weihrich and Mark V Cannice, 'Management - A global & Entrepreneurial Perspective', Tata Mcgraw Hill, 12th edition, 2007.
3. Andrew J. Dubrin, 'Essentials of Management', Thomson Southwestern, 7th edition, 2007.
4. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
5. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**PRINCIPLES OF MANAGEMENT**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	-	2	2	-	2	-	2	3	3	3	3
CO2	-	-	2	2	-	2	2	2	1	1	1	1
CO3	-	-	2	2	-	2	-	2	3	3	3	3
CO4	-	-	2	2	-	2	-	2	3	3	3	3
CO5	-	-	3	3	-	3	1	3	2	2	2	2
Average	-	-	2.2	2.2	-	2.2	1.5	2.2	2.4	2.4	2.4	2.4

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**PRINCIPLES OF MANAGEMENT**		
CO	**PSO1**	**PSO2**	
CO1	2	1	
CO2	2	3	
CO3	3	2	
CO4	2	1	
CO5	2	3	
Average	2.2	2	

	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To provide knowledge and training in using optimization techniques under limited resources for the engineering and business problems.

UNIT I LINEAR MODELS **12**

The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis.

UNIT II TRANSPORTATION MODELS AND NETWORK MODELS **9**

Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models.

UNIT III INVENTORY MODELS **7**

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice

UNIT IV QUEUEING MODELS **7**

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi-server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

UNIT V DECISION MODELS **10**

Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution – Replacement models – Models based on service life – Economic life– Single / Multi variable search technique – Dynamic Programming – Simple Problem.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Operations Research course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Develop the operational research models for the verbal description of the real system of linear models.	**K3**
CO2	Understand the mathematical optimization tools to solve optimization problems.	**K4**
CO3	Use mathematical and simulation software to solve the proposed models.	**K3**
CO4	Understand the transportation & network models and various techniques of operations research.	**K4**
CO5	Understand the techniques used in operations research to solve the real life problem in minimizing the industrial problems suggest an optimum solution.	**K5**

TEXT / REFERENCE BOOKS:

1. Hillier and Libeberman, “Operations Research”, Holden Day, 2005
2. Taha H.A., “Operations Research”, Sixth Edition, Prentice Hall of India, 2003.
3. Bazara M.J., Jarvis and Sherali H., “Linear Programming and Network Flows”, John Wiley, 2009.
4. Budnick F.S., “Principles of Operations Research for Management”, Richard D Irwin, 1990.
5. Philip D.T. and Ravindran A., “Operations Re search”, John Wiley, 1992.
6. Shennoy G.V. and Srivastava U.K., “Operation Research for Management”, Wiley Eastern, 1994.
7. Tulsian and Pasdey V., “Quantitative Techniques”, Pearson Asia, 2002.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name	**Operations Research**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	0	**1**	**2**	**2**	**1**	**2**	0	2	**3**	3	3	**3**
CO2	**2**	**3**	**2**	**2**	**3**	**2**	2	2	**1**	1	1	**1**
CO3	0	**1**	**2**	**2**	**1**	**2**	0	2	**3**	3	3	**3**
CO4	0	**1**	**2**	**2**	**1**	**2**	0	2	**3**	3	3	**3**
CO5	**1**	**2**	**3**	**3**	**2**	**3**	1	3	**2**	2	2	**2**
Average	0.6	1.6	2.2	2.2	1.6	**2.2**	**0.6**	**2.2**	**2.4**	**2.4**	**2.4**	**2.4**

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**Operations Research**		
CO	**PSO1**	**PSO2**	
CO1	2	3	
CO2	1	2	
CO3	3	1	
CO4	2	3	
CO5	1	1	
Average	1.8	2	

	HUMAN RIGHTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To sensitize the Engineering students to various aspects of Human Rights.

UNIT I Introduction to Human Rights **9**

Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

UNIT II Evolution and Laws of Human Rights **9**

Evolution of the concept of Human Rights Magana carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

UNIT III Theories and perspectives UN Laws and Agencies **9**

Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.

UNIT IV Human Rights in India **9**

Human Rights in India – Constitutional Provisions / Guarantees.

UNIT V Human Rights Various Commissions **9**

Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.

Total: 45 Hours

COURSE OUTCOMES:

After successful completion of the Human Rights course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand basics of Human Rights	**K2**
CO2	Understand the Evolution and Laws of Human Rights	**K2**
CO3	Summarize the various theories and perspectives UN Laws and Agencies	**K2**
CO4	Understand the Human Rights in India	**K2**
CO5	Understand the Human Rights of Various Commissions in India	**K2**

REFERENCE BOOKS:

1. Chandra U., "Human Rights", Allahabad Law Agency, Allahabad, 2014.
2. Kapoor S.K., "Human Rights under International law and Indian Laws", Central Law Agency, Allahabad, 2014.
3. Upendra Baxi, The Future of Human Rights, Oxford University Press, New Delhi.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	HUMAN RIGHTS											
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	2	2	-	2	-	2	3	3	3	3
CO2	-	-	2	2	-	2	2	2	1	1	1	1
CO3	-	-	2	2	-	2	-	2	3	3	3	3
CO4	-	-	2	2	-	2	-	2	3	3	3	3
CO5	-	-	3	3	-	3	1	3	2	2	2	2
Average	-	-	2.2	2.2	-	2.2	1.5	2.2	2.4	2.4	2.4	2.4

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	HUMAN RIGHTS		
CO	PSO1	PSO2	
CO1	2	1	
CO2	2	3	
CO3	3	2	
CO4	2	1	
CO5	2	3	
Average	2.2	2	

	PROFESSIONAL ETHICS IN ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES 9

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V GLOBAL ISSUES 9

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the professional ethics in engineering course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Identify the multiple ethical interests at stake in a real-world situation or in practice.	**K4**
CO2	Understand the variety of moral issues related to engineering ethics.	**K2**
CO3	Identify the ethical concerns in research and intellectual contexts, including academic integrity.	**K4**
CO4	Analyze the risk Benefit Analysis and Reducing Risk in the work environment.	**K6**
CO5	Understand the internships, fieldwork nature and safety responsibilities with rights.	**K2**

TEXT BOOKS:

1. Stephen P. Robbins and Mary Coulter, 'Management', Prentice Hall of India, 8th edition.
2. Charles W L Hill, Steven L McShane, 'Principles of Management', Mcgraw Hill Education, Special Indian Edition, 2007.
3. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.

REFERENCE BOOKS:

1. Hellriegel, Slocum & Jackson, ' Management - A Competency Based Approach', Thomson South Western, 10th edition, 2007.
2. Harold Koontz, Heinz Weihrich and Mark V Cannice, 'Management - A global & Entrepreneurial Perspective', Tata Mcgraw Hill, 12th edition, 2007.
3. Andrew J. Dubrin, 'Essentials of Management', Thomson Southwestern, 7th edition, 2007.
4. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
5. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**PROFESSIONAL ETHICS IN ENGINEERING**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	-	2	2	-	2	-	2	3	3	3	3
CO2	-	-	2	2	-	2	2	2	1	1	1	1
CO3	-	-	2	2	-	2	-	2	3	3	3	3
CO4	-	-	2	2	-	2	-	2	3	3	3	3
CO5	-	-	3	3	-	3	1	3	2	2	2	2
Average	-	-	2.2	2.2	-	2.2	1.5	2.2	2.4	2.4	2.4	2.4

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**PROFESSIONAL ETHICS IN ENGINEERING**		
CO	**PSO1**	**PSO2**	
CO1	2	1	
CO2	2	3	
CO3	3	2	
CO4	2	1	
CO5	2	3	
Average	2.2	2	

	QUALITY CONTROL AND RELIABILITY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To make the students to understand the various quality control techniques and to construct the various quality control charts for variables and attributes and also the design concepts for reliable system and maintenance aspects in industries.

UNIT I INTRODUCTION AND PROCESS CONTROL FOR VARIABLES 9

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality control: Quality cost-Variation in process causes of variation –Theory of control chart- uses of control chart – Control chart for chart -process capability – process capability studiesσvariables – X chart, R chart and simple problems, Six sigma concepts.

UNIT II PROCESS CONTROL FOR ATTRIBUTES 9

Control chart for attributes –control chart for non-conforming – p chart and np chart – control chart for nonconformities– C and U charts, State of control and process out of control identification in charts, pattern study.

UNIT III ACCEPTANCE SAMPLING 9

Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans.

UNIT IV LIFE TESTING – RELIABILITY 9

Life testing – Objective – failure data analysis, Mean failure rate, means time to failure, mean time between failure, hazard rate – Weibull model, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability –simple problems, Acceptance sampling based on reliability test – O.C Curves.

UNIT V QUALITY AND RELIABLITY 9

Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles.

Note: *Use of approved statistical table permitted in the examination*

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Quality Control and Reliability Engineering course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the concepts of Quality Control and Statistical Process Control variables (SPC).	**K4**
CO2	Understand the Control Charts for Variables and Central Limit Theorem.	**K4**
CO3	Understand the Natural and assignable causes of variation and process control for attributes	**K4**

CO4	Draw and explain the Mean Chart Limits (x-Charts) and Setting the Range Chart Limits (R-Charts)	**K4**
CO5	Understand the Mean and Range Charts and acceptance sampling.	**K3**

TEXT BOOKS:

1. Douglas. C. Montgomery, "Introduction to Statistical quality control", John wiley, 4th edition 2001.
2. Srinath L. S., "Reliability Engineering", Affiliated East west press, 1991.

REFERENCES:

1. John. S. Oakland. Statistical process control", Elsevier, 5th edition, 2005
2. Grant, Eugene .L "Statistical Quality Control", McGraw-Hill, 1996.
3. Monohar Mahajan, "Statistical Quality Control", DhanpatRai& Sons, 2001.
4. Gupta R. C., "Statistical Quality control", Khanna Publishers, 1997.
5. Besterfield D.H., "Quality Control", Prentice Hall, 1993.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code				Semester							
Subject Name	**QUALITY CONTROL AND RELIABILITY ENGINEERING**										
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	0	1	2	1	1	2	-	-	-	-	-	3
CO2	2	3	2	2	2	2	-	-	-	-	-	1
CO3	3	2	2	2	2	2	-	-	-	-	-	3
CO4	2	2	2	2	2	3	-	-	-	-	-	3
CO5	2	2	2	2	2	3	-	-	-	-	-	2
Average	1.8	2	2	1.8	1.4	2.4	-	-	-	-	-	2.4

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**QUALITY CONTROL AND RELIABILITY ENGINEERING**		
CO	**PSO1**	**PSO2**	
CO1	2	3	
CO2	2	2	
CO3	3	1	
CO4	2	3	
CO5	1	2	
Average	2	2.2	

	VALUE ANALYSIS AND VALUE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To provide the basic concepts and features of value analysis and value engineering.

UNIT I CONCEPTS 9

Introduction – status of VE in India and origin country – impact of VE application – types of values – types of function – function identification on product – function matrix – function analysis – elements of costs – calculation of costs – cost allocation to function – evaluation of worth in VE methodology.

UNIT II TECHNIQUES 9

General techniques: brain storming – godson feasibility ranking – morphological analysis – ABC analysis – probability approach – make or buy.

UNIT III ANALYSIS 9

Function – cost-worth analysis – function analysis – system techniques – function analysis matrix – customer oriented FAST diagram – fire alarm – Langrange plan – evaluation methods – matrix in evaluation – break even analysis.

UNIT IV VALUE ENGINEERING IN JOB PLAN 9

Orientation phase – information phase – functional analysis – creative phase – evaluation phase – recommendation phase – implementation phase – audit phase.

UNIT V CASE STUDIES 9

Water treatment plant – engineering management, pump component, motor component, wet grinder, automobile, hospital.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Value Analysis and Value Engineering course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1	Solve complex engineering tasks based on technical-economic disciplines.	K4
CO2	Calculation of costs and evaluation of worth in Value Engineering Methodology.	K4
CO3	Understand the general techniques of brainstorming and ABC analysis.	K3
CO4	Understand functionality important for the customer will improve the worth of the Product and eliminate the unwanted functionality to reducing the overall cost.	K3
CO5	Apply Value Engineering and Value Analysis in the manufacturing products.	K4

TEXT BOOKS:

1. Mukhophadhyaya A K, “Value Engineering”, Sage Publications Pvt. Ltd., New Delhi, 2003.
2. Richard J Park, “Value Engineering – A Plan for Inventions”, St.Lucie Press, London, 1998.

REFERENCES:

1. Larry W Zimmesman. P E , “VE –A Practical Approach for Owners Designers and Contractors”, CBS Publishers, New Delhi, 1992.
2. Arthus E Mudge, “Value Engineering”, McGraw Hill Inc., New York, 1971.
3. Army Materiel Command U S, “Value Engineering (Engineering Design Handbook)”, University Press of the Pacific, 2006.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	VALUE ANALYSIS AND VALUE ENGINEERING											
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	0	0	1	0	2	-	-	-	0	0
CO2	2	1	0	0	1	0	2	-	-	-	0	0
CO3	2	3	2	2	2	2	2	-	-	-	1	1
CO4	0	1	2	2	1	2	0	-	-	-	3	3
CO5	2	3	2	2	2	2	2	-	-	-	1	1
Average	2	1.8	2	2	1.4	2	2	-	-	-	2	2

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	VALUE ANALYSIS AND VALUE ENGINEERING		
CO	PSO1	PSO2	
CO1	3	2	
CO2	2	2	
CO3	2	2	
CO4	3	3	
CO5	3	2	
Average	2.6	2.2	

COURSE OBJECTIVE:

TOTAL QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

- To facilitate the understanding of Quality Management principles and process.

UNIT I INTRODUCTION **9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of TQM - Definition of TQM – TQM Framework - Contributions of Deming, Juran and Crosby – Barriers to TQM.

UNIT II TQM PRINCIPLES **9**

Leadership – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – PDSA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS & TECHNIQUES I **9**

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV TQM TOOLS & TECHNIQUES II **9**

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures.

UNIT V QUALITY SYSTEMS **9**

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Total Quality Management course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO 1	Develop an understanding on quality management philosophies and frameworks.	K3
CO 2	Adopt TQM methodologies for continuous improvement of quality.	K3
CO 3	Measure the cost of poor quality, process effectiveness and efficiency to identify areas for improvement.	K3
CO 4	Apply benchmarking and business process reengineering to improve management processes.	K3
CO 5	Determine the set of indicators to evaluate performance excellence of an organization.	K4

TEXT BOOK:

1. Dale H. Besterfiled, etc. at "Total Quality Management", Pearson Education Asia, Third Edition, 2006.

REFERENCE BOOKS:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 6th Edition, South-Western (Thomson Learning), 2005.
2. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.
3. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd.,2006.
4. Janakiraman,B and Gopal, R.K, "Total Quality Management – Text and Cases", Prentice Hall (India) Pvt. Ltd.
5. R. Pugazhenthi, A. Baradeswaran, K. Balachandran, and P. Balamurali, "Total Quality Management", sams publications, 2015.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**Total Quality Management**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	1	-	-	2	2	-	2	3	3	3	3
CO2	-	1	-	-	2	2	-	2	3	3	3	3
CO3	-	2	-	-	3	3	-	3	2	2	2	2
CO4	-	2	-	-	2	1	-	1	-	-	-	-
CO5	-	2	-	-	3	3	-	3	2	2	2	2
Average	-	1.6	-	-	2.4	2.2		2.2	2.5	2.5	2.5	2.5

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**Total Quality Management**		
CO	**PSO1**	**PSO2**	
CO1	1	2	
CO2	2	3	
CO3	1	3	
CO4	2	3	
CO5	1	1	
Average	1.4	2.4	

	Production Planning and Control	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory Control.
- To know the recent trends like manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

UNIT I INTRODUCTION 9

Objectives and benefits of planning and control-Functions of production control-Types of production-job- batch and continuous-Product development and design-Marketing aspect - Functional aspects-Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration-Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

UNIT II WORK STUDY 9

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT III PRODUCT PLANNING AND PROCESS PLANNING 9

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi-product system.

UNIT IV PRODUCTION SCHEDULING 9

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size-ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems-elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

COURSE OUTCOMES:

After successful completion of the Production Planning and Control course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Develop manufacturing logic and knowledge with help of production planning process.	**K2**
CO2	Understand the concept of work study and ergonomics.	**K3**

CO3	Able to prepare production planning and control activities such as work study, product planning, production scheduling, Inventory Control.	**K4**
CO4	Estimate data requirements and sources, Collection of cost, Allowances in production.	**K4**
CO5	Able to plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).	**K5**

TEXT BOOKS:

1. James. B. Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.
2. Mart and Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.

REFERENCES

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000.
3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990.
4. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
5. Melynk, Denzler, " Operations management – A value driven approach" Irwin Mcgraw hill.
6. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984.
7. Upendra Kachru, " Production and Operations Management – Text and cases" 1st Edition, Excel books 2007.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**Production Planning and Control**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	1	-	-	-	-	-	-	-
CO2	3	2	1	1	2	1	-	-	-	-	-	-
CO3	2	3	2	2	3	2	-	-	-	-	1	1
CO4	-	1	2	2	2	2	-	-	-	-	3	3
CO5	1	2	3	3	3	3	-	-	-	-	2	2
Average	2	1.8	2	2	2.2	2	-	-	-	-	2	2

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**Production Planning and Control**		
CO	**PSO1**	**PSO2**	
CO1	2	2	
CO2	2	3	
CO3	3	2	
CO4	2	2	
CO5	2	1	
Average	2.2	2	

	ENERGY AUDIT AND ENERGY CONSERVATION METHODS	**L**	**T**	**P**	**C**

		3	**0**	**0**	**3**

COURSE OBJECTIVE:

- This course provides the knowledge about energy audit and energy conservation methods in I.C. Engines.

UNIT I ENERGY AND ENVIRONMENT 9

Introduction - fossil fuels reserves - world energy consumption - green house effect, global warming - Renewable energy sources - environmental aspects utilization - energy prizes - energy policies.

UNIT II ENERGY CONSERVATION 9

Energy conservation schemes - industrial energy use - energy surveying and auditing - energy index – Energy cost - cost index - energy conservation in engineering and process industry, in thermal Systems, in buildings and non-conventional energy resources scheme

UNIT III ENERGY TECHNOLOGIES 9

Fuels and consumption - boilers - furnaces - waste heat recovery systems - heat pumps and Refrigerators - storage systems - insulated pipe work systems - heat exchangers.

UNIT IV ENERGY MANAGEMENT 9

Energy management principles - energy resource management - energy management information Systems - instrumentation and measurement - computerized energy management - energy Auditing.

UNIT V ECONOMICS AND FINANCE 9

Costing techniques - cost optimization - optimal target investment schedule - financial appraisal and Profitability - project management.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Energy Audit and Energy Conservation Methods course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Understanding the basics of demand side management and mechanisms (technical, legal or financial) that influences energy consumption. Recognizing opportunities for increasing rational use of energy.	K3
CO2:	Understanding the basics of energy auditing with application on different sectors.	K4
CO3:	Understood and acquired fundamental knowledge on the science of energy and on both the conventional and non-conventional energy technologies	K4
CO4:	Acquired the skills needed for the energy monitoring, auditing and management.	K3
CO5:	Capable of design and analysis of energy conversion systems.	K5

TEXT BOOKS:

1. MurphyW.R. and McKAYG.,"Energy Management, Butterworths, London, 1982.
2. Trivedi P.R., Julka B.R., "Energy Management", Common wealth publishers, 1997.

REFERENCES:

1. David Merick, Richard Marshal, “Energy, present and future options”, Vol. I and II, John Wiley and Sons, 1981.
2. Chaigier N.A. “Energy Consumption and Environment ", McGraw-Hill, 1981.
3. Ikken P.A. Swart R.J and Zwerves.S, “Climate and Energy ", 1989.
4. Ray D.A. “Industrial Energy Conservation ", Pergamaon Press, 1980.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					**Semester**							
Subject Name	**ENERGY AUDIT AND ENERGY CONSERVATION METHODS**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	0	0	1	0	2	-	-	-	-	0
CO2	2	1	0	0	1	0	2	-	-	-	-	0
CO3	2	1	0	0	1	0	2	-	-	-	-	0
CO4	1	2	3	3	2	3	1	-	-	-	-	2
CO5	0	1	2	2	1	2	0	-	-	-	-	3
Average	**1.75**	**1.2**	**2.5**	**2.5**	**1.2**	**2.5**	**1.75**	**-**	**-**	**-**	**-**	**2.5**

PSOs matrices of courses selected

Subject Code		**Semester**	
Subject Name	**ENERGY AUDIT AND ENERGY CONSERVATION METHODS**		
CO	**PSO1**	**PSO2**	
CO1	2	2	
CO2	2	2	
CO3	3	1	
CO4	3	1	
CO5	3	1	
Average	**2.6**	**1.4**	

	QUALITY CONTROL AND RELIABILITY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To make the students to understand the various quality control techniques and to construct the various quality control charts for variables and attributes and also the design concepts for reliable system and maintenance aspects in industries.

UNIT I INTRODUCTION AND PROCESS CONTROL FOR VARIABLES 9

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality control: Quality cost-Variation in process causes of variation – Theory of control chart- uses of control chart – Control chart for chart -process capability – process capability studiesσvariables – X chart, R chart and simple problems, Six sigma concepts.

UNIT II PROCESS CONTROL FOR ATTRIBUTES 9

Control chart for attributes –control chart for non-conforming – p chart and np chart – control chart for nonconformities– C and U charts, State of control and process out of control identification in charts, pattern study.

UNIT III ACCEPTANCE SAMPLING 9

Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans.

UNIT IV LIFE TESTING – RELIABILITY 9

Life testing – Objective – failure data analysis, Mean failure rate, means time to failure, mean time between failure, hazard rate – Weibull model, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability –simple problems, Acceptance sampling based on reliability test – O.C Curves.

UNIT V QUALITY AND RELIABLITY 9

Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles.

Note: *Use of approved statistical table permitted in the examination.*

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Quality Control and Reliability Engineering course, the student will be able to

CO	Course Outcome Statements	Knowledge Level
CO1:	Understand the concepts of Quality Control and Statistical Process Control variables (SPC).	K4
CO2:	Understand the Control Charts for Variables and Central Limit Theorem.	K4
CO3:	Understand the Natural and assignable causes of variation and process control for attributes	K4
CO4:	Draw and explain the Mean Chart Limits (x-Charts) and Setting the Range Chart Limits (R-Charts)	K3
CO5:	Understand the Mean and Range Charts and acceptance sampling.	K4

TEXT BOOKS:

1. Douglas.C.Montgomery, "Introduction to Statistical quality control", John wiley, 4th edition2001.
2. SrinathL.S., "Reliability Engineering", Affiliated East west press, 1991.

REFERENCES:

1. John.S.Oakland. Statistical process control", Elsevier, 5th edition, 2005
2. Grant, Eugene .L "Statistical Quality Control", McGraw-Hill, 1996.
3. MonoharMahajan, "Statistical Quality Control", DhanpatRai& Sons, 2001.
4. GuptaR.C., "Statistical Quality control", Khanna Publishers, 1997.
5. Besterfield D.H., "Quality Control", Prentice Hall, 1993.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code				Semester							
Subject Name	**QUALITY CONTROL AND RELIABILITY ENGINEERING**										
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	0	1	2	1	1	2	-	-	-	-	-	3
CO2	2	3	2	2	2	2	-	-	-	-	-	1
CO3	3	2	2	2	2	2	-	-	-	-	-	3
CO4	2	2	2	2	2	3	-	-	-	-	-	3
CO5	2	2	2	2	2	3	-	-	-	-	-	2
Average	1.8	2	2	1.8	1.4	2.4	-	-	-	-	-	2.4

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**QUALITY CONTROL AND RELIABILITY ENGINEERING**		
CO	**PSO1**	**PSO2**	
CO1	2	3	
CO2	2	2	
CO3	3	1	
CO4	2	3	
CO5	1	2	
Average	2	2.2	

	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To introduce the process planning concepts to make cost estimation for various products after process planning.

UNIT I WORK STUDY AND ERGONOMICS 9

Method study – Definition – COURSE OBJECTIVE – Motion economy – Principles – Tools and techniques – Applications – Work measurements – Purpose – Uses – Procedure – Tools and techniques – Standard time – Ergonomics – Principles – Applications.

UNIT II PROCESS PLANNING 9

Definition – Objective – Scope – Approaches to process planning – Process planning activities – Finished part requirements – Operating sequences – Machine selection – Material selection parameters – Se t of documents for process planning – Developing manufacturing logic and knowledge – Production time calculation – Selection of cost optimal processes.

UNIT III INTRODUCTION TO COST ESTIMATION 9

Objective of cost estimation – Costing – Cost accounting – Classification of cost – Elements of cost – Simple problems.

UNIT IV COST ESTIMATION 9

Types of estimates – Methods of estimates – Data requirements and sources – Collection of cost – Allowances in estimation.

UNIT V PRODUCTION COST ESTIMATION 9

Estimation of material cost, labour cost and over heads – Allocation of overheads – Estimation for different types of jobs manufactured by casting – Forging – Welding and machining.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Process Planning and Cost Estimation course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the concept of work study and ergonomics.	**K2**
CO2	Develop manufacturing logic and knowledge with help of production planning process.	**K3**
CO3	Analyze the various type of cost estimating process.	**K4**
CO4	Estimate data requirements and sources, Collection of cost, Allowances in production.	**K4**
CO5	Determine the machining time for various operation in various machines in production Shops.	**K5**

TEXT BOOKS:

1. Sinha, B.P., "Mechanical Estimating and Costing", Tata McGraw-Hill, Publishing Co., 1995.
2. Ostwalal, P.F. and JairoMunez, "Manufacturing Processes and Systems", 9th Edition, JohnWiley, 1998.

REFERENCE BOOKS:

1. Russell, R.S. and Tailor, B.W., "Operations Management", 4th Edition, PHI, 2003.

2. Chitale, A.V. and Gupta, R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**Process Planning and Cost Estimation**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	1	-	-	-	-	-	-	-
CO2	3	2	1	1	2	1	-	-	-	-	-	-
CO3	2	3	2	2	3	2	-	-	-	-	1	1
CO4	-	1	2	2	2	2	-	-	-	-	3	3
CO5	1	2	3	3	3	3	-	-	-	-	2	2
Average	2	1.8	2	2	2.2	2	-	-	-	-	2	2

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**Process Planning and Cost Estimation**		
CO	**PSO1**		**PSO2**
CO1	2		2
CO2	2		3
CO3	3		2
CO4	2		2
CO5	2		1
Average	2.2		2

	SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To make the students familiar with the various concepts and functions of supply chain management, so that the students will be in a position to manage the supply chain management.

UNIT I INTRODUCTION **9**

Definition of Logistics and SCM: Evolution, Scope, Importance& Decision Phases – Drivers of SC Performance and Obstacles.

UNIT II LOGISTICS MANAGEMENT **9**

Factors – Modes of Transportation - Design options for Transportation Networks-Routing and Scheduling – Inbound and outbound logistics- Reverse Logistics – 3PL- Integrated Logistics Concepts- Integrated Logistics Model – Activities - Measuring logistics cost and performance – Warehouse Management - Case Analysis.

UNIT III SUPPLY CHAIN NETWORK DESIGN **9**

Distribution in Supply Chain – Factors in Distribution network design –Design options-Network Design in Supply Chain – Framework for network Decisions - Managing cycle inventory and safety.

UNIT IV SOURCING, AND PRICING IN SUPPLY CHAIN **9**

Supplier selection and Contracts - Design collaboration - Procurement process. Revenue management in supply chain.

UNIT V COORDINATION AND TECHNOLOGY IN SUPPLY CHAIN **9**

Supply chain coordination - Bullwhip effect – Effect of lack of co-ordination and obstacles – IT and SCM - supply chain IT frame work, E Business & SCM, Metrics for SC performance – Case Analysis.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Supply Chain Management course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the logistics and supply chain management	**K2**
CO2	Analyze the design options for Transportation Networks for logistics management.	**K4**
CO3	Develop Framework for network Decisions in managing cycle inventory and safety	**K3**
CO4	Evaluating the Revenue management in supply chain Management	**K4**
CO5	Find the solution for various types of case analysis in supply chain management	**K2**

TEXT BOOKS:

1. Supply Chain Management, Strategy, Planning, and operation – Sunil Chopra and Peter Meindl- PHI, Second edition, 2007.
2. Logistics, David J. Bloomberg, Stephen Lemay and Joe B. Hanna, PHI, 2002.

REFERENCE BOOKS:

1. Logistics and Supply Chain Management –Strategies for Reducing Cost and Improving Service. Martin Christopher, Pearson Education Asia, Second Edition.
2. Modeling the supply chain, Jeremy F.Shapiro, Thomson Duxbury, 2002.
3. Handbook of Supply chain management, James B.Ayers, St.Lucle Press, 2000.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**Supply Chain Management**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1	2	1	-	-	-	-	-	-
CO2	-	1	2	2	2	2	-	-	3	-	3	3
CO3	1	2	3	3	3	3	-	-	2	-	2	2
CO4	3	2	1	1	2	1	-	-	-	-	-	-
CO5	2	3	2	2	3	2	-	-	1	-	1	1
Average	2.2	2	1.8	1.8	2.4	1.8	-	-	2	-	2	2

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**Supply Chain Management**		
CO	**PSO1**	**PSO2**	
CO1	2	1	
CO2	2	2	
CO3	1	2	
CO4	1	3	
CO5	2	1	
Average	1.6	1.8	

	INDUSTRIAL MARKETING AND MARKET RESEARCH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To enable students to deal with newer concepts of marketing concepts like strategic marketing segmentation, pricing, advertisement and strategic formulation. The course will enable a student to take up marketing as a professional career.

UNIT I INDUSTRIAL MARKETING **9**

Nature of Industrial Marketing: Industrial Marketing Vs Consumer Marketing Relational approach to Industrial Marketing- The Nature of Industrial Demand &Industrial Customer. Types of Industrial Products: Major Equipment; Accessory Equipment; Raw and Processed Materials; Component Parts and Sub- Assemblies; Operating Supplies; Standardized and Non-standardized parts, Industrial services.

UNIT II PRICING **9**

Pricing for Industrial Products – Pricing COURSE OBJECTIVE - Price Decision Analysis –Breakeven analysis – net pricing – discount pricing – trade discounts – geographic pricing – factory pricing – freight allowance pricing – Terms of Sale – Outright purchase – Hire-purchase – Leasing.

UNIT III MARKET RESEARCH **9**

Introduction to Market Research, Types of Research – Basic & Applied, Nature, Scope, objective, Importance & Limitations of Market Research. Sources and collection of Marketing Data. Secondary data – Advantages &Limitations, Sources – Govt. & Non Govt. Primary Data – Advantages &Limitations, Sources, Methods of Collection Primary Data – Observation, Mail, Personal Interview, Telephonic Interview, Internet Interviewing.

UNIT IV TECHNIQUES **9**

Market Research Techniques. National readership survey, Retail Store Audit, Consumer Panels, Test Marketing, Research in Advertising Decisions, Marketing Audit, Data Base Marketing, Focus Group Interviews. Sampling, Questionnaire & Scaling Techniques. Probability and Non Probability Sampling, Sampling methods, Sample Design, Questionnaire design and drafting. Scaling techniques like Nominal, Ordinal, Interval, Ratio, Perceptual Map, Semantic Differential, Likert, Rating & Ranking Scales.

UNIT V IMPLEMENTATION **9**

Setting up & Implementation of Marketing Research Project, Steps in formulating Market Research Projects, One project for consumer durables and one for non-durables to be discussed.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Industrial Marketing and Market Research course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the industrial and consumer marketing research and to learn about the various industrial products	**K2**
CO2	Analyze the price for industrial products and Evaluate the industrial purchasing decisions	**K4**

CO3	Apply selected research methods and Analyze and interpret both qualitative and quantitative data. Build a simple questionnaire from a web-based survey administration site.	**K3**
CO4	Evaluate appropriate research problem formulation and measurement levels of data	**K3**
CO5	Develop new product strategies & innovations	**K4**

TEXT BOOKS:

1. Ralph S. Alexander, James S. Cross, Richard M. Hill, "Industrial Marketing", Homewood, 1967.
2. Rajendra Nargundkar, "Marketing Research", Tata McGraw Hill, 2008.

REFERENCE BOOKS:

1. Robert R. Reeder; Edward G. Brierty; Betty H. Reeder**,** "Industrial Marketing – Analysis, Planning and Control", Prentice Hall, 1991**.**
2. Ghosh P K, "Industrial Marketing", Oxford University Press, India.
3. Ramanuj Majumdar, "Marketing Research-Text, Applications and Case Studies".
4. Donald R. Cooper, "Business research Methods", McGraw-Hill, 2005

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**Industrial marketing and Market Research**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	1	-	-	1	-	-	-	-	-	-	-
CO2	-	3	2	-	3	-	-	2	1	1	1	1
CO3	-	2	1	-	2	-	-	1	-	-	-	-
CO4	-	2	3	-	3	-	-	3	2	2	2	2
CO5	-	1	2	-	2	-	-	2	3	3	3	3
Average	-	1.8	2	-	2.2	-	-	2	2	2	2	2

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**Industrial marketing and Market Research**		
CO	**PSO1**	**PSO2**	
CO1	3	2	
CO2	2	2	
CO3	2	1	
CO4	1	2	
CO5	3	3	
Average	2.2	2	

INTELLECTUAL PROPERTY RIGHTS

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

- To give an idea about IPR, registration and its enforcement.

UNIT I INTRODUCTION **9**

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II REGISTRATION OF IPRs **10**

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad.

UNIT III AGREEMENTS AND LEGISLATIONS **10**

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT IV DIGITAL PRODUCTS AND LAW **9**

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT V ENFORCEMENT OF IPRs **7**

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

Total: 45 Hours

COURSE OUTCOMES:

After successful completion of the Intellectual Property Rights course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Apply the Intellectual Property portfolio to enhance the value of the firm.	**K2**
CO2	Understand the Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and international.	**K2**
CO3	Understanding various practical aspects of registration of Copy agreements and legislations of intellectual property rights.	**K2**
CO4	Understand and lean the digital products and law intellectual property rights Knowledge.	**K2**
CO5	Understand enforcement of intellectual property rights through the Case Studies.	**K2**

TEXT BOOKS:

1. S.V. Satarkar, Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.
2. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012.

REFERENCE BOOKS:

1. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.
2. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**INTELLECTUAL PROPERTY RIGHTS**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	1	-	-	2	2	-	2	3	3	3	3
CO2	-	1	-	-	2	2	-	2	3	3	3	3
CO3	-	2	-	-	3	3	-	3	2	2	2	2
CO4	-	2	-	-	2	1	-	1	-	-	-	-
CO5	-	2	-	-	3	3	-	3	2	2	2	2
Average	-	1.6	-	-	2.4	2.2		2.2	2.5	2.5	2.5	2.5

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**INTELLECTUAL PROPERTY RIGHTS**		
CO	**PSO1**		**PSO2**
CO1	1		2
CO2	2		3
CO3	1		3
CO4	2		3
CO5	1		1
Average	1.4		2.4

COURSE OBJECTIVE:

DISASTER MANAGEMENT **L T P C**

3 0 0 3

- To provide basic conceptual understanding of disasters and its relationships with development.
- To gain understand approaches of Disaster Risk Reduction (DRR) and the relationship between vulnerability, disasters, disaster prevention and risk reduction.
- To understand Medical and Psycho-Social Response to Disasters.

UNIT I INTRODUCTION TO DISASTER **6**

Introduction- Concepts and definitions: disaster, hazard, vulnerability, risk, capacity, impact, prevention, mitigation).

UNIT II APPROACHES TO DISASTER RISK REDUCTION **12**

Disasters- Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills etc); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility.

UNIT III PRINICPLES OF DISASTER MEDICAL MANAGEMENT **8**

Disaster Impacts - Disaster impacts (environmental, physical, social, ecological, economical, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate-change and urban disasters.

UNIT IV PUBLIC HEALTH RESPONSE AND INTERNATIONAL COOPERATION **12**

Disaster Risk Reduction (DRR) - Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post-disaster environmental response (water, sanitation, food safety, waste management, disease control); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

UNIT V DISASTER RISK MANAGEMENT **7**

Disasters, Environment and Development - Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land-use changes, urbanization etc.), sustainable and environmental-friendly recovery; reconstruction and development methods.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the disaster management course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understanding about the basic concepts of Disaster Management.	**K2**
CO2	Develop the knowledge by providing existing models in risk reduction strategies.	**K3**
CO3	Develop awareness among students in the disaster medicine and make them understand and prepare the natural and manmade disaster.	**K3**
CO4	Understand the health management of disaster is to build capacities that will reduce disaster health risks and contribute to public health.	**K2**

CO5 Create awareness among participants on Disaster Management Scenario. **K3**

TEXT/REFERENCE BOOKS:

1. http://ndma.gov.in/ (Home page of National Disaster Management Authority).
2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs).
3. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.
4. Singh B.K., 2008, Handbook of Disaster Management: techniques & Guidelines, Rajat Publication.
5. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**DISASTER MANAGEMENT**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	1	-	-	2	2	-	2	3	3	3	3
CO2	-	1	-	-	2	2	-	2	3	3	3	3
CO3	-	2	-	-	3	3	-	3	2	2	2	2
CO4	-	2	-	-	2	1	-	1	-	-	-	-
CO5	-	2	-	-	3	3	-	3	2	2	2	2
Average	-	1.6	-	-	2.4	2.2		2.2	2.5	2.5	2.5	2.5

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**DISASTER MANAGEMENT**		
CO	**PSO1**	**PSO2**	
CO1	1	2	
CO2	2	3	
CO3	1	3	
CO4	2	3	
CO5	1	1	
Average	1.4	2.4	

	ENGINEERING ECONOMICS	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVE:

- To enable students to understand the fundamental economic concepts applicable to engineering and to learn the techniques of incorporating inflation factor in economic decision making.

UNIT I INTRODUCTION TO ECONOMICS 8

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis - V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.

UNIT II VALUE ENGINEERING 10

Make or buy decision, Value engineering – Function, aims, Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor - Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

UNIT III CASH FLOW 9

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

UNIT IV REPLACEMENT AND MAINTENANCE ANALYSIS 9

Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

UNIT V DEPRECIATION 9

Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives-introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

TOTAL: 45 Hours

COURSE OUTCOMES:

After successful completion of the Engineering Economics course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions.	**K2**
CO2	Identify the worthiness of the product by Make or buy decision and know the value of the time value of money.	**K3**

CO3	Understand the cash flow of the industrial system by various methods.	**K2**
CO4	Analyze the capital recovery with return and concept of challenger and defender replacement with maintenance analysis.	**K4**
CO5	Identify the depreciation of the components of the industrial system by Straight line, declining balance, Sum of the year's digits and sinking fund methods.	**K3**

TEXT BOOKS:

1. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.

REFERENCES:

1. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2011.
2. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2010.
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 2011.
4. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**ENGINEERING ECONOMICS**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	-	-	-	1	-	2	-	-	-	-	-
CO2	-	-	2	2	3	2	2	2	1	1	1	1
CO3	-	-	2	2	2	2	-	2	3	3	3	3
CO4	-	-	-	-	1	-	2	-	-	-	-	-
CO5	-	-	1	1	2	1	3	1	-	-	-	-
Average	-	-	1.6	1.6	1.8	1.6	2.2	1.6	2	2	2	**2**

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**ENGINEERING ECONOMICS**		
CO	**PSO1**	**PSO2**	
CO1	3	3	
CO2	3	3	
CO3	2	3	
CO4	3	3	
CO5	2	3	
Average	3	3	

	ENTREPRENEURSHIP DEVELOPMENT	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVE:

- To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.

UNIT I ENTREPRENEURSHIP 9

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intra preneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT II MOTIVATION 9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self-Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, objective.

UNIT III BUSINESS 9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

UNIT IV FINANCING AND ACCOUNTING 9

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation – Income Tax, Excise Duty – Sales Tax.

UNIT V SUPPORT TO ENTREPRENEURS 9

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures- Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

TOTAL : 45 Hours

COURSE OUTCOMES:

After successful completion of the Entrepreneurship Development course, the student will be able to

CO	COURSE OUTCOME STATEMENTS	KNOWLEDGE LEVEL
CO1	Understand the basic concepts of entrepreneurship and its application in the recognition of product/ service/ process opportunities	**K2**
CO2	Analyze the issues associated with securing and managing financial resources in new and established organizations.	**K4**
CO3	Develop the distinct entrepreneurial, assess opportunities and constraints for new business ideas	**K3**
CO4	Understanding of new knowledge or new technology with her/his insights for the business.	**K2**
CO5	Identifying opportunities and challenges affiliated with the organization and financing of new initiatives such as new business ventures.	**K3**

TEXT BOOKS:

1. Khanka. S.S., "Entrepreneurial Development" S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.

2. Donald F Kuratko, “Entreprenuership – Theory, Process and Practice”, 9th Edition, Cengage Learning, 2014.

REFERENCE BOOKS:

1. Hisrich R D, Peters M P, “Entrepreneurship” 8th Edition, Tata McGraw-Hill, 2013.
2. Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis” 2nd Edition Dream tech, 2005.
3. Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, 2011.
4. EDII “Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development”, Institute of India, Ahmadabad, 1986.

Mapping of Program outcome with course outcome based on attainment levels

Subject Code					Semester							
Subject Name	**Entrepreneurship Development**											
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	-	-	-	1	-	2	-	-	-	-	-
CO2	-	-	2	2	3	2	2	2	1	1	1	1
CO3	-	-	2	2	2	2	-	2	3	3	3	3
CO4	-	-	-	-	1	-	2	-	-	-	-	-
CO5	-	-	1	1	2	1	3	1	-	-	-	-
Average	-	-	1.6	1.6	1.8	1.6	2.2	1.6	2	2	2	**2**

PSOs matrices of courses selected

Subject Code		Semester	
Subject Name	**Entrepreneurship Development**		
CO	**PSO1**	**PSO2**	
CO1	3	3	
CO2	3	3	
CO3	2	3	
CO4	3	3	
CO5	2	3	
Average	3	3	