BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI

NEW COURSE STRUCTURE - Effective from academic session 2021- 22

Based on CBCS system & OBE model

Recommended scheme of study

(For Mechanical Engineering)

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic, and ecological environment, striving continuously for excellence in education, research, and technological service to the National needs.

Institute Mission

1. To educate students at Undergraduate, Postgraduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
2. To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
3. To develop effective teaching learning skills and state of art research potential of the faculty.
4. To build national capabilities in technology, education, and research in emerging areas.
5. To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

The Mechanical Engineering Department of Birla Institute of Technology, Mesra, Ranchi strives to be globally recognized for quality engineering education and research leading to well qualified engineers, academicians and researchers who are innovative, entrepreneurial, and successful in achieving excellence in their field of study.

Department Mission

1. To impart quality education to the students and enhancing their knowledge and skills to be globally competitive Mechanical Engineers.
2. To maintain state of the art research facilities to provide its students and faculty to create, interpret, apply, and disseminate knowledge with an understanding of the limitations.
3. To develop linkages and interaction with industry, R & D organization, and educational institution for excellence in consultancy practices, research, and teaching.
4. To provide conducive environment for learning, creativity, and problem-solving skill.

Graduate Attributes

1. **Engineering Knowledge**: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

2. **Problem Analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/ Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems** using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

7. **Environment and Sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

9. **Individual and Teamwork**: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

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

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

12. **Life-long Learning**: Recognize the need for and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.

Programme Educational Objectives (PEOs)

1. To provide a quality undergraduate education for students entering the mechanical engineering profession of seeking carriers in related fields.
2. To advance scientific knowledge through basic and applied research.
3. To disseminate technical information through scholarly publication, conferences, and continuing education.
4. To enable to acquire knowledge of relevant technologies and multidisciplinary fields including broad social, ethical, and environmental issues within which the engineering is practiced.
5. To develop problem solving approach using analytical abilities, effective communication skills and teamwork.
6. To create awareness and understanding related to social issues, apart from developing a sense of commitment to the community and profession with sincere involvement.

(A) Programme Outcomes (POs)

Engineering Graduates will be able to:

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

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

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

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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

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

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

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

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

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

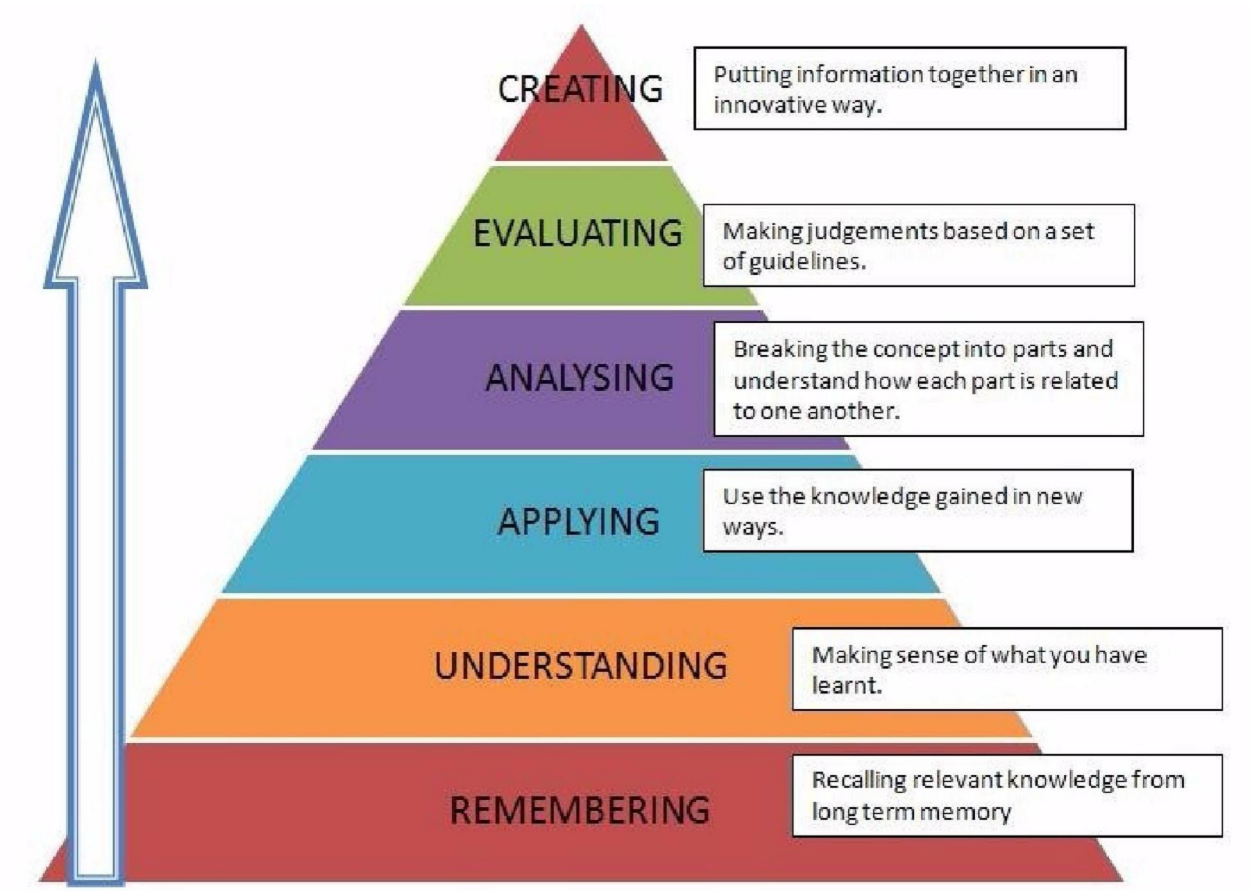
(B) Programme Specific Outcomes (PSOs)

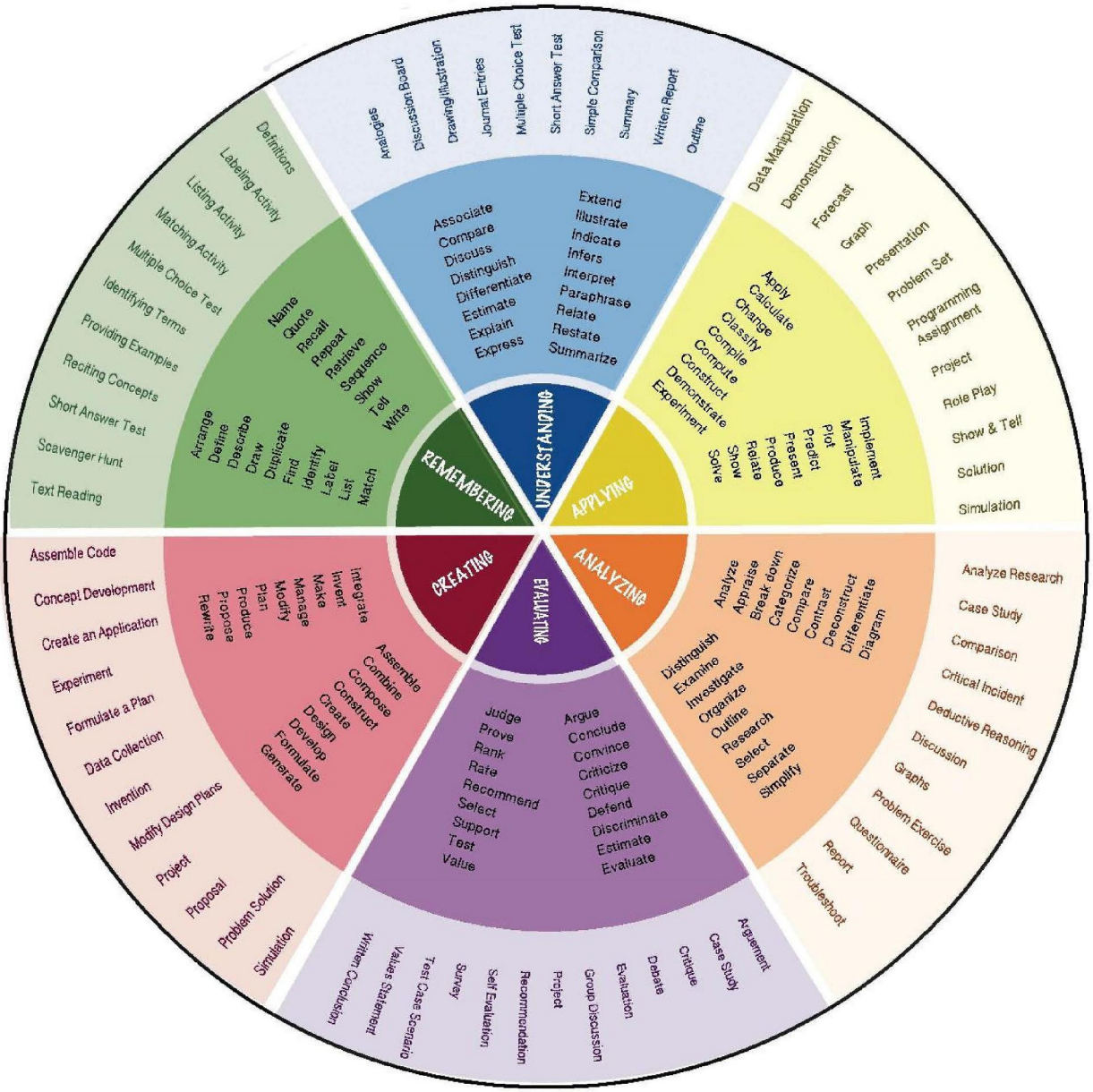
1. The student will be able to design mechanical systems in various fields and challenges such as machine elements, thermal systems, manufacturing, and industrial and inter disciplinary fields like additive manufacturing, soft computing to meet the demand of the day in industry as well as society.
2. The student will be capable to start their entrepreneurship, be employable and suitable for various fields like design, manufacturing, production industries, academic and industries, research, and development organizations in and outside the country.
3. The student will be able to pursue advanced degrees in engineering, business or other professional fields through their knowledge and learnt skills through formal as well as informal self-study and motivation.

BLOOM'S TAXONOMY FOR CURRICULUM DESIGN AND ASSESSMENT:

Preamble

The design of curriculum and assessment is based on Bloom's Taxonomy. A comprehensive guideline for using Bloom's Taxonomy is given below for reference.




REMEMBERING
UNDERSTANDING
APPLYING
ANALYZING
EVALUATING
CREATING
Definitions
Labeling Activity
Listing Activity
Matching Activity
Multiple Choice Test
Identifying Terms
Providing Examples
Reciting Concepts
Short Answer Test
Scavenger Hunt
Text Reading
Name
Quote
Recall
Repeat
Retrieve
Sequence
Show
Tell
Write
Arrange
Define
Describe
Draw
Duplicate
Find
Identify
Label
List
Match
Analogies
Discussion Board
Drawing/Illustration
Journal Entries
Multiple Choice Test
Short Answer Test
Simple Comparison
Summary
Written Report
Outline
Associate
Compare
Discuss
Distinguish
Differentiate
Estimate
Explain
Express
Extend
Illustrate
Indicate
Infers
Interpret
Paraphrase
Relate
Restate
Summarize
Data Manipulation
Demonstration
Forecast
Graph
Presentation
Problem Set
Programming Assignment
Project
Role Play
Show & Tell
Solution
Simulation
Apply
Calculate
Change
Classify
Compile
Compute
Construct
Demonstrate
Experiment
Implement
Manipulate
Plot
Predict
Present
Produce
Relate
Show
Solve
Analyze Research
Case Study
Comparison
Critical Incident
Deductive Reasoning
Discussion
Graphs
Problem Exercise
Questionnaire
Report
Troubleshoot
Analyze
Appraise
Break down
Categorize
Compare
Contrast
Deconstruct
Differentiate
Diagram
Distinguish
Examine
Investigate
Organize
Outline
Research
Select
Separate
Simplify
Argument
Case Study
Critique
Debate
Evaluation
Group Discussion
Project
Recommendation
Self Evaluation
Survey
Test Case Scenario
Values Statement
Written Conclusion
Judge
Prove
Rank
Rate
Recommend
Select
Support
Test
Value
Argue
Conclude
Convince
Criticize
Critique
Defend
Discriminate
Estimate
Evaluate
Assemble Code
Concept Development
Create an Application
Experiment
Formulate a Plan
Data Collection
Invention
Modify Design Plans
Project
Proposal
Problem Solution
Simulation
Integrate
Invent
Make
Manage
Modify
Plan
Produce
Propose
Rewrite
Assemble
Combine
Compose
Construct
Create
Design
Develop
Formulate
Generate

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEW COURSE STRUCTURE - To be effective from academic session 2021- 22
Based on CBCS system & OBE model
Recommended scheme of study
(For Mechanical Engineering)

Semester of Study	Course Level	Course Code	Course Name	Mode of delivery & credits *L-Lecture; T-Tutorial; P-Practical*			Total Credit *C-Credit*
THEORY				**L (*Periods/ week*)**	**T *(Periods/ week)***	**P *(Periods/ week)***	**C**
FIRST	**FS**	MA103	Mathematics - I	3	1	0	4
		PH113	Physics	3	1	0	4
		BE101	Biological Science for Engineers	2	0	0	2
	GE	EE101	Basic Electrical Engineering	3	1	0	4
		CS101	Programming for Problem Solving	3	1	0	4
	LABORATORIES						
	HSS	MT132	Communication Skills - I	0	0	3	1.5
	FS	PH114	Physics Lab	0	0	3	1.5
	GE	CS102	Programming for Problem Solving Lab	0	0	3	1.5
		PE101	Workshop Practice	0	0	3	1.5
	MC	MC101/102/ 103/104	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
							25
SECOND	**THEORY**						
	FS	MA107	Mathematics - II	3	1	0	4
		CH101	Chemistry	3	1	0	4
		CE101	Environmental Science	2	0	0	2
	GE	ME101	Basics of Mechanical Engineering	3	1	0	4
		EC101	Basics of Electronics and Communication Engineering	3	1	0	4
	LABORATORIES						
	FS	CH102	Chemistry Lab	0	0	3	1.5
	GE	EC102	Electronics and Communication Lab	0	0	3	1.5
		ME102	Engineering Graphics	0	0	4	2

	MC	MC105/106/ 107/108	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
							24
THIRD	**THEORY**						
	FS	MA203	Numerical Methods	2	0	0	2
	PC	ME201	Thermodynamics	3	0	0	3
		ME203	Fluid Mechanics & Hyraulic Machines	3	1	0	4
		ME205	Strength of Materials	3	1	0	4
		PE213	Manufacturing Processes	3	0	0	3
		PE214	Metallurgical and Materials Engineering	3	0	0	3
	LABORATORIES						
	FS	MA204	Numerical Methods Lab.	0	0	2	1
	MC	MC201/202/ 203/204	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
	PC	ME202	Fluid Mechanics & Hyraulic Machines Lab	0	0	3	1.5
		ME204	Mechanical Engineering Lab I	0	0	3	1.5
			TOTAL				**24**
FOURTH	**THEORY**						
	HSS	MT131	Universal Human Values 2(UHV2) : Understanding Harmony	3	0	0	3
	PC	ME207	Kinematics & Dynamics of Machines	3	0	0	3
		ME209	Energy Conversion Systems	3	0	0	3
		ME211	Machine Design	3	0	0	3
	PE		Program Elective -I	3	0	0	3
	OE		Open Elective-I/MOOC	3	0	0	3
	LABORATORIES						
	GE	EE102	Electrical Engineering. Lab	0	0	3	1.5
	MC	MC205/206 / 207/208	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
	PC	ME208	Dynamics of Machines Lab	0	0	4	2
		PE226	Manufacturing Processes Lab	0	0	3	1.5
			TOTAL				**24**
FIFTH	**THEORY**						
	PC	ME301	I C Engines & Gas Turbines	3	0	0	3
		ME303	Mechanical Vibration	3	0	0	3
		ME315	Heat &Mass Transfer	3	0	0	3
	PE		Program Elective -II	3	0	0	3

	PE		Program Elective -III	3	0	0	3
	OE		Open Elective-II/MOOC	3	0	0	3
	LABORATORIES						
	HSS	MT133	Communication Skills - II	0	0	3	1.5
	PC	ME302	Heat Transfer Lab	0	0	3	1.5
		ME304	Internal Combustion Engines Lab	0	0	3	1.5
		ME306	Mechanical Engineering Lab II	0	0	3	1.5
TOTAL							**24**
SIXTH	**THEORY**						
	PC	ME311	Computer Aided Design	2	0	0	2
		ME305	Automobile Engineering	3	0	0	3
		ME307	Robotics Engineering	3	0	0	3
	PE		Program Elective -IV	3	0	0	3
			Program Elective -V	3	0	0	3
	OE		Open Elective-III/MOOC	3	0	0	3
	PROJ	MC300	Summer Training				2
	LABORATORIES						
	PC	ME308	Robotics &Automation Lab	0	0	3	1.5
		ME310	Automobile Engineering Lab	0	0	3	1.5
TOTAL							**22**
SEVENTH	**THEORY**						
	PC	ME401	Refrigeration & Air Conditioning	3	0	0	3
	HSS	MT204	Constitution of India	2	0	0	NC
	PROJ	ME400M	Minor Project				3
	PE		Program Elective -VI	3	0	0	3
	OE		Open Elective-IV/MOOC	3	0	0	3
	LABORATORIES						
	PC	ME404	Refrigeration & Air Conditioning Lab	0	0	3	1.5
		ME406	Computer Aided Design & Drafting Lab	0	0	3	1.5
TOTAL							**15**
EIGTH	**PROJ**	ME400	Research Project / Industry Internship				**10**
							168

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEW COURSE STRUCTURE - To be effective from academic session 2021- 22
Based on CBCS system & OBE model
PROGRAMME ELECTIVES
(For Mechanical Engineering)

Level	Course Code	Course Name	Mode of delivery & credits *L-Lecture; T-Tutorial; P-Practical*			Total Credit *C- Credit*
			L (*Periods/ week*)	**T *(Periods/ week)***	**P *(Periods/ week)***	**C**
2(PE-I) 4th SEM	ME 213	Thermo Fluid Engineering	3	0	0	3
	ME 215	Composite Materials	3	0	0	3
	ME 217	Renewable Energy Resources	3	0	0	3
	PE 220	Industrial Statistics	3	0	0	3
	ME 219	Non-Destructive Testing	3	0	0	3
3(PE-II) 5th SEM	ME 357	Measurement & Instrumentation	3	0	0	3
	ME 349	Turbomachinery	3	0	0	3
	PE 317	Advanced Welding Technology	3	0	0	3
	ME 351	Finite Element Methods	3	0	0	3
	ME 353	Computational Fluid Dynamics	3	0	0	3
3(PE-III) 5th SEM	ME 355	Advanced Solid Mechanics	3	0	0	3
	ME 377	Mechatronics	3	0	0	3
	PE 318	Rapid Prototyping and Tooling	3	0	0	3
	ME 367	Industrial Tribology	3	0	0	3
3(PE -IV) 6th SEM	ME 363	Vehicle Dynamics	3	0	0	3
	ME 365	Design of Mechanisms	3	0	0	3
	PE 324	Surface Engineering & Laser Additive Manufacturing	3	0	0	3
	ME 359	Power Plant Engineering	3	0	0	3
	ME 369	Gas Dynamics	3	0	0	3
3(PE -V) 6th SEM	ME 373	Hydraulic & Pneumatic Control	3	0	0	3
	ME 375	Power Gear Train	3	0	0	3
	PE 348	Engineering Optimization	3	0	0	3
	ME 361	Combustion	3	0	0	3
4(PE-VI) 7th SEM	ME 409	Industrial Management	3	0	0	3
	ME 479	Advanced Heat Transfer	3	0	0	3
	ME 481	Theory of Elasticity	3	0	0	3
	PE 406	Non- Conventional Machining Processes	3	0	0	3
	ME 483	NonLinear Dynamics and Chaos	3	0	0	3
	PE 413	A I and Data Analytics	3	0	0	3

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEW COURSE STRUCTURE - To be effective from academic session 2021- 22
Based on CBCS system & OBE model
OPEN ELECTIVES
(For Other than Mechanical Engineering Branches)

Level	Course Code	Course Name	Mode of delivery & credits *L-Lecture; T-Tutorial; P-Practical*			Total Credit *C- Credit*
			L (*Periods/ week*)	**T *(Periods/ week)***	**P *(Periods/ week)***	**C**
2(OE-I) 4th SEM	ME 292	Smart & New Materials	3	0	0	3
	ME 293	Experimental Methods in Engineering	3	0	0	3
3(OE-II) 5th SEM	ME 392	Renewable Energy Sources	3	0	0	3
	ME 393	Elements of Hydel & Thermal Power Plants	3	0	0	3
3(OE-III) 6th SEM	ME 391	Elements of Nuclear & Diesel Power Plants	3	0	0	3
	ME 394	Elements of Modal Analysis	3	0	0	3
4(OE-IV) 7th SEM	ME 489	Mechatronics & its applications	3	0	0	3
	ME 497	Industrial Robotics & Automation	3	0	0	3

1st SEMESTER
(COMMON COURSES)

COURSE INFORMATION SHEET

Course code: MA 103
Course title: Mathematics I
Pre-requisite(s): Basic Calculus, Basic Algebra
Co- requisite(s): Nil
Credits:4 L: 3 T: 1 P: 0
Class schedule per week: 4
Class: B Tech
Semester / Level: First
Branch: Mechanical Engineering

Course Objectives:
This course enables the students to understand

1.	Infinite sequences and series.
2.	Theory of matrices including elementary transformations, rank and its application inconsistency of system of linear equations, eigenvalues, eigenvectors etc.
3.	Multivariable functions, their limits, continuity, partial differentiation, properties and applications of partial derivatives.
4.	Integrals of multivariable functions viz. double and triple integrals with their applications.
5.	Properties like gradient, divergence, curl associated with derivatives of vector point functions and integrals of vector point functions.

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

CO1	Decide the behaviour of sequences and series using appropriate tests.
CO2	Get an understanding of partial derivatives and their applications in finding maxima - minima problems.
CO3	Apply the principles of integral to solve a variety of practical problems in engineering and sciences.
CO4	Demonstrate a depth of understanding in advanced mathematical topics.
CO5	Enhance and develop the ability of using the language of mathematics in engineering.

(MA 103) Mathematics I
Syllabus

Module	Hours
Module 1: Sequences and Series Sequences, Convergence of Sequence. Series, Convergence of Series, Tests for Convergence: Comparison tests, Ratio test, Cauchy's root test, Raabe's test, Gauss test, Cauchy's Integral test, Alternating series, Leibnitz test, Absolute and Conditional Convergence.	9
Module 2: Matrices Rank of a Matrix, elementary transformations, Row - reduced Echelon form. Vectors, Linear Independence and Dependence of Vectors. Consistency of system of linear equations. Eigenvalues, Eigenvectors, Cayley - Hamilton theorem.	9
Module 3: Advance Differential Calculus Function of several variables, Limit, Continuity, Partial derivatives, Euler's theorem for homogeneous functions, Total derivatives, Chain rules, Jacobians and its properties, Taylor series for function of two variables, Maxima – Minima, Lagrange's method of multipliers.	9
Module 4: Advance Integral Calculus Beta and Gamma functions: definition and properties. Double integrals, double integrals in polar coordinates, Change of order of integration, Triple Integrals, cylindrical and spherical coordinate systems, transformation of coordinates, Applications of double and triple integrals in areas and volumes.	9
Module 5: Vector Calculus Scalar and vector point functions, gradient, directional derivative, divergence, curl, vector equations and identities. Line Integral, Work done, Conservative field, Green's theorem in a plane, Surface and volume integrals, Gauss – divergence theorem, Stoke 's theorem.	9

Text Books:

1. M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11th Edition, Pearson Educations, 2008E.
2. H. Anton, I. Brivens and S. Davis, Calculus, 10th Edition, John Wiley and sons, SingaporePte. Ltd., 2013.
3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.

Reference Books:

1. M. J. Strauss, G. L. Bradley And K. J. Smith, Calculus, 3rd Ed, Dorling.Kindersley(India) Pvt. Ltd. (P Ed), Delhi, 2007.
2. David C. Lay, Linear Algebra and its Applications, 3rd Edition, Pearson Ed. Asia, Indian Reprint, 2007.
3. D. G. Zill and W.S. Wright, Advanced Engineering Mathematics, 4th Edition, 2011.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Semester Examination	25
End Semester Examination	50
Quiz (s)	10+10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√				√
End Semester Examination	√	√	√		√
Quiz (s)	√	√	√		
Assignment	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	1	1	1	1	3	3	2	2
CO2	3	3	3	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	1	1	1	1	3	3	2	2
CO4	2	2	3	3	1	1	1	1	3	3	2	2
CO5	2	2	3	3	1	1	1	1	3	3	2	2

If satisfying< 34%=1, 34-66% =2, > 66% = 3

COURSE INFORMATION SHEET

Course code: PH 113
Course title: Physics
Pre-requisite(s): Intermediate Physics and Intermediate Mathematics
Co- requisite(s): NIL
Credits: L:3 T:1 P:0
Class schedule per week: 4
Class: B. Tech
Semester / Level: First
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To explain principles of physical optics.
2	To construct Maxwell's equations from basic principles and use it to solve electromagnetic plane wave equations.
3	To distinguish between Newtonian Mechanics and special theory of relativity and develop the relationship of length contraction, time dilation and Einstein energy mass relation and to apply the concepts of special theory of relativity in various field of physics and engineering.
4	To illustrate the phenomena of old quantum theory and derive Heisenberg uncertainty principle and Schrödinger's equations.
5	To understand basic lasing action, study various types of lasers and to have basic idea of fiber optics.

Course Outcomes

After the completion of this course, students will be able:

CO1	To interpret the intensity variation of light due to Polarization, interference and diffraction.
CO2	To formulate and solve the engineering problems on electromagnetism.
CO3	To explain special theory of relativity and apply its concepts in various fields of physics and engineering.
CO4	To explain fundamentals of quantum mechanics and apply it to problems on bound states.
CO5	To analyze working principle of lasers and to summarize its applications.

(PH 113) PHYSICS

Module	Hours
Module 1: Physical Optics Polarization, Malus' Law, Brewster's Law, Double Refraction, Interference in thin films (Parallel films), Interference in wedge-shaped layers, Newton's rings, Fraunhofer diffraction by single slit, Double slit.	9
Module 2: Electromagnetic Theory Curl, Gradient, Divergence, Gauss theorem, Stokes theorem, Gauss's law, Applications, Concept of electric potential, Relationship between E and V, Polarization of dielectrics, dielectric constant, Boundary conditions for E & D, Gauss's law in magnetostatics, Ampere's circuital law, Boundary conditions for B & H, Equation of continuity of charge, Displacement current, Maxwell's equations.	9
Module 3: Special Theory of Relativity Introduction, Inertial frame of reference, Galilean transformations, Postulates, Lorentz transformations and its conclusions, Length contraction, time dilation, velocity addition, Mass change, Einstein's mass energy relation.	9
Module 4: Quantum Mechanics Planck's theory of black-body radiation, Compton effect, Wave particle duality, De Broglie waves, Davisson and Germer's experiment, Uncertainty principle, physical interpretation of wave function, Schrodinger equation in one dimension, free particle, particle in an infinite square well	9
Module 5: Lasers Spontaneous and stimulated emission, Einstein's A and B coefficients, Population-inversion, Light amplification, Basic laser action, Ruby and He-Ne lasers, Properties and applications of laser radiation, Elementary ideas of fiberoptics and application of fiber optic cables.	9

Text books:

T1: A. Ghatak, Optics, 4th Edition, Tata Mcgraw Hill, 2009

T2: Mathew N.O. Sadiku, Elements of Electromagnetics, Oxford University Press, 2001

T3: Arthur Beiser, Concept of Modern Physics, 6th edition, Tata McGraw- Hill, 2009

Reference books:

R1: Fundamentals of Physics, Halliday, Walker and Resnick

Gaps in the syllabus (to meet Industry/Profession requirements) : NA

POs met through Gaps in the Syllabus : NA

Topics beyond syllabus/Advanced topics/Design : NA

POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	Y
Tutorials/Assignments	Y
Seminars	N
Mini projects/Projects	N
Laboratory experiments/teaching aids	N
Industrial/guest lectures	N
Industrial visits/in-plant training	N
Self- learning such as use of NPTEL materials and internets	Y
Simulation	N

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End Sem Examination Marks	50
Quiz	10+10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	√	√		
End Sem Examination Marks	√	√	√	√	√
Quiz I	√	√			
Quiz II			√	√	

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Graduate Attributes

Course Outcome #	Graduate Attributes											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	2		3	3	3		3	2	2		3
2	3	3		3	3	3		3	2	2		3
3	3	1		2	1	2		3	2	2		3
4	3			3	2	2		2	2	2		3
5	2	3		3	3	3	3	2	2	2		3

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1 and CD2
CD2	Tutorials/Assignments		CO2	CD1 and CD2
CD3	Seminars		CO3	CD1 and CD2
CD4	Mini projects/Projects		CO4	CD1 and CD2
CD5	Laboratory experiments/teaching aids		CO5	CD1 and CD2
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		-	-
CD9	Simulation		-	-

COURSE INFORMATION SHEET

Course code: BE101
Course title: Biological Science for Engineers
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits:2 L:2 T:0 P:0
Class schedule per week: 02
Class: B. Tech
Semester / Level: First
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1.	Recognize and understand the basic cell biology, biomolecules, related metabolic pathways and applicable bioenergetics.
2.	Relate common biological phenomenon at molecular level.
3.	Describe the chemical nature of enzymes and mechanism of action for their function in biochemical reactions.
4.	Correlate the molecular methods of biological signal generation and propagation in living system.
5.	Comprehend the steps involved in common application of biotechnology such as applicable for creation of transgenics, stem cells, plant metabolites production, PCR, ELISA.

Course Outcomes

After the completion of this course, students will be able to:

CO1	monstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules involved in living system.
CO2	erpret the biomechanism involved in signal generation and transmission.
CO3	Correlate the basic methods involved in common biotechnological application.
CO4	Apply and effectively communicate scientific reasoning and data involved in common biotechnological applications.

Module	Hours
Module 1: Basic Cell Biology Origin of life, Cell theory, Cell Structure and function, Biomolecules, Cell cycle and cell division, Biological Organization.	5
Module 2: Bioenergetics and Metabolism Gibbs free energy and thermodynamics, aerobic and anaerobic respiration, Glycolysis, Krebs cycle and electron transport chain, Beta oxidation, Photosynthesis.	6
Module 3: Enzymes and its Application Classification of enzymes, Structure and mechanism of enzyme action and uses of enzymes, factors affecting enzyme activity, Immobilization of enzymes and their application.	5
Module 4: Biological Signal Generation and Propagation Nerve cell structure and signal propagation. Mechanism of vision and hearing, cell signaling, Circadian rhythm.	6
Module 5: Engineering Biological Systems and its Applications Central dogma of molecular biology, Methods in genetic engineering and application, PCR, ELISA and its application, stem cell and tissue engineering. Artificial Intelligence in Biology, Plant factory.	6

Books Recommended

Recommended Text Book

1. Purves et al, (1998) Life: *The Science of Biology,* 4th Ed.
2. R. Dulbecco, The Design of Life.
3. Lehninger A, Principals of Biochemistry , 5th Ed

Reference Book

1. Stryer, L. (2002). *Biochemistry*. New York: W.H. Freeman.
2. K. Wilson & K.H. Goulding, (2006) *A biologist's guide to Principles and Techniques of Practical Biochemistry*.

Gaps in the syllabus (to meet Industry/Profession requirements)

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End Sem Examination Marks	50
Assignment / Quiz (s)	10+10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4
Mid Sem Examination Marks	√	√	√	√
End Sem Examination Marks	√	√	√	√
Quiz I	√	√	√	
Quiz II	√	√	√	

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	3	1	1	1	2	1	1	1	1
2	3	3	3	3	1	1	1	2	1	1	1	1
3	1	3	3	3		1	1	1		1	1	1
4	2	2	2	2		2	2	2		1	1	2

If satisfying< 34%=1, 34-66% =2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, 2, 3, 4	CD1, CD2, CD3, CD8
CD2	Tutorials/Assignments	CO1, 2, 3, 4	CD1, CD2, CD3, CD8
CD3	Seminars		
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

Course Information Sheet

Course code: EE 101
Course title: Basic Electrical Engineering
Pre-requisite(s): Basic Sciences
Co- requisite(s): NIL
Credits:4 L: 3 T: 1 P: 0
Class schedule per week: 4
Class: B. Tech.
Semester / Level: FIRST
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1.	Classify different electrical circuit elements and apply suitable laws and theorems for the analysis of electrical systems.
2.	Represent series / parallel electric / magnetic circuits.
3.	Employ three phase circuits for transfer of electrical power both under balanced and unbalanced condition.
4.	Interpret the system responses under different operating conditions such as resonance, mutual coupling and star-delta conversion.
5.	Assess the working of different A.C. electrical machines.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Solve electrical circuits using Kirchhoff's laws and apply concepts of magnetic circuits in electrical systems.
CO2	Analyze A.C. electrical circuits having dependent and independent sources for computation of responses such as voltage, current, power.
CO3	Evaluate the advantages of 3 phase system in electrical industrial applications and differentiate between balanced and unbalanced operation.
CO4	Assess the applicability of circuit theorems for practical applications.
CO5	Integrate the sources of energy for transferring power to the consumers (load).

(EE 101) Basic Electrical Engineering
Syllabus

Module	Hours
Module 1: Single-phase AC Circuits: Series Circuits: Common signals and their waveforms, RMS and Average value, Form factor & Peak factor of sinusoidal waveform, Impedance of Series circuits. Phasor diagram, Active Power, Power factor. Power triangle. Parallel Circuits: Admittance method, Phasor diagram. Power, Power factor. Power triangle, Series- parallel Circuit, Power factor improvement, Series and Parallel Resonance: Resonance curve, Q–factor, Dynamic Impedance and Bandwidth.	9
Module 2: Single-phase AC Circuits: Series Circuits: Common signals and their waveforms, RMS and Average value, Form factor & Peak factor of sinusoidal waveform, Impedance of Series circuits. Phasor diagram, Active Power, Power factor. Power triangle. Parallel Circuits: Admittance method, Phasor diagram. Power, Power factor. Power triangle, Series- parallel Circuit, Power factor improvement, Series and Parallel Resonance: Resonance curve, Q–factor, Dynamic Impedance and Bandwidth.	9
Module 3: Three-Phase Circuits: Line and Phase relation for Star and Delta connection, Power relations, Analysis of balanced and unbalanced 3 phase circuits, Measurement of Power.	9
Module 4: Circuit Theorems: Superposition theorem, Thevenin's & Norton's Theorem, Maximum Power Transfer theorem for Independent and Dependent Sources for DC and AC circuits. Coupled Circuits (Dot rule), Self and mutual inductances, Coefficient of coupling.	9
Module 5: Working principles of AC Generators, motors and transformers, working principles of measuring equipments such as digital voltmeter, ammeter, power factor meter and wattmeter.	9

Text books:

1. Hughes, Electrical Technology, Pearson, 10th Edition, 2011.
2. Fitzgerald and Higginbotham, Basic Electrical Engineering, McGraw Hill Inc, 1981.
3. D.P. Kothari and I.J. Nagrath, Basic Electrical Engineering, 3rd Edition, TMH, 2009.

Reference books:

1. W. H. Hayt, Jr J. E. Kemmerly and S. M. Durbin, Engineering Circuit Analysis, 7th EdnTMH, 2010.
2. Electrical Engineering Fundamental, Vincent Del Toro, Prentice Hall, New Delhi.

Gaps in the syllabus (to meet Industry/Profession requirements)

1. Application of principles of magnetic circuits to electrical machines like transformers,generators and motors.
2. Field applications of three phase equipment and circuits in power system.
3. Applications of circuit theorems in electrical and electronics engineering.

POs met through Gaps in the Syllabus

3, 4, 12

Topics beyond syllabus/Advanced topics/Design

1. Concepts of electric, magnetic and electromagnetic fields
2. 3 - Φ power generation and transmission
3. Power factor improvement for three phase systems
4. Utility of reactive power for creation of electric and magnetic fields

POs met through Topics beyond syllabus/Advanced topics/Design

2, 3, 4, 12

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Semester Examination	25
End Semester Examination	50
Quiz (s)	10+10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√	√		
End Semester Examination	√	√	√	√	√
Quiz (s)	√	√	√	√	√
Assignment	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3	3	1	3	1	1	1				2
CO2	3	3	3	1	3	1	1	1				2
CO3	3	3	3	3	3	1	2	2		1	1	2
CO4	3	3	3	1	3		1	1		1	1	2
CO5	3	3	3	3	3	1	1	1	1	1	1	2

3= High, 2=Medium, 1=Low

COURSE INFORMATION SHEET

Course code: CS 101
Course title: Programming for Problem Solving
Pre-requisite(s): NIL
Co- requisite(s): Programming for Problem Solving Lab
Credits:4 L: 3 T: 1 P: 0
Class schedule per week: 4
Class: B.Tech
Semester / Level: First
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

1.	To learn computer language.
2.	To learn coding for solving scientific and engineering problems.
3.	To learn the problem-solving process through computer.
4.	To know the limitations of system during program execution.
5.	To know the practical application of various programming techniques.

Course Outcomes

After the completion of this course, students will be able:

CO1	To formulate simple algorithms for arithmetic and logical problems.
CO2	To translate the computer algorithms to computer programs.
CO3	To test and execute the programs and correct syntax and logical errors.
CO4	To apply programming to solve simple numerical method problems, differentiation of function and simple integration.
CO5	To decompose a problem into functions and synthesize a complete program using divide and conquer approach.

(CS 101) Programming for Problem Solving

Syllabus

Module	Hours
Module 1: Introduction to Programming: Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) Problem Solving: Steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.	9
Module 2: Arithmetic expressions and precedence, Conditional Branching and Loops, Writing and evaluation of conditionals, Iterations, Loops.	9
Module 3: Array, Character array, strings. Case studies to discuss the various Problems related to Basic science (Matrix addition, Matrix-matrix multiplication, Roots of an equation etc.), Sorting, Searching.	9
Module 4: Functions (including using built in libraries), Parameter passing in functions, call by value, call by reference. Passing arrays to functions, Recursion (Finding Factorial, Fibonacci series, Ackerman function etc.).	9
Module 5: Structures, Defining structures and Array of Structures Pointers: Defining pointers, Use of Pointers in self-referential structures, File Handling.	9

Text Books:

1. Jery R Hanly, Problem solving and Program design in C, 7th Edition, Pearson Education.
2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
3. ReemaThareja, Introduction to C Programming, 2nd Edition, Oxford University Press, 2015.
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice.
5. Byron Gottfried, Schaum's Outline of Programming with C, Tata McGraw-Hill.

Mapping of Course Outcome with Program Outcomes

Course Outcome	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	1	3	1	2	1	1
CO2	3	3	3	3	3	1	1	2	1	2	1	1
CO3	3	3	2	3	3	1	1	1	1	2	2	2
CO4	3	3	3	3	2	1	1	2	1	2	3	2
CO5	3	3	2	2	3	1	1	2	1	2	2	2

COURSE INFORMATION SHEET

Course code: PH 114
Course title: Physics Lab
Pre-requisite(s): Intermediate Physics (Theory and Lab)
Co- requisite(s): NIL
Credits: 1.5 L:0 T:0 P:3
Class schedule per week: 3
Class: B. Tech
Semester / Level: FIRST
Branch: Mechanical Engineering
Name of Teacher:

List of Experiments

1. Error analysis in Physics Laboratory
2. To determine the frequency of AC mains with the help of sonometer
3. To determine the wavelength of sodium light by Newton's rings Method
4. To determine the resistance per unit length of a Carey Foster's bridge wire and thento find the resistivity of the material of a given wire.
5. Measurement of mechanical equivalent of heat by electrical method
6. Determination of refractive index of the material of a prism using spectrometer andsodium light
7. To determine the frequency of electrically maintained tuning fork by Melde'sexperiment
8. Measurement of voltage and frequency of a given signal using cathode rayoscilloscope
9. To determine the wavelength of prominent spectral lines of mercury light by a plane transmission grating using normal incidence
10. To determine the electromotive force (emf) of an unknown cell using a stretchedwire potentiometer
11. To study the frequency response and quality factor of series LCR circuit.
12. To find the specific rotation of sugar solution by using a polarimeter.
13. To determine the Hall voltage and calculate the Hall coefficient and carrierconcentration of a semiconductor sample

COURSE INFORMATION SHEET

Course code: CS 102
Course title: Programming for Problem Solving Lab
Pre-requisite(s): NIL
Co- requisite(s): Programming for Problem Solving
Credits:1.5 L: 0 T: 0 P: 3
Class schedule per week: 3
Class: B. Tech
Semester / Level: First
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

1.	To learn computer language.
2.	To learn coding for solving scientific and engineering problems.
3.	To learn the problem-solving process through computer.
4.	To know the limitations of system during program execution.
5.	To know the practical application of various programming techniques.

Course Outcomes

After the completion of this course, students will be able:

CO1	To formulate simple algorithms for arithmetic and logical problems.
CO2	To translate the computer algorithms to computer programs.
CO3	To test and execute the programs and correct syntax and logical errors.
CO4	To apply programming to solve simple numerical method problems, differentiation of function and simple integration.
CO5	To decompose a problem into functions and synthesize a complete program using divide and conquer approach.

Sample Program List

Module 1 & Module 2: Introduction and Control Flow

1. Write an interactive program that will read in a +ve integer value and determine the following
   i) If the integer is a prime number
   ii) If the integer is a Fibonacci number
2. WAP in C to compute sinx = $x - x^3/3! + x^5/3! - x^7/7!$ ….. to five place of accuracy. Test the program for x = 1, x = 2, and x = 3. In each case display the number of terms used to obtain the final answer.
3. WAP to generate every 3rd integer beginning with I = 2 and continue for all integers that are less than 150. Calculate the sum of those integers that are evenly divisible by 5.
4. WAP to find whether a given year is a leap year or not. Modify it to generate a list of leap years between two year limits given by user.
5. WAP to display the following pattern :

```
                    11
                11  10  11
            11  10   9  10  11
        11  10   9   8   9  10  11
```

6. Using Ternary / Conditional operator find the greatest among 3 numbers.
7. WAP to convert a decimal number into an equivalent number of the input base. Testyour program for base 2, 8 & 16.
8. WAP to read a number n, and print it out digit-by-digit, as a series of words. For e.g.123 would be printed as “one two three”.
9. WAP to check whether any input +ve integer is palindrome or not.
10. WAP to simulate a simple calculator (+ - / * %) that takes two operands and an operator as input and displays the result.
11. WAP to find the GCD of two input +ve integer numbers. Using this find GCD of 9 numbers.
12. WAP to swap the values of two variables without using a third variable.

Module 3: Array

13. Read a line of mixed text, and then write it out with all lower case and uppercase letters reversed, all digits replaced by 0s and all other characters (non-letters and non- digits) replaced by ‘*’.
14. WAP to find the product of two matrices A and B. Display the source matrices and product matrix C in matrix format.
15. WAP to find whether a given matrix is a triangular matrix or not.
16. WAP to find the transpose of a matrix. Display the source and the transposed matrixin matrix format.
17. Implement Prob. No. – 14 to 16 using functions for reading, manipulating anddisplaying the corresponding matrices in matrix form.
18. WAP to sort a list of strings alphabetically using a 2-dim. Character array.
19. WAP to display the row sum and the column – sum of an input 2- dim. Matrix. Display the source matrix with row and column sum.

Module 4: Functions, Pointer & String

20. Write a recursive function to calculate S = 2 + 4 + 6 + 8 + …… +2N. Implement the function in a complete C program.
21. Write a function that accepts two arguments an array and its size n. It performs Bubble up sort on the array elements. Using indirection operator '*' implement this in a complete C program. Display the source and the sorted array.
22. Using pointer, write a function that receives a character string and a character as argument. Delete all occurrences of this character in the string. The function should return corrected string with no holes.
23. Write a function for reading character string using pointer. Calculate the length of the string (without using strlen ()). Finally print the string in reverse order, using pointer.
24. Implement prob. No. 14 using pointers representation of 2 – dim. array.
25. Implement prob. No. 15 using pointer representation of 2 dim. array.
26. Implement prob. No. 16 using pointer representation of 2 dim. array.
27. WAP to sort a list of strings into alphabetical order using array of pointers.

Module 5: Structure and File

28. Create records of 60 students, where each record has fields-name, roll, GPA and fees. Write a function update () to reduce the fees of those students who have obtained GPA greater than 8.5 by 25% of the original fees. Write a complete program to exercise this function in the main program and display all the records before and after updation.
29. Define a structure that describes a hotel. It should have members that include the name, address, grade, average room charge and number of rooms. Write a function to perform the following operations:
    a) To print out hotels of a given grade in order of charges.
    b) To print out hotels with room charges less than a given value.
30. WAP to concatenate the contents of two files into a third file.
31. WAP to copy the content of one file into another file. Names of both the files are to be input as command line arguments

<u>Mapping of Course Outcome with Program Outcomes</u>

Course Outcome	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	1	3	1	2	1	1
CO2	3	3	3	3	3	1	1	2	1	2	1	1
CO3	3	3	2	3	3	1	1	1	1	2	2	2
CO4	3	3	3	3	2	1	1	2	1	2	3	2
CO5	3	3	2	2	3	1	1	2	1	2	2	2

COURSE INFORMATION SHEET

Course code: PE 101
Course title: Workshop Practice
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: First
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:

This course enables the students to:

1.	Familiarize with the basic manufacturing processes.
2.	Impart knowledge and skill to use tools, machines, equipment, and measuringinstruments.
3.	Practice on manufacturing of components using workshop trades.
4.	Educate students of safe handling of machines and tools.
5	Exercise individual as well as group activity with hands-on training in differentworkshop trades

Course Outcomes:

At the end of the course, a student should be able to:

CO1	Be conversant with the basic manufacturing processes.
CO2	Identify and apply suitable tools and instruments for machining, welding, fitting, carpentry, foundry and forging.
CO3	Manufacture different components using various workshop trades.
CO4	Take safety and precautionary measures of self and machines during operations.
CO5	Develop skills to work as an individual or in a team during trade practices.

LIST OF EXPERIMENT:

- MACHINE SHOP

EXPERIMENT – I: Center Lathe

Objective: To study lathe machine and to machine a given job on center lathe as per drawing.

- MACHINE SHOP

EXPERIMENT-II: Shaper Machine

Objective: To study Shaper machine and to machine a given job on shaper as per drawing.

- CARPENTRY SHOP

EXPERIMENT-I: Carpentry Tools and Instruments

Objective: To study the various tools, instruments and equipment used in carpentry practice.

- CARPENTRY SHOP

EXPERIMENT-II: Carpentry Practice

Objective: To perform the carpentry work by making a wooden job using different tools.

- FITTING SHOP

EXPERIMENT-I: Fitting Tools and Measuring Instruments

Objective: To study the various tools used in fitting shop and perform fitting operations (like marking, chipping, hack-sawing, filing, drilling etc.)

- FITTING SHOP

EXPERIMENT-II: Fitting Assembly Practice

Objective: To make a job clamping plate as per given drawing by fitting operations and to check for its assembly with a given component.

FORGING SHOP EXPERIMENT-I: Forging Tools
Objective: To study different tools and equipment used in hand forging practice.

- FORGING SHOP

EXPERIMENT-II: Forging Practice

Objective: To learn about hand forging practice by making a job (make a square bar from round blank and bend it at a sharp corner of 90 degree as per drawing).

- FOUNDRY SHOP

EXPERIMENT-I: Green Sand Moulding

Objective: To get acquainted with various tools and equipment used in making green sand mould (to practice green sand mould making with single piece pattern).

- FOUNDRY SHOP

EXPERIMENT-II: Aluminium Casting

Objective: To get acquainted with melting and pouring of metal in a mould (given two- piece patterns of handle) and to make aluminium casting.

- WELDING SHOP

EXPERIMENT-I: Manual Metal Arc Welding

Objective: To study arc welding processes including arc welding machines (AC & DC), electrodes and equipment. To joint two pieces of given metal by arc welding process.

- WELDING SHOP

EXPERIMENT-II: Gas Welding

Objective: To study gas welding processes including types of flames produced, filler metals and fluxes etc. To joint two pieces of given metal by gas welding process.

Books recommended:

TEXT BOOK

- S K Hajra Choudhury, A K. Hajra, "Elements of Workshop Technology: Vol- I and Vol -II", Media Promotors Pvt Ltd. **(T1)**
- B S Raghuwanshi, "A course in Workshop Technology", Dhanpat Rai Publications. **(T2)**

REFERENCE BOOK

- P.N. Rao, "Manufacturing Technology Vol-1and Vol-II", Tata McGraw Hill. **(R1)**

Kalpakjian, "Manufacturing Engineering and Technology", Pearson. **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:Course

Delivery Methods:

	Course Delivery methods	
CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	
CD7	Simulation	√

Course Evaluation:

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	**30**
Quiz 1	**10**
Viva-Voce	**20**
End Semester Examination	% Distribution
Examination: Experiment Performance	**30**
Quiz 2	**10**

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Day to day performance & Lab files	√	√	√	√	√
Quiz-1	√	√	√		
Quiz -2	√	√	√		
Viva-Voce	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

Indirect Assessment –

Student Feedback on Faculty

1. Student Feedback on Course Outcome

Course Outcome	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2				1					2
CO2	3	1	2									1
CO3	3	2	2	1								2
CO4	2					2						1
CO5	2	2	2	1		1			3	1		1

If satisfying< 34%=1, 34-66% =2, > 66% = 3

2nd SEMESTER

(COMMON COURSES)

COURSE INFORMATION SHEET

Course code: MA 107
Course title: Mathematics II
Pre-requisite(s): Mathematics - I
Co- requisite(s): NIL
Credits:4 L: 3 T: 1 P: 0
Class schedule per week: 3 Lectures, 1 Tutorial**.**
Class: B. Tech
Semester / Level: Second
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives: This course enables the students to understand

1.	Various methods to solve linear differential equations of second and higher order.
2.	special functions viz. Legendre's and Bessel's and different properties associated withthem.
3.	Diverse mathematical techniques for solving partial differential equations of first order and higher order, along with their applications in wave and heat equations using Fourier series.
4.	The theory of functions of a complex variable, complex differentiation and integration.
5	About random variables and elementary probability distribution.

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

CO1	Investigate the occurrence of differential equations in science and engineering and use methods available for their solutions.
CO2	Gain an understanding on complex variable functions and using their properties in real life problems.
CO3	Construct appropriate probability models in solving real world problems.
CO4	Demonstrate a depth of understanding in advanced mathematical topics.
CO5	Enhance and develop the ability of using the language of mathematics in engineering.

(MA 107) Mathematics- II

Syllabus

Module	Hours
Module 1: Ordinary Differential Equations – I Linear differential equations, Wronskian, Linear independence and dependence of solutions, Linear differential equations of second and higher order, Operator method, Legendre's and Euler – Cauchy's form of linear differential equation, Method of variation of parameters.	9
Module 2: Ordinary Differential Equations – II Ordinary and singular points of differential equation, Power and Frobenius series solutions. Bessel's differential equation, Bessel function of first kind and its properties. Legendre's differential equation, Legendre's polynomial and its properties.	9
Module 3: Fourier series and Partial Differential Equations Fourier series: Euler formulae for Fourier series, Dirichlet conditions, Half range Fourier series. Partial Differential Equations: Linear partial differential equations, Lagrange's method. Method of separation of variables and its application in solving one dimensional wave and heat equations.	9
Module 4: Complex Variable-Differentiation & Integration Function of a complex variable, Limit, Continuity, Differentiability, Analyticity, Analytic functions, Cauchy – Riemann equations. Harmonic functions, Harmonic Conjugate. Cauchy's theorem, Cauchy's Integral formula, Taylor and Laurent series expansions. Singularities and its types, Residues, Residue theorem.	9
Module 5: Applied Probability Discrete and continuous random variables, cumulative distribution function, probability mass and density functions, expectation, variance, moment generating function. Introduction to Binomial, Poisson and Normal Distribution.	9

Text Books:

1. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. D. G. Zill and W.S. Wright, Advanced Engineering Mathematics, 4th Edition, 2011.
3. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Edition, McGraw Hill, 2004.
4. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, 3rd Edition, Narosa Publishing, 2009.
5. R. A . Johnson, I. Miller and J. Freund: Probability and Statistics for Engineers, PHI.
6. S. C. Gupta and V.K . Kapoor.: Fundamental of Mathematical Statistics, Sultan Chandand Sons.

Reference Books:

2. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition ., Wiley India, 2009.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
4. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice HallIndia, 1995.
5. G. F. Simmons, Differential Equations with Applications and Historical Notes, TMH, 2nd Edition, 2003.
6. P. L. Meyer: Introductory Probability and Statistical Applications, Oxford & IBH.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Semester Examination	25
End Semester Examination	50
Quiz (s)	10+10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√				√
End Semester Examination	√	√	√		√
Quiz (s)	√	√	√		
Assignment	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1	1	1	3	3	2	2
CO2	3	3	3	2	1	1	1	1	3	3	2	2
CO3	3	3	3	2	1	1	1	1	3	3	2	2
CO4	2	2	3	3	1	1	1	1	3	3	2	2
CO5	2	2	3	3	1	1	1	1	3	3	2	2

If satisfying< 34%=1, 34-66% =2, > 66% = 3

COURSE INFORMATION SHEET

Course code: CH 101
Course title: Chemistry
Pre-requisite(s): Intermediate level chemistry
Co- requisite(s): NIL
Credits:4 L: 3 T: 1 P: 0
Class schedule per week: 04
Class: B. Tech.
Semester /Level: 2
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1.	To create concept of Chemical bonding & Coordination Chemistry.
2.	To understand the basic 3D structure in organic chemistry including stereochemistry, aromaticity and reaction mechanism.
3.	To understand the reaction dynamics and to know different types of catalysis.
4.	To understand the modern techniques related to spectroscopy and structural characterization.
5.	To develop knowledge on the physical state and electrochemistry of molecules.

Course Outcomes

After the completion of this course, students will be:

CO1	Able to explain the bonding in a molecular structure.
CO2	Able to explain the 3D structure, aromaticity and stereochemistry of organic molecules.
CO3	Able to explain the spectroscopic data for structural characterization of the molecules.
CO4	Able to predict the rate, molecularity and mechanism of a simple as well as catalytic reaction.
CO5	Able to interpret the phases of solid and the electrochemical behavior of the molecules.

(CH 101) Chemistry
Syllabus

Module	Hours
Module 1: Chemical Bonding *Ionic bond:* Radius ratio rule, Born-Landé equation, Born-Haber cycle. *Metallic Bond:* valence bond and band theories, defects in solids, Werner's Theory, Bonding in Transition metal complexes, Ligands, coordination complexes, Ligand Field, Crystal Field Theory, Octahedral, Tetrahedral and square planar complexes, CFSE, Jahn Teller theorem, electronic spectra, magnetism, and isomerization in coordination compounds.	9
Module 2: Organic Structure and Stereochemistry *Covalent bond:* Lewis structure, Valence Bond theory, Molecular orbital theory, Molecular orbital of diatomic and polyatomic system, hybridization, conjugated molecules, Huckel molecular orbital theory of conjugated systems. Isomerism, Geometrical isomerism: *cis–trans* and syn-anti isomerism; Optical isomerism & Chirality; Wedge, Fischer, Newmann and Sawhorse Projection formulae and interconversions; E/Z, D/L, R/S nomenclature system; Conformational studies of ethane, n-butane, Cyclohexane.	9
Module 3: Kinetics and Catalysis Order & molecularity of reactions: chain, parallel, Competing, Side, Consecutive reactions; Kinetics of Fast reactions, Characteristics of catalyst, types of catalysis, catalytic poison; Theories of catalysis; Acid base catalysis: including kinetics, Enzyme catalysis, Mechanism and kinetics of enzyme catalyzed reaction, Michaelis-Menten equation, Important catalysts inindustrial processes; Hydrogenation using Wilkinsons catalyst, Hydroformylation by using Cobalt-catalyst, Phase transfer catalyst.	9
Module 4: Spectroscopic Techniques Absorption and emission Spectroscopy, Lambert-Beers Law, Principles and applications of UV-Visible, Factors influencing for UV-VIS spectrum; Rotational and Vibrational spectroscopy, Principle of FT-IR, and NMR spectroscopy; Modern techniques in structural elucidation of compounds by UV-VIS, IR, & NMR Spectroscopy.	9
Module 5: Phase and Chemical equilibrium Phase Rule: Terms Involved, Phase diagram of one component (Water) & two component (Pb/Ag) system & their applications. Law of chemical equilibrium, equilibrium constants and their significance, Weak and strong electrolytes, Standard electrode potential and its application to different kinds of half cells, EMF and its measurement and application, Batteries and Fuel Cells, Chemical and Electrochemical corrosion, Factors affecting the rate of corrosion.	9

Text books:

1. Huheey, J. E., Inorganic Chemistry: Principles of Structure and Reactivity, 4th edition, Pearson.
2. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Seventh Edition, Pearson
3. Atkins, P. W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press,2014.

Reference books:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier (2009).
3. William Kemp, Organic Spectroscopy, 3rd Ed., 2008 Macmillan.

Gaps in the syllabus (to meet Industry/Profession requirements) : NAPOs

met through Gaps in the Syllabus : NA

Topics beyond syllabus/Advanced topics/Design : NA

POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	Y
Tutorials/Assignments	Y
Seminars	N
Mini projects/Projects	N
Laboratory experiments/teaching aids	Y
Industrial/guest lectures	Y
Industrial visits/in-plant training	N
Self- learning such as use of NPTEL materials and internets	Y
Simulation	N

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Mid Sem Examination Marks	25
End Sem Examination Marks	50
Quiz	10+10
Assignment	5

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Sem Examination Marks	√	√	√		
End Sem Examination Marks	√	√	√	√	√
Quiz I	√	√			
Quiz II			√	√	

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Graduate Attributes

Course Outcome #	Graduate Attributes											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	2		3	3	3		3	2	2		3
2	3	3		3	3	3		3	2	2		3
3	3	1		2	1	2		3	2	2		3
4	3			3	2	2		2	2	2		3
5	2	3		3	3	3	3	2	2	2		3

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1 and CD2
CD2	Tutorials/Assignments		CO2	CD1 and CD2
CD3	Seminars		CO3	CD1 and CD2
CD4	Mini projects/Projects		CO4	CD1 and CD2
CD5	Laboratory experiments/teaching aids		CO5	CD1 and CD2
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		-	-
CD9	Simulation		-	-

COURSE INFORMATION SHEET

Course code: ME 101
Course title: Basics of Mechanical Engineering
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 4 L: 3, T: 1, P: 0
Class schedule per week: 04
Class: B. Tech
Semester / Level: Second
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1.	To introduce system of forces, and write equation of equilibrium.
2.	To analyse motion of particle and rigid body subjected to force.
3.	To grasp the importance of internal, external combustion engines and heat transfer.
4.	To apprehend the fundamentals of friction and vibration.
5.	To understand the different sources of energy.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Write and solve the equations of equilibrium for particles and structures memberssubjected to forces.
CO2	Write and solve the equations of motion for particles and rigid bodies subjected toforces.
CO3	Discuss the basics of Boilers, IC Engines and heat transfer.
CO4	Aware of different types of vibrations and friction.
CO5	Outline the non-conventional energy resources.

(ME 101) Basics of Mechanical Engineering

Syllabus

Module	Hours
Module 1: System of Forces and Structure Mechanics Addition of Forces, Moment of a Force, Couple, Varignon's theorem, Free Body Diagram, Equilibrium in Two and Three Dimensions, Equivalent Forces and Moment. Types of Trusses, Plane and Space Trusses. Analysis of Plane Trusses by: Method of Joints and Method of Sections, Analysis of Frames with Hinged Joints. Hooke's Law of elasticity, Stress and Strain, Relation between elastic constants, Thermal Stresses, Properties of surfaces such as centroid and area moment of inertia.	9
Module 2: Kinematics & Kinetics of rigid bodies Types of rigid body motion– translation, rotation about fixed axis, equations defining the rotation of a rigid body about a fixed axis, plane motion, absolute and relative velocity in plane motion, instantaneous center of rotation. Equation of translational and rotational motion, Newton's law and D'Alembert's principle –inertia force and inertia couple.	9
Module 3: Friction and Vibration Interfacial Friction (a) Laws of dry friction, static & kinetic co-efficient of friction, Analysis of static, kinetic and rolling friction.(b) Analysis of frictional forces in inclined planes, wedges, screw jacks and belt drives. Vibrations: Types of vibration, free un-damped longitudinal vibrations, free damped longitudinal vibrations.	9
Module 4: Boilers and Internal Combustion Engine Boiler Mountings and Accessories, Fire Tube and Water Tube Boilers, Cochran Boiler, Babcock and Wilcox Boiler. Basic components and terminology of IC engines, working of four stroke/two stroke - petrol/diesel engine, classification and application of IC engines. Heat transfer: various modes of heat transfer, one dimensional steady state conduction, Application to composite walls and cylinder.	9
Module 5: Non-Conventional Energy and their resources Renewable and Non-renewable Energy Resources, Advantages and Disadvantages of Renewable Resources, Renewable Energy Forms and Conversion, Solar Energy, Wind Energy, Tidal Energy, Ocean Thermal Energy; Geothermal Energy, Nuclear Energy, Hydro Energy.	9

Text Books

1. Engineering Mechanics, Irving H. Shames, P H I. ltd, 2011.

2. Engineering Mechanics, S. Timoshenko, D. H. Young, J. V. Rao, Sukumar Pati, McGrawHill education, 2017.

3. Theory of vibrations with applications, Thomson and Dahleh, Pearson Education, 5th Edition, 2008.

4. Boiler operator, Wayne Smith, LSA Publishers, 2013.

5. Internal Combustion Engines, M. L. Sharma and R. P. Mathur, Dhanpat Rai Publications,2014.

6. Heat Transfer, J. P. Holman, Souvik Bhattacharya, Mcgraw Higher Ed Publishers, 2011.

7. Fundamentals of Renewable Energy Processes, Aldo Vieira Da Rosa, Elsevier publication,2012.

Reference Books

1. Engineering Mechanics : statics, James L. Meriam, L. G. Kraige, Wiley, 7th Edition, 2011.

2. Engineering Mechanics, S. Rajasekaran & G. Sankarasubramaniam, Vikash publishinghouse, 2018.

3. Engineering Vibration, Daniel J. Inman, Pearson, 2013.

4. An Introduction to Steam Boilers, David Allan Low, Copper Press Publisher, 2012.

5. Internal Combustion Engines – V Ganesan, McGraw hill, 2017.

6. Heat and Mass Transfer: Fundamentals and Applications, Yunus A. Cengel, Afshin J.Ghajar, McGraw Hill Education Publisher, 2017.

7. Non Conventional Energy Resources, B. H. Khan, McGraw Hill Education Publisher,2017.

8. Principles of Mechanical Engineering, R. P. Sharma & Chilkesh Ranjan, Global Academic Publishers, 2016.

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedureDirect Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End Sem Examination Marks	50
Quizzes (1 and 2)	10+10
Assignment	05

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	√	√		
End Sem Examination Marks	√	√	√	√	√
Quizzes	√	√	√	√	√
Assignment	√	√	√	√	√

If satisfying< 34%=1, 34-66% =2, > 66% = 3

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

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

COURSE INFORMATION SHEET

Course code: EC 101
Course title: Basics of Electronics & Communication Engineering
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: L: 3 T: 1 P: 0 C: 4
Class schedule per week: 04
Class: B. Tech.
Semester / Level: Second
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:

This course enables the students:

1.	To understand PN Junction, diodes and their applications.
2.	To comprehend BJT, FET and their bias configurations.
3.	To grasp importance of feedback in amplifier circuits, op amp and its applications.
4.	To understand number system, Logic Gates and Boolean algebra.
5.	To apprehend fundamentals of communication technology.

Course Outcomes:

After the completion of this course, students will be able to:

CO1	Explain PN Junction, diodes and their applications.
CO2	Appraise the BJT, FET and their biasing techniques.
CO3	Comprehend feedback in amplifier circuits, op amp and its applications.
CO4	Translate one number system into another, build circuits with Logic Gates,electronic components and OPAMP IC 741 and analyze the measurement results using CRO.
CO5	Appraise the fundamentals of communication technology.

(EC 101) Basics of Electronics & Communication Engineering

Syllabus

Module	Hours
Module 1: Diodes and Applications: Introduction to PN junction diodes; Characteristics of semiconductor diodes: V-I characteristics, diode-resistance, temperature-dependence, diode-capacitance; DC & AC load lines; Breakdown Mechanisms; Zener Diode – Operation and Applications; Diode as a Rectifier: Half Wave and Full Wave Rectifiers with and without C-Filters.	9
Module 2: Bipolar Junction Transistors (BJT): PNP and NPN Transistors, Basic Transistor Action, Input and Output Characteristics of CB, CE and CC Configurations, dc and ac load line analysis, operating point, Transistor biasing: Fixed bias, emitter bias/self-bias, Low-frequency response of CE amplifier. Field Effect Transistors: JFET, Idea of Channel Formation, Pinch-Off and saturation Voltage, Current-Voltage Output Characteristics; MOSFET: Basic structure, operation and characteristics.	9
Module 3: Sinusoidal Oscillators: Concept of positive and negative feedback, Barkhausen criterion for sustained oscillations, Determination of Frequency and Condition of oscillation, Hartley and Colpitt's oscillator. Operational Amplifiers: Characteristics of an Ideal and Practical Operational Amplifier (IC 741), Inverting and non-inverting amplifiers, Offset error voltages and currents; Power supply rejection ratio, Slew Rate and concept of Virtual Ground, Summing and Difference Amplifiers, Differentiator and Integrator, RC phase shift oscillator.	9
Module 4: Logic Gates and Boolean algebra: Introduction to Boolean Algebra and Boolean operators, Symbolic representation, Boolean algebraic function and Truth table of different Digital logic Gates (AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR); Realization of Basic logic gates using universal gates, Adder, Subtractor, adder/subtractor.	9
Module 5: Electronic communication: Introduction to electronic communication system, Electromagnetic Communication spectrum band and applications, Elements of Electronic Communication System; Merits and demerits of analog and digital communication, Modes of communication; Signal radiation and propagation; Need for modulation; Introduction to Amplitude modulation and Angle modulation.	9

Text Books:

1. Millman J., Halkias C.C., Parikh Chetan, Integrated Electronics: Analog and Digital Circuits and Systems, 2nd Edition, Tata McGraw-Hill.
2. Mano M.M., Digital Logic and Computer Design, Pearson Education, Inc, Thirteenth Impression, 2011.
3. Singal T. L., Analog and Digital Communications, 2nd Edition, Tata McGraw-Hill.
4. Haykin S., Moher M., Introduction to Analog & Digital Communications, 2nd Edition, Wiley India Pvt. Ltd.

Reference Book:

1. Boylstead R.L., Nashelsky L., Electronic Devices and Circuit Theory, 10th Edition Pearson Education, Inc.

Gaps in the syllabus (to meet Industry/Profession requirements): Teaching through paper

POs met through Gaps in the Syllabus: P10 will be met though report-writing/presentation-based assignment

Topics beyond syllabus/Advanced topics/Design: Teaching through paper

POs met through Topics beyond syllabus/Advanced topics/Design: Teaching through paper

CD #	**Course Delivery methods**
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Quizzes
CD3	Assignments/Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid SEM Examination Marks	25
End SEM Examination Marks	50
Quizzes	10+10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	√	√		
End Sem Examination Marks	√	√	√	√	√
Quiz I	√	√	√		
Quiz II			√	√	

If satisfying < 34% = 1, 34-66% = 2, > 66% = 3

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #		Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	1	2	3	1	1				3	
CO2	3	3	1	2	3	1	1				3	
CO3	3	3	1	2	3	1	2		1	1	3	2
CO4	3	3	1	2	3	1	2		1	1	3	2
CO5	3	3	1	2	3	1	1				3	

If satisfying < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1, CO2, CO3, CO4	CD1
CD2	Quizzes	CO1, CO2, CO3	CD2
CD3	Assignments/Seminars	CO3	CD3
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: CH 102
Course title: Chemistry Lab
Pre-requisite(s): Intermediate level Chemistry
Co- requisite(s): NIL
Credits: 1.5 L: 0 T: 0 P: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Second
Branch: Mechanical Engineering
Name of Teacher:

Syllabus

1. Gravimetric estimation of Nickel by Dimethylglyoxime.
2. Quantitative estimation of Ca^{2+} and Mg^{2+} ions by complexometric titration using Na_2-EDTA.
3. To verify Bears Law using Fe^{3+} solution by spectrophotometer/colorimeter and to determine the concentration of a given unknown Fe^{3+} solution.
4. Separation of binary organic mixture by acid-base extraction and analysis using givenFTIR and NMR spectrum.
5. Preparation of Diazoamino Benzene and report the melting point and yield of product.
6. Draw melting point-mass percent composition diagram for two component mixture and determine the Eutectic Temperature.
7. To study the kinetics of acid-catalyzed hydrolysis of ethyl acetate and to evaluate thevalue of the rate constant.
8. To determine the rate law for the reaction between iodide and hydrogen peroxide in anacidic environment and to determine the effect of a catalyst on the rate of reaction.
9. To determine the strength of the given strong acid by strong base Potentiometrically.
10. To determine the transition temperature of the given salt hydrate.
11. Qualitative detection of special elements in organic compounds.
12. To draw the pH-titration curve of strong acid vs strong base.

Reference book:

1. Experimental Physical Chemistry, By B. Viswanathan, P. S. Raghavan, Narosa Publishing House (1997).
2. Vogels Textbook of Practical Organic Chemistry
3. Experiments in General chemistry, C. N. R. Rao and U. C. Agarwal
4. Experimental Organic Chemistry Vol 1 and 2, P R Singh, D S gupta, K S Bajpai,Tata McGraw Hill

COURSE INFORMATION SHEET

Course code: EC 102
Course title: Electronics & Communication Lab
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits:1.5 L: 0 T: 0 P: 3
Class schedule per week: 03
Class: B. Tech.
Semester / Level: Second
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:
This course enables the students:

1.	To demonstrate the measurement of voltage, frequency using CRO.
2.	To explain PN junction characteristics and its applications.
3.	To understand the frequency response of BJT amplifier and OPAMP.
4.	To Realize logic gates and implement simple Boolean expression.
5.	To explain the Amplitude Modulation and Frequency Modulation

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

CO1	Make use of CRO for measuring different parameters.
CO2	Appraise PN junction characteristics and its applications.
CO3	Experiment with Diodes, BJT and OPAMP.
CO4	Design specified circuit using given electronic components/ICs/logic gates.
CO5	Demonstrate the working of Amplitude Modulation and Frequency Modulation

Syllabus
List of Compulsory experiments:

1. Measurement of voltage, time period and frequency of different signals on CRO.
2. Measurement of frequency and phase of two different signals using Lissajous pattern.
3. To determine the forward and reverse bias characteristics of PN junction diode.
4. To determine the reverse bias characteristics of Zener diode and application as a voltage regulator.
5. Measurement of rectification efficiency and ripple factor of Half-wave and Full-wave rectifier Circuits with and without C-Filter.
6. To determine the frequency response of CE transistor amplifier and finding its gain bandwidth product.
7. To determine the transfer characteristics of JFET and measurement of its voltage gain.
8. Design of RC phase shift oscillator using IC-741 Op-Amp and finding its frequency of oscillation.

9. Design of Inverting and Non-inverting amplifier using IC 741 OP-AMP and finding its frequency response.
10. Realization of Basic logic gates (AND, OR, NOT) using NAND Gate (IC-7400).
11. Implementation of Boolean expression F = (A.B.C + D.E) using AND Gate(IC 7408) andOR Gate (IC 7432).
12. Generation of Amplitude modulated wave and calculation of percentage of modulation using standard setup.
13. Generation of FM-wave and its detection using standard setup.

Text Books:

1. Millman J., Halkias C.C., Parikh Chetan, Integrated Electronics: Analog and Digital Circuits and Systems, 2nd Edition, Tata McGraw-Hill.
2. Mano M.M., Digital Logic and Computer Design, Pearson Education, Inc, Thirteenth Impression, 2011.
3. Singal T. L., Analog and Digital Communications, 2nd Edition, Tata McGraw-Hill.
4. Haykin S., Moher M., Introduction to Analog & Digital Communications, 2nd Edition, Wiley India Pvt. Ltd..

Reference Book:

1. Boylstead R.L., Nashelsky L., Electronic Devices and Circuit Theory, 10th Edition Pearson Education, Inc.

Gaps in the syllabus (to meet Industry/Profession requirements): N/APOs

met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Tutorials/Assignments
CD3	Seminars/ Quiz (s)
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self- learning such as use of NPTEL materials and internets
CD9	Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	**(60)**
Attendance Marks	**12**
Lab Viva marks	**24**
Lab file Marks	**12**
Day-to-day performance Marks	**12**
End SEM Evaluation	**(40)**
Lab quiz Marks	**20**
Lab performance Marks	**20**

Assessment Components	CO1	CO2	CO3	CO4	CO5
Progressive Evaluation	√	√	√	√	√
End SEM Evaluation	√	√	√	√	√

If satisfying < 34% = 1, 34-66% = 2, > 66% = 3

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	1	2	1	1	1				3	
CO2	3	2	1	2	2	1	1				1	
CO3	3	2	1	2	2	1	2		1	1	1	1
CO4	3	3	1	2	3	1	2		1	1	3	1
CO5	3	2	1	2	1	1	1				3	

If satisfying < 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		
CD2	Tutorials/Assignments/Quiz (s)		
CD3	Seminars		
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids	CO1, CO2, CO3, CO4	CD5
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation	CO1, CO2, CO3, CO4	CD9

COURSE INFORMATION SHEET

Course code: ME 102
Course title: Engineering Graphics
Credits: 2.0 L: 0, T:0 , P:4
Class schedule per week: 04
Class: B. Tech
Semester / Level: Second
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1.	To understand the basic principles of Engineering Graphics, which include projections of1D, 2D and 3D objects.
2.	To visualize a solid object (including sectioned) and convert it into drawing.
3.	To visualize different views of any object.
4.	To develop skill to draw objects using software.
5.	To inculcate the imagination and mental visualization capabilities for interpreting the geometrical details of common engineering objects.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand the fundamentals of Engineering Graphics and sketch the orthographic projections of points, lines and planes.
CO2	Sketch the orthographic projections of solids and section of solids.
CO3	Sketch three dimensional isometric views and development of the surfaces.
CO4	Create and modify orthographic projections using AutoCAD software.
CO5	Create three dimensional solid models using AutoCAD software.

(ME 102) Engineering Graphics Lab

Syllabus

Module	Hours
Module 1: Introduction to orthographic projections, Conventions, Fundamentals of First and Third Angle projection, Orthographic projections of points, lines and planes.	9
Module 2: Projections of simple solids - axis perpendicular to HP, VP and inclined to one or both planes, Sectioning of solids, section plane perpendicular to one plane and parallel or inclined to other plane.	9
Module 3: Development of surfaces- Development of prisms, pyramids and cylindrical & conical surfaces, Isometric projection and isometric views of different planes and simple solids, introduction to perspective projection.	9
Module 4: Working with AutoCAD Commands, Cartesian Workspace, Basic Drawing & Editing Commands, Drawing: Lines, Rectangles, Circles, Arcs, Polylines, Polygons, Ellipses, Creating Fillets and Chamfers, Creating Arrays of Objects, Working with Annotations, Adding Text to a Drawing, Hatching, Adding Dimensions, Dimensioning Concepts, Adding Linear Dimensions, Adding Radial & Angular Dimensions, Editing Dimensions.	9
Module 5: Create views of engineering parts in AutoCAD, case studies with examples of Mechanical/ Electrical/Civil engineering drawings.	9

Text Books

1. Engineering Drawing by N. D. Bhatt, Charotar Publishing House Pvt.Ltd., 53rd, Edition, 2014.

2. Engineering Drawing and Graphics + AutoCAD by K. Venugopal, New Age International (P) Limited, 4th Reprint: June, 2017.

Reference Books

1. Engineering Graphics with Autocad by J. D. Bethune, Prentice Hall, 2007.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive evaluation	60
End Semester Lab Examination Marks	40

Assessment Components	CO1	CO2	CO3	CO4	CO5
Progressive evaluation Marks	√	√	√	√	√
End Semester Lab Examination Marks	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	3	2	3	1			3	3	3		
CO2	3	3	2	3	1			3	3	3		
CO3	3	3	2	3	1			3	3	3		
CO4	3	3	2	3	3			3	3	3		
CO5	3	3	2	3	3			3	3	3		

3rd SEMESTER

COURSE INFORMATION SHEET

Course code: MA 203
Course title: Numerical Methods
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 2 (L: 2, T: P: 0)
Class schedule per week: 2
Class: B. Tech
Semester / Level: Third
Branch: Mechanical Engineering

SYLLABUS

Module	Hours
Module –I Errors and Nonlinear Equations: Error Analysis: Definition and sources of errors, propagation of errors, floating-point arithmetic, Solution of Nonlinear equations: Bisection method, Regula-Falsi method, Secant method, Newton-Raphson method and its variants, General Iterative method.	5
Module –II System of Linear Equations; Gauss-Elimination, Gauss-Jordan, LU-Decomposition, Gauss-Jacobi and Gauss- Siedel methods to solve linear system of equations and Power method to find least and largest eigen values.	5
Module –III Interpolation: Lagrange's interpolation, Newton's divided differences interpolation formulas, inverse interpolation, interpolating polynomial using finite differences.	5
Module –IV Differentiation and Integration: Differentiation using interpolation formulas, Integration using Newton-Cotes formulas: Trapezoidal rule, Simpson's rule.	5
Module –V Solution of Ordinary Differential Equations: Euler's method, modified Euler's method, Runge - Kutta Methods of second and fourth order to solve initial value problems.	5

Text books:

1. Jain M.K, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age Publications, 2004.
2. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI.
3. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Reference books:

1. S.C. Chapra and R. P. Canale, Numerical Methods for Engineers, McGraw Hill, 1985.
2. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, Seventh Edition, 2003.
3. R. W. Hamming: Numerical Methods for Scientists and Engineers, Second Edition, Dover .

COURSE INFORMATION SHEET

Course code: ME 201
Course title: Thermodynamics
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 **(**L:3, T: 0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: Third
Branch: Mechanical Engineering

Course Objectives:

This course enables the students to:

1	Get acquainted with the basic concepts and fundamental aspects of thermodynamics.
2	Outlining the first law of thermodynamics and its applications.
3	Limitations of first law of thermodynamics and the development of second law of thermodynamics.
4	Study and analyse different air standard cycles.

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

CO1	Understand the fundamental concepts of control volume, thermodynamic equlibrium and heat and work etc.
CO2	Apply the thermodynamical concepts of Zeroth law and First Laws of thermodynamics applied in various thermodynamics problems.
CO3	Understand the limitations of First Law and apply the concepts of second Law of thermodynamics for analysing various thermodynamical problems.
CO4	Analyse the Clausius Inequality and Exergy analysis for various relevant problems.
CO5	Identify and understand the Air standard cycles, Starling, Eriksson, Otto Diesel cycles for engineering applications.

SYLLABUS

Module	Hours
Module -I Introduction: Fundamental Concepts: Macroscopic versus microscopic point of view, definitions of system and surrounding, concept of control volume, thermodynamic state, processes and cycles, point function and path function, quasi-static process, concepts of simple compressible substances, dimensions and units, thermodynamic equilibrium; Temperature and Zeroth law; Concept of ideal gases and their equations of state; pure substance and phase, Thermodynamic properties and use of tables of thermodynamic properties; Thermodynamic definition of work, work done at the moving boundary of a system, other systems that involve work, Definition of heat, comparison of Heat and Work.	8
Module –II First Law of Thermodynamics: The first law referred to cyclic and non-cyclic processes, concept of internal energy of a system, conservation of energy for simple compressible closed systems; Definitions of enthalpy and specific heats; First law applied to a control volume, general energy equation; steady flow energy equation on unit mass and time basis, application of SFEE for devices such as boiler, turbine, heat exchangers, pumps, nozzles, etc.	8
Module – III Second Law of Thermodynamics: Limitations of the first law, concept of a heat engine, heat pump, refrigerator, statements of the second law, their equivalence, reversible heat engine, Carnot theorems and corollaries, Concept of reversibility; Internal and external irreversibility, Absolute thermodynamic temperature scale.	8
Module - IV Clausius Inequality, entropy, change in entropy in various thermodynamic processes, entropy balance for closed and open systems, Principle of increase-in-Entropy, entropy generation. Third law of thermodynamics, absolute entropy, available and unavailable energy, irreversibility. Exergy analysis of thermal power plant.	8
Module –V Air Standard Cycles: Carnot, Stirling, Ericsson, Otto, Diesel, Dual cycles	8

Text books:

1. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.
2. Yonus A Cengel and Michale A Boles, 2002, Thermodynamics: An Engineering Approach, McGraw Hill.

Reference books:

1. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India.
3. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals* ofThermodynamics, John Wiley and Sons.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	1	1	1	1	1	1	1	1	3	2	-
CO2	3	3	3	3	1	1	1	1	1			1	3	2	-
CO3	3	3	3	3	1	1	1	1	1			1	3	2	-
CO4	3	3	3	3	1	1	1	1	1	1	1	1	3	2	-
CO5	3	3	3	3	1	1	1	1	1			1	2	2	-

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods				
CD	Course Delivery methods		Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		-	-
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		CO1-5	CD 8
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: ME 203
Course title: Fluid Mechanics and Hydraulic Machines
Pre-requisite(s): NIL
Co- requisite(s): NIL

Credits: 4 **(**L:3, T:1, P:0)
Class schedule per week: 4
Class: B. Tech
Semester / Level: Third
Branch: Mechanical Engineering

Course Objectives:

This course enables the students to:

1	Get acquainted with the basic concepts and fundamental aspects of fluid dynamics.
2	Outlining the conservation laws of fluid flow.
3	Study and analyse different hydraulic turbines
4	Develop an understanding of different power consuming hydraulic devices and pumps.

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

CO1	Explain the various fluid properties applicable to fluid statics and dynamics.
CO2	Apply Basic fluid mechanics theorems to fluid flow problems.
CO3	Analyse various losses encountered in fluid flow devices, and able to explain the Boundary layer concept on separated and un separated flows.
CO4	Understand the working principles of various hydraulic turbines and able to apply them to evaluate their performances.
CO5	Understand the working of power absorbing devices like pumps and able to evaluate their performance characteristics.

SYLLABUS

Module	Hours
Module -I **Fluid statics:** Concept of continuum and physical properties of fluids, specific gravity, viscosity surface Tension, vapor pressure. Total pressure and center of pressure, Measurement of pressure- Piezometer, U-tube and differential tube manometers, mechanical gauges	8
Module –II **Fluid kinematics :** Eulerian and Lagrangian description of fluid flow, Stream line, path line and streak lines and stream tub. Classification of fluid flows-steady & unsteady, uniform, non-uniform, laminar, turbulent, rotational, and irrotational flows, equation of continuity. **Fluid dynamics** : Surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its applications.	8
Module – III **Closed conduit flow:** Reynold's experiment- Darcy Weisbach equation, Minor and major losses in pipes- pipes in series and pipes in parallel- total energy line-hydraulic gradient line. Measurement of flow, pitot-static tube, venturimeter, orifice meter. Concept of Boundary layer, separation of boundary layer and its control.	8
Module – IV **Hydraulic Turbines:** Hydrodynamic force of jets on stationary and moving vanes, velocity diagrams, work done and efficiency. Hydraulic Turbines: Classification of turbines, impulse and reaction turbines, working proportions, work done, efficiencies, draft tube theory and functions and efficiency. Performance of hydraulic turbines, geometric similarity, unit and specific quantities, governing of turbines, selection of type of turbine.	8
Module –V Centrifugal pumps : Classification, working, work done, manometric head, losses and efficiencies, specific speed, pumps in series and parallel, performance characteristic curves, NPSH, Model studies, Reciprocating pumps, working, discharge, slip, indicator diagrams.	8

Text books :

1. Hydraulics, fluid mechanics and Hydraulic machinery MODI and SETH.
2. Hydraulic Machines by Jagdishlal
3. Fluid Mechanics, Fundamentals and Applications (in SI Unit) by Yunus A. Cangel and John M. Cimbala, McGraw Hill.

Reference books :

1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, Kotaria& Sons.
2. Fluid Mechanics with Engineering Application by J.B. Franzini and Finnemore, McGraw Hill.
3. Fluid Mechanics by V. L. Streeter.

Online Resources

https://www.youtube.com/watch?v=fa0zHI6nLUo
https://www.youtube.com/watch?v=XGnGBo-FrlA
http://engineeringvideolectures.com/video/15763

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	1							2	3	2	-
CO2	3	3	3	2	2							2	3	2	-
CO3	3	3	3	2	2							2	3	2	-
CO4	3	3	3	2	2				2	1	1	2	3	2	-
CO5	3	2	2	2	2				2	1	1	2	2	2	-

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors	CO-1-5	CD1
CD2	Tutorials/Assignments	CO-1-5	CD2
CD3	Seminars	-	-
CD4	Mini projects/Projects	-	-
CD5	Laboratory experiments/teaching aids	-	-
CD6	Industrial/guest lectures	-	-
CD7	Industrial visits/in-plant training	-	-
CD8	Self- learning such as use of NPTEL materials and internets	CO-1-5	CD8

COURSE INFORMATION SHEET

Course code: ME 205
Course title: Strength of Materials
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 4 **(**L: 3, T:1, P:0)
Class schedule per week: 4
Class: B. Tech
Semester / Level: Third
Branch: Mechanical Engineering

This course enables the students to:

1	Understand the fundamental concepts of stresses and strains for different materials and the strength of structural elements.
2	Analyse and comprehend principal stresses due to the combination of two-dimensional stresses on an element.
3	Evaluate the nature of stresses developed in structural members subjected to transverse loading such as beams.
4	Calculate the elastic deformation and deflection occurring in various types of beams for different types of loading.
5	Evaluate the behaviour of torsional members, columns, thin and thick cylinders.

Course Outcomes:
After the completion of this course, students will be:

CO1	.Understand the concepts of stress, Mohr's circle of stress, strain transformation.
CO2	Apply the relationship of shear force, bending moment to solve problems related to beams.
CO3	Understand and Apply the concepts of double integration method, Macaulat's method, moment of area method to analyse the deflection of beams problem.
CO4	Analyse the shear centre method, shear flow diagram for their applications in various beam structures.
CO5	Apply the fundamental laws of strength of materials to analyse thick and thin cylinders for stresses.

SYLLABUS

Module	Hours
Module -I Stress at a point on a plane, Stress transformation equation, Principal stresses, Mohr's circle of stresses, Strain transformation equation, principal strain, strain rosette.	9
Module –II Types of Beam, Types of loading and support, Relationship between Shear force, Bending Moment and intensity of loading, SFD, BMD, Point of Contraflexure, second moment of area, parallel axes theorem, Bending stress and shear stress in beam.	9
Module – III Deflection of Beam, Double integration method, Macaulay's method, Moment area method, Buckling of column.Strain energy method, Castigliano's theorem, application of energy method on different types of beam and thin circular ring.	9
Module - IV Shear Centre: Theory of shear flow, shear flow diagrams and shear center for thin walled symmetrical sections. Bending of curved beams: Beams of small and large initial curvature, evaluation of circumferential stresses.	9
Module –V Thin and thick cylinders: Radial and circumferential stresses, stresses produced due to shrink fit. Rotating Disc: Stresses in disc of uniform thickness and uniform strength.	9

Text books:

1. Strength of Materials by E J Hearn.
2. Strength of Materials by S.S.Rattan.

Reference Books:

1. Mechanics of Materials by S. Timoshenko and James M. Gere.
2. Strength of Materials by Ryder.
3. Advanced Mechanics of Material by Seely& Smith

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	1	1		1	1		1			2	3	2	-
CO2	3	3	2	2		1	1		2			2	3	2	-
CO3	3	3	2	3		1	1		2			2	3	2	-
CO4	3	3	3	3		1	1		2	1		2	3	2	-
CO5	3	2	3	3	2	1	1	1	2		1	2	2	2	-

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		-	-
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		-	-
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: PE 213
Course title: Manufacturing Processes
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 **(**L:3 T:0 P:0)
Class schedule per week: 3
Class: B. Tech
Semester Third
Branch: Mechanical Engineering

Course Objectives:

This course enables the students to:

1	Examine the technical aspect related to basic manufacturing processes
2	Get acquainted with different methods of manufacturing used
3	Analyse different aspects of a manufacturing process along with their appropriate usage and scope
4	Derive relationship and use empirical relations to study the effects of manufacturing parameters on a process
5	Develop an understanding of existing and emerging manufacturing processes

Course Outcomes:

After the completion of this course, students will be able to:

CO1	Explain the basic principles behind different Casting, Welding, Forming and machining processes
CO2	Select appropriate manufacturing process for a given component design
CO3	Identify advantages and limitations of various casting, welding, machining and forming techniques
CO4	Correctly explain and construct mathematical relationships existing amongst various parameters in different manufacturing processes
CO5	Select appropriate welding process for a given joint

SYLLABUS

Module	Hours
Module -I: Casting Introduction to foundry process and its importance; sand casting: patterns, pattern allowances, gating system components introduction and significance. Centrifugal casting , Hot chamber and cold chamber die casting; Investment casting	8
Module –II: Theory of Metal Cutting Geometry of single point cutting tool, Introduction to orthogonal cutting; Tool forces in orthogonal cutting, types of chips, tool failure, tool life, cutting tool materials.	8
Module – III **Module 3: Machine Tools** Construction, operations and specifications of lathe and shaper. Construction, operations and specifications of milling & drilling machine. Introduction to grinding and types of grinding processes. .	8
Module - IV: Metal Deformation Processes Metal forming processes: Introduction to recovery, recrystallization and grain growth; Hot working and cold working Rolling: Classification of rolling processes, rolling mills, products of rolling and main variables Forging: Open and closed die forging, forging operations Extrusion: Classification of extrusion processes, hot and cold extrusion processes Sheet metal forming operations: Blanking and piercing, deep drawing, bending.	8
Module –V: Welding Principle, working and application of oxy- acetylene gas welding. Electric arc welding: MMAW/SMAW, SAW, GTAW and GMAW, Resistance welding. Soldering and Brazing	8

Text books:

1. SeropeKalpakjian and Steven Schmidt , Manufacturing Processes for Engineering Materials, Pearson Education, 6th Edition
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Material. Processes, and systems, 2nd Edition, Wiley India, 2007
3. P.N. Rao, Manufacturing Technology – Metal Cutting and Machine Tools, McGraw Hill.
4. P.N. Rao, Manufacturing Technology, Foundry, Forming and Welding, McGraw Hill
5. Hajra Choudhury, Elements of Workshop Technology–Vol.-II, Media Promoters and Publishers

Reference books:

1. E. P. DeGarmo, J. T. Black, and R. A. Kohser, Materials and processes in Manufacturing, PHI.
2. P. F. Ostwald, and Jairo Munoz, Manufacturing Processes and Systems, 9th ed., Wiley, India, 2002
3. Principles of metal casting, Rosenthal. P. C, Tata Mc Graw Hill
4. M. C. Shaw, Metal Cutting Principles, Oxford University Press, Oxford, 1984

Gaps in the syllabus (to meet Industry/Profession requirements):

Non-Conventional Machining Processes, Analysis of Manufacturing Processes

POs met through Gaps in the Syllabus:
PO1-5, PO12
Topics beyond syllabus/Advanced topics/Design:
Advanced Manufacturing Processes

POs met through Topics beyond syllabus/Advanced topics/Design:
PO1-5, PO12

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution				
Mid Semester Examination	25				
Quizzes	10 + 10				
Assignment	5				
End Semester Examination	**% Distribution**				
End Semester Examination	50				
Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Semester Examination	√	√			

Quiz1	√	√	√	√	
Quiz 2	√	√	√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (COs) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	2	3		1			1		1		3	3
CO2	3	3	3	2	3		1			1		1		3	3
CO3	3	3	2	2	3		1			1		1		3	3
CO4	3	3	3	2	3		1			1		1	3	3	3
CO5	3	3	3	2	3		1			1		1		3	3

< 34% = 1, 34-66% = 2, > 66% = 3

Mapping Between Course Outcomes (COs) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: PE 214
Course title: Metallurgical and Materials Engineering
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 (L: 3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: Third
Branch: Mechanical Engineering

Course Objectives:

This course enables the students to:

1	Examine the properties and structures of materials and get acquainted with metallographic principles and material characterization techniques.
2	Understand the thermodynamics of solids and invariant transformations involved in phase diagrams, comprehend the construction of iron carbon phase diagram and appreciate the effects of alloying elements in steel
3	Analyze the kinetics of phase transformation of steel, understand heat treatment operations associated with steels and introduced to concept of hardenability
4	Acknowledge important non-ferrous alloys, polymers and understand theirproperties, microstructure, and applications
5	Introduced to various material testing methods related to its mechanical andfunctional properties.

Course Outcomes:

After the completion of this course, students will be able to:

CO1.	Analyze and select various engineering materials for various purposes anddescribe the various material characterization techniques
CO2.	Explain the thermodynamics of solids, elucidate iron carbon diagram andidentify the effects of alloying elements on steel
CO3.	Describe the kinetics involved with steel transformation and understand theapplication of various heat treatment operations
CO4.	Identify the different types of non-ferrous alloys and explain its properties
CO5.	Apply and explain various methods of material testing procedures

SYLLABUS

Module	Hours
Module I: Introduction to Material Science and Metallurgy Definition, scope and classification of engineering solids; Properties of engineering solids and their applications; Structure of solids – crystalline and non-crystalline; Basics of crystallography – point/space lattice, unit cell, crystal system, crystal lattice, and crystal structure; Structure of elemental and compound crystal structures with examples; Crystallographic indexing of directions and planes, Influence of crystal structure on properties; Defects in crystalline solids – definition, classification and examples of dimension-wise crystal defects; Macroscopic symmetry elements; Influence of crystal defects on engineering properties; Solid solutions; Synthesis of solids by different routes – from vapour, melt or solids; Solidification of pure and alloyed systems; Evolution and concept of macrostructure – mono and polycrystalline aggregates; Principles of metallography – sample selection, preparation and examination; Optical or light microscopy; Interpretation of optical microstructure; Standard techniques of material characterization – structural examination; Standard techniques of material characterization – compositional analysis.	8
Module II: Phase Diagrams and Fe-C equilibrium Diagram Thermodynamics of solids: component, phase, thermodynamic system - single and multicomponent, specific heat, enthalpy, entropy, Free energy concept - Gibbs and Helmholz energy; Condensed and uncondensed systems; Gibbs phase rule and degree of freedom – examples and application; Phase equilibrium and phase transformations; Invariant and non-invariant phase changes; Binary phase diagrams – miscible, immiscible and partially miscible systems; Isomorphous system; Utility of phase diagram; Phase diagrams with invariant transformations involving a liquid phase– peritectic, eutectic, syntactic, monotectic and metatectic; Phase diagrams showing solid state phase invariant transformations; Interpretation of microstructural evolution in binary systems using phase diagrams – effect on properties; Iron-carbon and iron-cementite equilibrium diagram; Definition and microstructure of steel and cast iron; Important phase transformations in steel; Classification of plain carbon steel and cast iron, Properties and utility of steel and cast iron; Effect of alloying elements on steel; Alloy steel – main classes and application; Important non-ferrous alloys and applications – aluminium and copper based alloys; Distinction from steel and ferrous alloys; Strengthening mechanisms of ferrous and non-ferrous alloys	10
Module III: Transformation curve and Heat Treatment Methods Kinetics of phase transformation – mechanism of solute transport; Diffusion; Shear; Isothermal decomposition of austenite in steel (TTT diagram); Non-isothermal decomposition of austenite in steel (CCT diagram); Homogeneous and Heterogeneous Nucleation Mechanism and Growth – Thermodynamics and kinetics; Heat treatments of steel – annealing, normalizing, hardening and tempering; Special heat treatments of steel (TMT, Austempering, Martempering, etc.); Concept of hardenability of steel, Jominy hardenability test; Mechanism of hardening of steel; Cold working and hot working; Strain hardening; Annealing of cold worked alloys - recovery, recrystallization and grain growth; Surface hardening, case hardening and surface engineering of steel; Heat treatment furnaces – types, uses and special features, Ovens, Heating elements, Temperature controllers and principles; Quenching and quanchants – process, stages and equipment, Heat treatment defects – types, causes, effects, precaution and remedies, Inspection and control	10

Module IV: Types of Alloys and applications Types and application of plain and alloyed cast iron – grey, spheroidal graphitic, white and malleable cast iron; Heat treatment and microstructure; Important non-ferrous alloys – Al, Cu, Pb, Zn, Ti, Mg and Ni based alloys; Heat treatments, Important properties and applications; Composition, microstructure, properties and classification of various grades of stainless steel, maraging steel and superalloys, Heat treatments, Applications; Engineering ceramics – classification, fabrication, structure and properties; Important ceramics – refractory, glass, clay, cutting tools and functional ceramics; Engineering polymers: synthesis, structure and classification; Engineering properties; Applications	6
Module V: Material Testing methods Testing of mechanical properties I: Surface (hardness, friction) and bulk (under tension and compression) mechanical properties, Definition and types of wear, Classification of mechanical properties – definition and units; Testing of mechanical properties II: Fatigue, impact, creep – definition, types and significance, Various combinations of important mechanical properties and testing, Review of failures; Functional properties: Thermal conductivity, Electrical conductivity, Emission – photo and thermoelectric, Magnetism, Topography, Colour, Reflection, Surface energy, Wetting, Catalysis, Adhesion/cohesion; Corrosion and oxidation properties and testing, Types, Conditions, Laws, Thermodynamics and kinetics, Prevention; Case studies of engineering failures due to stress, wear, erosion, fatigue cycles, thermal cycles, corrosion, oxidation, creep, etc.	6

Text Books:

1. V. Raghvan, Material Science and Engineering, Prentice Hall India (T1)
2. William D. Callister Jr., Materials Science and Engineering, Wiley Publication (T2)
3. Y. Lakhtin, Physical Metallurgy (T3)
4. J. F. Shackelford – Introduction to Materials Science and Engineering – (T4)
5. R. E. Reedhill – Physical Metallurgy

Principles (T5)

Reference Books

1. George Dieter, Physical Metallurgy, McGraw Hill Education (R1)
2. B.D. Cullity, Elements of X Ray Diffraction, Pearson Education (R2)

Gaps in the syllabus (to meet Industry/Profession requirements):

Study of Advanced Materials, Nano Materials, Non-Destructive Testing methods

POs met through Gaps in the Syllabus:

PO 1-5

Topics beyond syllabus/Advanced topics/Design:

Electrical, Optical, Thermal, Magnetic and Electrical properties of materials. Composites, Degradation of Materials, Environmental and Societal Considerations in Material Science. Powder Metallurgy, Plastic Technology.

POs met through Topics beyond syllabus/Advanced topics/Design:

PO 1-5, 11-12

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and ProgramSpecific Outcomes (PSOs):

COs	**POs**												**PSOs**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	3			2		3	1		3	3	3	3
CO2	3	3	3	3	1	2	2			2		3	3	2	3
CO3	3	3	2	3	1	1	1		2			3	3	2	3
CO4	3	3	2	3	2	3	3	1	2		2	2	2	3	3
CO5	3	3	2	3	3	1			2	2		2	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course code:	MA 204
Course title:	Numerical Methods Lab.
Pre-quisite(s):	NIL
Co- requisite(s):	NIL
Credits:	1 (L: 0, T:0, P:2)
Class schedule per week:	2
Class:	B. Tech
Semester / Level:	Third
Branch:	Mechanical Engineering

List of experiments:

1. ASSIGNMENT – 1

Objective: Find a simple root of f (x) = 0 using bisection method. Read the end points of the interval (a, b) in which the root lies, maximum number of iterations n and error tolerance eps.

2. ASSIGNMENT – 2

Objective: Find a simple root of f (x) = 0 using Regula-Falsi method. Read the end points of the interval (a,b) in which the root lies, maximum number of iterations n and error tolerance eps.

3. ASSIGNMENT – 3

Objective: Find a simple root of f (x) = 0 using Newton Raphson method. Read any initial approximation x0, maximum number of iterations n and error tolerance eps.

4. ASSIGNMENT – 4

Objective: Solution of a system of n x n linear equations using Gauss elimination method with partial pivoting. The program is for 10 x 10 system or higher order system.

5. ASSIGNMENT – 5

Objective: Matrix inversion and solution of n x n system of equations using Gauss-Jordan method. If the system of equations is larger than 15 x 15 change the dimensions of the float statement.

6. ASSIGNMENT – 6

Objective: Program to solve a system of equation using Gauss-Seidel iteration method. Order of the matrix is n, maximum number of iterations niter, error tolerance is eps and the initial approximation to the solution vector is x0. If the system of equations is larger than 10 x 10 change the dimension in float.

7. ASSIGNMENT – 7

Objective: Program to find the largest Eigen value in magnitude and the corresponding Eigen vector of a square matrix A of order n using power method.

8. ASSIGNMENT – 8

Objective: Program for Lagrange interpolation.

9. ASSIGNMENT – 9

Objective: Program for Newton divided difference interpolation

10. ASSIGNMENT – 10
Objective: Program for Newton's forward and backward interpolation

11. ASSIGNMENT – 11 Objective: Program for Gauss's central difference interpolation (both backward and forward).

12. ASSIGNMENT – 12
Objective: Program to evaluate the integral of f(x) between the limits a tob using Trapezoidal rule of integration based on n subintervals or n + 1 nodal points. The values of a, b and n are to be read. The program is tested for f(x) = 1/ (1 + x).

13. ASSIGNMENT – 13
Objective: Program to evaluate the integral of f(x) between the limits a tob using Simpson's rule of integration based on 2n subintervals or 2n + 1 nodal points and the integrand is written as a function subprogram. The values of a, b and n are to be read. The program is tested for f(x) = 1/ (1 + x).

14. ASSIGNMENT – 14
Objective: Program to solve an IVP, dy/dx = f(x), y(x0) = y0 using Euler method. The initial value x0, y0, the final value xf and the step size h are to be read. The program is tested for f(x,y) = -2xy2 .

15. ASSIGNMENT – 15
Objective: Program to solve an IVP, dy/dx = f(x), y(x0) = y0 using classical Runge-Kutta fourth order method with step size h, h/2 and computes the estimate of the truncation error. Input parameters are: initial point, initial value, number of intervals and the step length h. Solutions with h, h/2 and the estimate of the truncation error are available as output. The right hand side The program is tested for $f(x,y) = -2xy^2$.

Text books:

1. Jain M.K, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age Publications, 2004.
2. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI.
3. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Reference books:

1. S.C. Chapra and R. P. Canale, Numerical Methods for Engineers, McGraw Hill, 1985.
2. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, Seventh Edition, 2003.
3. R. W. Hamming: Numerical Methods for Scientists and Engineers, Second Edition, Dover.

COURSE INFORMATION SHEET

Course code: ME 202
Course title: Fluid Mechanics and Hydraulic Machines lab
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 1.5 (L:0, T:0, P:3)
Class schedule per week: 3
Class: B. Tech
Semester / Level: Third
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

1	To make student familiar with various fluid mechanics systems and machines
2	To make the student confident how to perform experiments related to fluid mechanics systems and machines
3	To explain the standard measurement techniques of fluid mechanics and their applications.
4	To identify importance of various experimental errors
5	To study performance of various fluid mechanics systems and machines under different operating conditions
6	To analyze the experimental data obtained from various fluid mechanics systems and machines to conclude the results in meaningful way.

Course Outcomes

After the completion of this course, students will be:

1	Able to apply the knowledge to perform the experiments on various fluid(static and dynamics) devices
2	Able to compare the experimental results of various fluid(static and dynamics) devices with the with the theoretical results
3	Able to analyse the better procedure to perform the experiments on various fluid(static and dynamics) devices for least sources of errors
4	Able to evaluate the performance curves of various hydro turbines and Compare the results with the theoretical results.
5	Able to evaluate performance and to decide suitable fluid flow devices, pumps and turbines for different working conditions.

List of experiments:

1. To determine the surface profile of liquid under free and forced vortex conditions.
2. To determine the centre of pressure of a plane surface under partial and submerged conditions.
3. To calibrate a Triangular notch.
4. To determine the coefficient of discharge through mouth pieces (convergent and divergent).
5. To determine the friction factor f for the turbulent flow through the commercial pipes of various sizes.

6. To study the effect of liquid jet impact on hemispherical and flat plate vanes.
7. To draw the characteristic curves of a Francis turbine.
8. To draw the characteristic curves of a Pelton turbine.
9. To draw the characteristic curves of a Modern Francis turbine (Mixed flow type).
10. To draw the characteristic curves of a multistage centrifugal pump.
11. To draw the characteristic curves of a reciprocating pump.
12. To draw the characteristic curves of a jet pump.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive evaluation	60
End Sem Lab Examination Marks	40

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	1	2		2	3				3	2	1	2	3	2	-
CO2	3	3	3	2	3				3	2	1	2	3	2	-
CO3	3	3	3	2	3				3	2	1	2	3	2	-
CO4	3	3	3	3	3				3	2	1	2	3	2	-
CO5	3	3	3	3	3				3	2	1	2	2	2	-

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

COURSE INFORMATION SHEET

Course code: ME 204
Course title: Mechanical Engineering Lab –I
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 1.5 **(**L: 0, T:0, P:3)
Class schedule per week: 3
Class: B. Tech
Semester / Level: Third
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

1	To make student familiar with modern and conventional tools for material testing.
2	To present real world engineering examples of solid mechanics.

Course Outcomes

After the completion of this course, students will be:

1.	Examine the hardness of materials (Hard steel and mild steel).
2.	Evaluate the tensile and impact strength of materials.
3.	Validate truss analysis for redundant truss and statically indeterminate trusses results experimentally.
4.	Analysis of rods.
5.	Compare the properties of two different lifting machines (Self-locking system)

List of experiments:

Group 1

1. To determine Brinell hardness number of mild steel
2. To determine Rockwell hardness number (HRC Scale) of hard steel.

Group 2

3. To determine the tensile strength of mild steel
4. To determine the impact strength of hard steel using conventional method.
5. To determine impact strength of mild steel using computer aided system.

Group 3

6. To determine forces in members of statically determinant truss
7. To determine forces in members of statically indeterminant truss
8. To determine the property of proving ring

Group 4

9. To determine shear force in a simply supported beam
10. To determine bending moment in simply supported beam
11. To determine the modulus of rigidity of a shaft using Torsion test

Group 5

12. To determine the properties of Screw Jack
13. To determine the properties of Worm and Worm Wheel

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive evaluation	60
End Semester Lab Examination Marks	40

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	1	1	1	3	3			3	3	3			3	2	-
CO2	1	3	2	3	3			3	3	3			3	2	-
CO3	3	3	3	3	3			3	3	3			3	2	-
CO4	3	3	3	3	3			3	3	3			3	2	-
CO5	3	3	3	3	1			3	3	3			2	2	-

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

4th SEMESTER

COURSE INFORMATION SHEET

Course code: MT 131
Course title: Universal Human Value2**:** Understanding Harmony
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 (L: 3, T: 0, P: 0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: Fourth
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions imparting the students to:

1	Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
2	Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3	Strengthening of self-reflection.
4	Development of commitment and courage to act.

SYLLABUS

Module	Hours
Module I: Course Introduction - Basic Guidelines, Content and Process for Value Education I. Purpose and motivation for the course, recapitulation from Universal Human Values-1. 2.Self-Exploration-what is it? Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. 3.Continuous Happiness and Prosperity- A look at basic Human Aspirations. 4.Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority. 5.Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario 6.Method to fulfill the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.	8
Module II: Understanding Harmony in the Human Being - Harmony in Myself 1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. 2.Understanding the needs of Self('I') and 'Body' - happiness and physical facility. 3.Understanding the Body as an instrument of' I' (I being the doer, seer and enjoyer).	8

4.Understanding the characteristics and activities of 'I' and ham1ony in 'I'. 5.Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. 6.Programs to ensure Sanyam and Health. Include practice sessions to discuss the role others have played 111 making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.	
Module III: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship 1.Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Respect as the foundational values of relationship 2.Understanding the meaning of Trust; Difference between intention and competence 3.Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship 4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals 5.Visualizing a universal harmonious order in society- Undivided Society, Universal Order from family to world family. Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.	8
Module IV: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence. 1.Understanding the harmony in the Nature 2.interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature. 3.Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. 4.Holistic perception of harmony at all levels of existence. 5.Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.	8
Module V: Implications of the above Holistic Understanding of Harmony on Professional Ethics 1.Natural acceptance of human values 2.Definitiveness of Ethical Human Conduct 3.Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order 4.Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. 5.Case studies of typical holistic technologies, management models and production systems 6.Strategy for transition from the present state to Universal Human Order: a)At the level of individual: as_ socially and ecologically responsible engineers, technologists and managers b)At the level of society: as mutually enriching institutions and organizations	8

7.Sum up. Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. to discuss the conduct as an engineer or scientist etc.	

Text Book:

I. Human Values and Professional Ethics by RR Gaur, R Sangal, GP Bagaria, Excel Books, New Delhi, 2010.

COURSE INFORMATION SHEET

Course code: ME 207
Course title: Kinematics and Dynamics of Machines
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 (L: 3, T: 0, P: 0)
Class schedule per week: 03
Class: B. Tech
Semester / Level: Fourth
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions imparting the students to:

1.	To understand basic principles of kinematic chains, Degree of freedom.
2.	To analyze velocity and acceleration of planar mechanisms, balancing in rotary and reciprocating machinery, forces and moments acting in planar mechanism
3.	To evaluate and design contact ratio, tooth profile and related parameters of gears.
4.	To design cam profiles for specified motion of follower, Flywheel and governor.
5.	To understand conservation of angular momentum and gyroscopic couple.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate various principles related to kinematics of planar mechanisms
CO2	Design planar mechanisms for relevant applications
CO3	Evaluate dimensions and kinematic parameters related to gear systems
CO4	Design cam profiles
CO5	Evaluate gyroscopic couple and precessional velocity of a gyroscopic system.

SYLLABUS

ME-207 Kinematics and Dynamics of Machines

Module	Lectures/hour
Module -I Planar mechanisms and kinematic analysis: Mechanisms and machines, Kinematic pairs, Kinematic chains, Kinematic inversions, Mobility and range of movement, Velocity and acceleration analysis (graphical and analytical), Coriolis' component of acceleration, Instantaneous center of zero velocity, Aronhold-Kennedy theorem of three centers.	8
Module –II Force analysis of planar mechanism and principles of flywheel and Governor: D'Alembert's principle and dynamic equilibrium, Dynamic force analysis (analytical method), Dynamically equivalent link, turning moment on crank shaft, Turning moment	8

diagram, fluctuation of energy and speed, flywheel, Principles of centrifugal governors: Porter, Proell and Hartnell governor.	
Module – III Balancing: Balancing of reciprocating and rotating masses, two plane balancing, Balancing of inline, V tween, and radial engines.	8
Module - IV Gear and Cam: Basic terminology of a spur gear, Types of gears, Fundamental law of gearing, contact ratio, Interference and undercutting, Gear trains, Basic terminology of cam, Displacement diagram, Velocity and acceleration of follower, Graphical determination of cam profiles.	8
Module –V Gyroscope: Euler's equation of motion, Euler's modified equation of motion, Steady state, Stability of spinning top, ship, two wheeled and four wheeled vehicles.	8

Textbooks:

1. A. Ghosh and A. K. Mallik, Theory of Mechanisms and Machines, Affiliated East-West Press Privet Limited, Third edition.
2. Thomas Bevan, The theory of Machines, CBS Publishers and Distributers Privet Limited, Third edition.
3. R. L. Norton, Kinematics and Dynamics of Machinery, McGraw Hill Education.

Reference Books:

1. John J. Uicker, Gordon R. Pennockand, Joseph E. Shigley Theory Of Machine And Mechanisms, Oxford University Press; 4th edition.
2. J. L. Meriam and L. G. Kraige, Engineering Mechanics: Dynamics, John Wiley and Sons Inc. Seventh edition.
3. S. S. Rattan, Theory of Machines, Tata McGraw Hill education, Third Edition.

Gaps in the Syllabus (to meet Industry/Profession requirements)

1. Detailed force analysis of gear and cam.

POs met through Gaps in the Syllabus: PO1, PO2, PO3, PO4 and PO5

Topics beyond syllabus/Advanced topics/Design

1. Balancing of locomotives.

POs met through Topics beyond syllabus/Advanced topics/Design: PO1, PO2, PO3, PO4 and PO5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment

1. Student Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	3	1	1	1	2	1	1	1	2	2	2
CO2	3	3	3	3	3	1	1	1	1			1	3	3	2
CO3	3	3	3	3	3	1	1	1	1			1	3	3	2
CO4	3	3	3	3	3	1	1	1	1	1	1	1	3	3	2
CO5	3	3	3	3	3	1	1	1	2		1	1	2	1	2

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	**Course Delivery Methods**	**Course Outcome**	**Course Delivery Method Used**
CD1	Lecture by use of Boards/LCD Projectors	CO1-5	CD1
CD2	Tutorials/Assignments	CO1-5	CD2
CD3	Seminars	CO1-5	CD3
CD4	Mini Projects/Projects	-	-
CD5	Laboratory Experiments/Teaching Aids	-	-
CD6	Industrial/Guest Lectures	-	-
CD7	Industrial Visits/In-plant Training	-	-
CD8	Self- learning such as use of NPTEL Materials and Internets	CO1-5	CD4
CD9	Simulation	-	-

COURSE INFORMATION SHEET

Course code: ME 209
Course title: Energy Conversion Systems
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 (L: 3, T: 0, P: 0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: Fourth
Branch: Mechanical Engineering

Course Objectives

This course envisions imparting the students to:

1	Provide basic knowledge of steam power cycle and different methods to improve the efficiency of the plant.
2	Develop comprehensive knowledge on boiler heat balance, steam turbine and condenser operation principles and to prepare the students to effectively use energy conversion theory in the practice of engineering.
3	Develop an intuitive understanding of energy conversion devices by emphasizing the scientific and engineering arguments.
4	Present a wealth of real-world engineering examples to give students a feel for how energy conversion principle is applied in engineering practice.
5	Classify, solve, and correlate Energy Conversion Systems problems.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand the basic working principle of vapor power system.
CO2	Understand the combustion and energy equations to study the performance of boiler.
CO3	Apply the energy equation to evaluate the performance of nozzle.
CO4	Analyze impulse and reaction turbo machines for energy transfer.
CO5	Evaluate the performance of condenser.

SYLLABUS

Module	Lectures/hour
Module -I **Vapour Power Cycle:** Components of steam power system; Carnot vapour cycle and Rankine cycle; their comparisons; P-v, T-s & h-s diagrams; Deviation of actual vapour power cycle from ideal cycle; mean temperature of heat addition; Reheat cycle; Ideal regenerative cycle; feed water heaters	8
Module –II **Fuels and Combustions:** Classification of fuels; basic chemistry and combustion equations; conversion of volumetric to weight analysis and vise-versa; theoretical and excess air; Boiler performance: Equivalent evaporation; Boiler efficiency; Heat balance; Boiler Draught and its classification; Chimney height, maximum discharge and efficiency.	8
Module – III **Steam Nozzles:** Introduction; types of steam nozzles; nozzle efficiency; velocity of steam flow through the nozzle; discharge and condition of maximum discharge through a nozzle; physical significance of critical pressure ratio and choked flow; Supersaturated flow through nozzle; General relationship between area, velocity and pressure in nozzle flow.	8
Module - IV **Steam Turbines:** Classifications; compounding of turbines; working principle, velocity diagrams, diagram work and efficiency of impulse and reaction turbine; degree of reaction, Parsons turbine, condition for maximum efficiency impulse and reaction turbine; Losses in steam turbines, reheat factor and condition line; governing of steam turbine; Back-pressure and pass-out Turbine.	8
Module –V **Steam condensers:** Classification of condensers; sources of air leakage into the condenser; effects of air leakage in condenser; vacuum efficiency; condenser efficiency; cooling water calculations; Air ejector.	8

Textbooks:

1. Steam and Gas Turbines – R. Yadav, Central Publishing House

2. Elements of Heat Engine – Pandey & Saha

3. Thermal Engineering – R. K. Rajput

4. Power Plant Engineering – P.K. Nag; Tata McGraw-Hill publication

Reference Books:

1. Power Plant Technology- M.M.Ei. -Wakil, McGraw Hill

2. Theory and Practice of Heat Engine – D. A. Rangham; Camb. Univ. Press.

Gaps in the Syllabus (to meet Industry/Profession requirements)

1. Detailed analysis of combined power cycle.
2. Renewable energy conversion principles.
3. Major emissions and control.
4. Economics of energy conversion system.

POs met through Gaps in the Syllabus: 1, 2, 3, 4, 5

Topics beyond syllabus/Advanced topics/Design

1. Design of different energy conversion systems like nuclear reactors, turbines, and renewable energy devices.

POs met through Topics beyond syllabus/Advanced topics/Design: 1, 2, 3, 4, 5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	3	2	1	1	1		1			2	3	2	1
CO2	3	2	3	2	1	1	1		1			3	3	2	1
CO3	3	2	3	2	1	1	1		1			2	3	2	1
CO4	3	2	3	2	1	1	1		1			2	3	2	1
CO5	3	2	3	2	1	1	1		1			2	3	2	1

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	**Course Delivery Methods**	**Course Outcome**	**Course Delivery Method Used**
CD1	Lecture by use of Boards/LCD Projectors	CO1-5	CD1
CD2	Tutorials/Assignments	CO1-5	CD2
CD3	Seminars	-	-
CD4	Mini Projects/Projects	-	-
CD5	Laboratory Experiments/Teaching Aids	-	-
CD6	Industrial/Guest Lectures	-	-
CD7	Industrial Visits/In-plant Training	-	-
CD8	Self- learning such as use of NPTEL Materials and Internets	-	-
CD9	Simulation	-	-

COURSE INFORMATION SHEET

Course code: ME 211
Course title: Machine Design
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 **(**L:3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: Fourth
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions imparting the students to:

1	To apply the concepts of stress analysis, theories of failure to select appropriate material and design machine components.
2	To design the variety of mechanical components.
3	To apply mechanical engineering theories for static and dynamic loading in design of mechanical components.
4	Judge, solve and correlate various parameters required for the performance of machine design at industry level.
5	Classify, solve, and correlate machine design problems.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate strong understanding on theories of failure materials due to static and dynamic loads.
CO2	Analyze various types of mechanical joints, power drives, bearings, and springs.
CO3	Evaluate stresses acting in various mechanical components.
CO4	Apply the appropriate types of power drives for designing mechanical systems.
CO5	Reviewing the concepts and modify the existing mechanical component in machine.

SYLLABUS

Module	Lectures/hour
Module I **Failure of materials:** Principles of Machine Design, standardization, Tolerances, Design against static and fluctuating loads, Theories of failures, Design of cotter joint and knuckle joint, Fatigue failure, Endurance limit, Notch Sensitivity, Gerber, Soderberg, Goodman, and Modified Goodman criteria, Design against combined loads.	8
Module –II **Design of threaded, welded, and riveted joints:** Threaded joints: Basic types of screw fastening, Bolt of uniform strength, Terminology of screw threads, Bolt under tension, Welded joints: Butt joints, Fillet joints, Strength of butt and fillet welds. Riveted joints: Types of rivet heads, types of rivet joints, Strength equations, Efficiency of joint, Caulking and fullering, Eccentrically loaded bolted, riveted and welded joints	8
Module – III **Design of brakes and clutches:** Types of Brakes and Clutches, Clutch/Brake selection and specification, Clutch and Brake materials, Disc Clutches, Shoe, Band and Disk Brakes.	8
Module - IV **Design of springs and bearing:** Spring configuration, Spring materials, Design of helical compression/extension springs. Bearings, Types of sliding contact bearings, bearing materials, lubricating oils, Petroff's equation, McKee's Investigation, Hydrostatic bearing, Rolling contact bearings.	8
Module –V **Design of Gears:** Types of gear, Terminology of gear, standard systems of gear tooth, Force analysis of spur, helical, bevel, and worm gears, Beam and wear strength of gears, Lewis and Buckingham's equation, Effective load on spur gear tooth.	8

Textbooks

1. Mechanical Engineering Design by J.E. Shigley, C.R. Mischke & R.G. Budynas, McGraw Hill.
2. Machine elements in Mechanical Design by R.L. Mott, Prentice Hall.
3. Introduction to Machine Design by V. B. Bhandari

Reference Books:

1. Machine Design, An Integrated Approach by Robert L. Norton, Second Edition.
2. Machine Design Data Handbook by K. Lingaiah
3. Mechanical Design of Machine Components by Ansel C. Ugural.
4. Mechanical Design by P. Childs, Elsevier.

Gaps in the syllabus (to meet Industry/Profession requirements)
Design of pressure vessels

POs met through Gaps in the Syllabus: 2,3,4,7,11

Topics beyond syllabus/Advanced topics/Design
Optimization techniques and statistical approach in machine design

POs met through Topics beyond syllabus/Advanced topics/Design: 2,3,5,7,9,11,12

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	1	1	1	1	1	1		1	1	2	2	2
CO2	3	3	2	2	1	1	1	1	1		1	1	2	2	2
CO3	3	3	3	3	1	1	1	1	1		1	1	2	2	2
CO4	3	3	2	2	1	1	1	1	1		2	1	2	2	2
CO5	3	3	3	3	1	1	1	1	1		3	1	2	2	2

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2 & CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD8, & CD9
CD3	Seminars	CO3	CD1, CD2, CD8, & CD9
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD8, & CD9
CD5	Laboratory Experiments/Teaching Aids	CO5	CD9 & CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: EE 102
Course title: Electrical Engineering Lab.
Pre-requisite: Physics, Fundamentals of Mathematics and Electrical Engineering
Co-requisite: NIL
Credits: 1.5 (L: 0, T: 0, P: 3)
Class schedule per week: 3
Class: B. Tech
Semester / Level: Fourth
Branch: Mechanical Engineering

Course Overview: Concepts of measuring instruments, AC RLC series parallel circuit operation, resonance, KVL and KCL, circuit theorems, 3-phase star and delta connections, measurement of low and high resistance of D.C. machine, measurement of power by three voltmeter, three-ammeter methods, measurement of power of 3-phase induction motor by two- wattmeter method.

Course Objectives
This course enables the students:

1	To describe students' practical knowledge of active and passive elements and operating on Measuring instruments
2	Todemonstrateelectricalcircuitfundamentalsandtheirequivalentcircuitmodelsforboth 1-φand3- φ circuits and use circuit theorems
3	To establish voltage & current relationships with the help of phasors and correlate them to Experimental results
4	1. Toconcludeperformanceof1–ΦACseriescircuitsby resonance phenomena 2. Toevaluatedifferentpowermeasurementforboth1-φand3-φcircuits

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

CO1	Classifyactiveandpassiveelements,explainworkinganduseofelectricalcomponents, Different types of measuring instruments;
CO2	IllustratefundamentalsofoperationofDCcircuits,1-φand3-φcircuitsandcorrelatetheprinciplesofDC,AC1-φand3-φcircuitstorotatingmachineslikeInductionmotorandD.Cmachine.;
CO3	Measure voltage, current, power, for DC and AC circuits and also represent them in Phasor notations;
CO4	Analyse response of a circuit and calculate unknown circuit parameters;
CO5	Recommend and justify power factor improvement method to save electrical energy.

List of Experiments:

1. Name: Measurement of low & high resistance of DC shunt motor

Aim:
(i) To measure low resistance of armature winding of DC shunt motor
(ii) To measure high resistance of shunt field winding of DC shunt motor

2. Name: AC series circuit

Aim:
(i) To obtain current & voltage distribution in AC RLC series circuit and to draw phasor diagram
(ii) To obtain power & power factor of single-phase load using 3- Voltmeter method and to draw phasor diagram

3. Name: AC parallel circuit

Aim:
(i) To obtain current & voltage distribution in AC RLC parallel circuit and to draw phasor diagram
(ii) To obtain power & power factor of single-phase load using 3- Ammeter method and to draw phasor diagram

4. Name: Resonance in AC RLC series circuit

Aim:
(i) To obtain the condition of resonance in AC RLC series circuit
(ii) To draw phasor diagram

5. Name: 3 phase Star connection

Aim:
(i) To establish the relation between line & phase quantity in 3 phase star connection
(ii) To draw the phasor diagram

6. Name: 3 phase Delta connection

Aim:
(i) To establish the relation between line & phase quantity in 3 phase delta connection
(ii) To draw phasor diagram

7. Name: 3 phase power measurement

Aim:
(i) To measure the power input to a 3-phase induction motor using 2 wattmeter method
(ii) To draw phasor diagram

8. Name: Self & mutual inductance

Aim:

To determine self & mutual inductance of coils

9. Name: Verification of Superposition, The venin's and Reciprocity theorem

Aim:
(i) To verify Superposition theorem for a given circuit
(ii) To verify The venin's theorem for a given circuit

10. Name: Verification of Norton's, Tellegen's and Maximum Power transfer theorem

Aim:
(i) To verify Norton's theorem for a given circuit
(ii) To verify Maximum Power transfer theorem for a given circuit

Gaps in the syllabus(to meet Industry/Professional requirements)

1. Application of principles of magnetic circuits to electrical machines like transformers, generators, and motors
2. Visualize Phase sequence

POsmetthroughGapsintheSyllabus:1,2,3,7.

Topics beyond syllabus/Advanced topics/Design

1. Assignment: Simulation of electrical circuits with dependent/independent sources by varioustechniques(Meshcurrent/NodeVoltage/Thevenin'stheorem/Norton'stheorem/Maximumpowertransfertheoremetc.)using MATLAB/PSIM/C++softwares
2. Active/reactive power calculation for 3–Φcircuits

POsmetthroughTopicsbeyondsyllabus/Advancedtopics/Design:5,6,7,8,9.

Mapping of with Course Outcomes

Experiment	CourseOutcomes				
	CO1	CO2	CO3	CO4	CO5
1	3	3	3	2	
2	3	3	3	3	2
3	3	3	3	3	2
4	3	3	3	3	2
5	3	3	3	1	
6	3	3	3	1	
7	3	3	3	2	2
8	3	3	3	3	
9	3	3	3	2	
10	3	3	3	2	

Course Delivery Methods	
CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Mini projects/Projects
CD4	Laboratory experiments/teaching aids
CD5	Self-learning such as use of NPTEL materials and internets
CD6	Simulation

Course Evaluation:

Daily individual assessment through viva:	20	
Regular evaluation of fair and rough copy:	15+5=20	
Progressive evaluation(60)		
Regularity/Punctuality:	10	
Assignment:	10	
Practical examinations:	20	
End sem Viva-voce :	20	End evaluation(40)
TOTAL:	**100**	

Mapping of Course Outcomes onto Course Objectives

Course Outcome#	Course Objectives			
	CO1	CO2	CO3	CO4
1	3	3	3	3
2	3	3	3	3
3	3	3	3	3
4	3	3	3	3
5	2	3	3	3

Mapping of Course Outcomes onto Program Outcomes

Course-Outcome#	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	3	3	3	3	L	3	3	3	3	3	3
2	3	3	3	2	2	2	2	3	3	3	3	3
3	3	3	3	2	2	2	2	2	3	3	2	3
4	3	3	3	3	3	1	2	2	3	3	2	2
5	3	3	3	3	3	2	3	3	3	3	3	3

Mapping of Course Outcomes onto Program Educational Objectives

Course Outcome #	Program Educational Objectives			
	1	2	3	4
1	3	3	2	2
2	3	3	3	
3	3	3	3	2
4	3	3	3	
5	3	3	2	2

Mapping Between COs and Course Delivery (CD) methods

Course Outcome	**Course Delivery Method**
CO1	CD1, CD2, CD4,CD5
CO2	CD1, CD4, CD5
CO3	CD1, CD3, CD4, CD5, CD6
CO4	CD1, CD2, CD4,CD5
CO5	CD4,CD5

Course Delivery(CD) methods		Program Outcomes(PO)											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CD1	Lecture by use of boards/LCD projectors	2	1	1	2	3	1						
CD2	Tutorials/ Assignments	2	2	2	2	3	3			3	3	1	2
CD3	Seminars												
CD4	Mini projects/Projects												
CD5	Laboratory experiments/teaching aids	3	3	3	3	3	1		2	3	2	2	3
CD6	Industrial/guest lectures												
CD7	Industrial visits/in-plant training												
CD8	Self-learning such as use of NPTEL materials and internets	3	3	3	3	3	3	2	3	2	3	2	2
CD9	Simulation	3	3	3		3	3			2	2		

COURSE INFORMATION SHEET

Course code: ME 208
Course title: Dynamics of Machines Lab
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 2 **(**L: 0, T:0, P: 4)
Class schedule per week: 4
Class: B. Tech
Semester / Level: Fourth
Branch: Mechanical Engineering

Course Objectives

This course enables the students to:

1	Understand the graphical representation of velocity and acceleration of different mechanism.
2	Familiarize the working principle and application of governor.
3	Acquire knowledge on dynamic balancing of reciprocating masses and wheel
4	Analyze the cam follower mechanism
5	Verify and determine gyroscopic couple

Course Outcomes

After the completion of this course, students will be able to:

CO1	Draw and analyze the velocity and acceleration diagram of different mechanism.
CO2	Analyze the characteristic curve of Hartnell governor.
CO3	Understand dynamic balancing of reciprocating masses.
CO4	Demonstrate the balancing of wheel.
CO5	Analyze the cam follower mechanism and gyroscope.

LIST OF EXPERIMENTS

Experiment no. 1: Slider Crank Mechanism
Objective: Analyse velocity and acceleration of a Slider Crank Mechanism using graphical method and computer programming.

Experiment no. 2: Whitworth Quick-Return Mechanism
Objective: Analyse velocity and acceleration of a Whitworth Quick-Return Mechanism using graphical method.

Experiment no. 3: Coriolis component of acceleration
Objective: Determine the Coriolis component of acceleration of the slider in a Crank and Slotted-Lever Mechanism.

Experiment no. 4: Instantaneous centers
Objective: Locate the instantaneous centres of a Whitworth Quick-Return and Crank and Slotted-Lever Mechanism.

Experiment no. 5: Hartnell Governor
Objective: To determine the position of the sleeve against the controlling force and the speed of a Hartnell Governor and plot the characteristics curve of theHartnell Governor.

Experiment no. 6: Balancing
*Objectiv*e: Balancing of reciprocating masses (Demo experiment).

Experiment no. 7: Wheel balancing

Objective: Balancing of wheel (Demo experiment).

Experiment no. 8: Cam profile

Objective: Draw the cam profile for the cycloidal motion of follower.

Experiment no. 9: Cam follower mechanism
Objective: To construct displacement diagram for cam follower mechanism and to determine jump speed against different inertia of the follower.

Experiment no. 10: Gyroscope
Objective: To study the gyroscopic couple due to simultaneous spin andprecession of a disc.

Reference Books

1. Theory of mechanisms and machines by A. Ghosh and A.K. Mallik, East West Press.
2. Theory of Machines by S.S.Rattan, TMH Pvt. Ltd.

Gaps in the syllabus (to meet Industry/Profession requirements)

No experiment on gear drives

POs met through Gaps in the Syllabus

PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design

Not Applicable

POs met through Topics beyond syllabus/Advanced topics/Design

PO1 TO PO5

CD #	Course Delivery Methods
CD1	Lecture by use of Boards/LCD Projectors
CD2	Tutorials/Assignments
CD3	Seminars

CD4	Mini Projects/Projects
CD5	Laboratory Experiments/Teaching Aids
CD6	Industrial/Guest Lectures
CD7	Industrial Visits/In-plant Training
CD8	Self- learning such as use of NPTEL Materials and Internets
CD9	Simulation

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation Marks	**60**
Attendance Marks	12
Lab Viva marks	24
Lab file Marks	12
Day-to-day performance Marks	12
End Semester Examination Marks	**40**
Lab quiz Marks	20
Lab performance Marks	20

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	1	1		1			1			1	3	1	3
CO2	3	2	2	2		1			2			2	3	3	3
CO3	3	3	2	2		1			2			2	3	3	3
CO4	3	3	3	3	2	3	1	1	2	1	1	2	3	3	3
CO5	3	3	3	3	2	3	1	1	2	1	1	2	2	1	2

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD #	**Course Delivery Methods**	**Course Outcome**	**Course Delivery Method Used**
CD1	Lecture by use of Boards/LCD Projectors		
CD2	Tutorials/Assignments		
CD3	Seminars		
CD4	Mini Projects/Projects		
CD5	Laboratory Experiments/Teaching Aids	CO1, CO2, CO3, CO4	CD5
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation	CO1, CO2, CO3, CO4	CD9

COURSE INFORMATION SHEET

Course code: PE 226
Course title: Manufacturing Processes Lab
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 1.5 (L:0, T:0, P: 3)
Class schedule per week: 3
Class: B.Tech.
Semester / Level: 4
Branch: Mechanical Engineering

Name of Teacher:

Course Objectives:
This course enables the students to:

1	Examine different patterns used in sand casting.
2	Get familiar with sand testing methods.
3	Get hands-on experience of various welding processes and select the best technique in engineering practices.
4	Develop skills in various machining processes.
5	Understand about retrofitting of a machine tool.

Course Outcomes:
At the end of the course, a student should be able to:

CO1	Design patterns used in sand casting.
CO2	Ascertain the quality of moulding sand for sand casting.
CO3	Apply arc welding processes for various applications.
CO4	Select and apply various machining processes as per applications.
CO5	Explain about retrofitting of a machine tool.

SYLLABUS

LIST OF EXPERIMENTS

Experiments	Shop/Lab	Title	Objective
1.	FOUNDRY SHOP	Pattern Study	To study different types of patterns used in sand casting.
2.	CARPENTRY SHOP	Pattern Making	To prepare a wooden pattern according to a given dimension for aluminium casting.
3.	FOUNDRY SHOP	Moulding Sand Testing	To determine the permeability number for a given moulding sand sample. To determine the amount of moisture for a given moulding sand sample. To determine the amount of clay for a given moulding sand sample.
4.	WELDING SHOP	Shielded Metal Arc Welding	To study the effect of AC and DC arc in manual/shielded metal arc welding.
5.	WELDING SHOP	Gas Metal Arc Welding	To study Submerged arc welding equipment and perform SAW welding
6.	WELDING SHOP	Spot Welding	To study resistance welding equipment and perform spot welding on thin sheets.
7.	MACHINE SHOP	Center Lathe	To perform different types of center lathe operation on job as per given dimensions.
8.	MACHINE SHOP	Shaper Machine	To machine on a rectangular job using shaper machine as per given job.
9.	MACHINE SHOP	Slotter Machine	To cut a slot on a job as per given dimensions.
10.	MACHINE SHOP	CNC Plasma Machine	To cut a sheet as per given job using CNC Air plasma machine
11.	MACHINE SHOP	CNC Surface Grinding Machine	To machine on a rectangular job using CNC surface grinding machine as per given job.
12.	MACHINING AUTOMATION LAB	Retrofitted Lathe	To study retrofitting attachment used on lathe and learn about retrofitting.

Text Books

1. S K Hajra Choudhury, A K. Hajra, “Elements of Workshop Technology: Vol- I and Vol -II”, Media Promotors Pvt Ltd. **(T1)**
2. B S Raghuwanshi, "A course in Workshop Technology", Dhanpat Rai Publications. **(T2)**

Reference Books

1. P.N. Rao, “Manufacturing Technology Vol-1and Vol-II”, Tata McGraw Hill. **(R1)**
2. Kalpakjian, "Manufacturing Engineering and Technology", Pearson. **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):
Nil

POs met through Gaps in the Syllabus:
Nil

Topics beyond syllabus/Advanced topics/Design:
POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	
CD2	Assignments/Seminars	
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	
CD7	Simulation	

Course Evaluation:

Direct Assessment-

Assessment Tool	**% Contribution during CO Assessment**				
Continuous Internal Assessment	60				
Semester End Examination	40				
Continuous Internal Assessment	**% Distribution**				
Day to day performance & Lab files	30				
Quiz 1	10				
Viva-voce	20				
End Semester Examination	**% Distribution**				
Examination: Experiment Performance	30				
Quiz 2	10				
Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	√
Quiz 1	√	√	√	√	√
Quiz 2	√	√	√	√	√
Viva-voce	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

Indirect Assessment –
1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	1	3						3	2	1	1			

CO2	3	1	1	3					3	2	1	1			
CO3	3	1	1	1					3	2	1	1			
CO4	3	2	1	1					3	2	1	1			
CO5	3	1	1						3	2	1	1			

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD3
CO2	CD3
CO3	CD3
CO4	CD3
CO5	CD3

COURSE INFORMATION SHEET

Course Code: ME 213(Program Elective-I)
Course Title: Thermo-Fluid Engineering
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 **(**L: 3 T: 0 P: 0)
Class schedule per week: 3
Class: B. Tech.
Semester / Level: Fourth
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1	Derive the governing equations of the fluid flow from both Lagrangian as well as Eulerian viewpoint
2	Understand the applicability of Lagrangian and Eulerian approach to various problems
3	Analyse the thermo-fluid aspects including the exergy of a system
4	Evaluate and understand the rotational and irrotational flows
5	Interpret the derived Navier-Stokes and energy equations and understand its physical significance

Course Outcomes

After the completion of this course, students will be able to:

CO1	Outline the applicability of the underlying principles of both the fluid flow and thermodynamics
CO2	Apply the knowledge of the governing equations related to the fluid flows and thermal systems
CO3	Analyze both closed and open systems and be able to independently use the Reynolds transport theorem
CO4	Analyze the exergy of both the open and closed systems
CO5	Apply the underlying concepts on various thermo-fluid systems

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction, Lagrangian and Eulerian descriptions; velocity and acceleration field; convective effects; streamline coordinates; the Reynolds transport theorem – its physical interpretation, relationship to material derivative, and applications to the fixed and nondeforming control volumes.	8
Module – II Fluid element kinematics; linear motion and deformation; relationship between stress and rate of strain; Euler's equation of motion; stress components; relationship between irrotational flow and viscosity.	8
Module –III Navier-Stokes equation and its applications; energy equation and its applications to various problems.	8
Module – IV Exergy: reversible work and irreversibility; exergy of a closed mass system; exergy of a flow stream; exergy transfer by heat, work and mass; exergy destruction; exergy balance for steady-flow systems.	8
Module – V Compressible flow: stagnation properties; speed of sound and Mach number; one-dimensional isentropic flow; variation of fluid velocity with flow area; property relations for isentropic flow of ideal gases; converging–diverging nozzles.	8

Text Books:

1. D.F. Young, B.R. Munson and T.H. Okiishi, *A Brief Introduction to Fluid Mechanics*, 3rd Ed., John Wiley and Sons Inc., 2003.
2. V.L. Streeter, E.B. Wylie and K.W. Bedford, *Fluid Mechanics*, 9th Ed., McGraw Hill, 2010.
3. Y.A. Cengel and M.A. Boles, *Thermodynamics: An Engineering Approach*, 4th Ed., McGraw Hill, 2001.

Reference Books:

1. M.C. Potter and D.C. Wiggert, *Mechanics of Fluids*, 2nd Ed., Pearson Education, 1997.
2. D.A. Kaminski and M.K. Jensen, *Introduction to Thermal and Fluid Engineering*, John Wiley & Sons, Inc., 2017.

Online Resources

1.https://nptel.ac.in/courses/112105183/
2.https://nptel.ac.in/courses/101103004/

Gaps in the Syllabus (to meet Industry/Profession requirements)

1. Deriving the moment of momentum equation and its applications
2. Turbulent boundary layers and flow separation over curved surfaces
3. A formal introduction to computational fluid dynamics

POs met through Gaps in the Syllabus

3, 4, 12

Topics beyond syllabus/Advanced topics/Design

1. An introduction to the tensors and its applications in fluid mechanics
2. Application of fluid mechanics to solve flow around stationary as well as rotating circular cylinder and sphere
3. An introduction to surface waves

POs met through Topics beyond syllabus/Advanced topics/Design

2, 3, 4, 12

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	3	2	3	2	2	1	1	1		1	3	3	3
CO2	3	3	2	3	2	2	2	1	1	1		1	3	3	2
CO3	2	3	3	3	2	3	2	1	1	1		2	3	2	3
CO4	2	2	3	3	2	2	2	1	1	1		1	3	3	2
CO5	2	1	3	2	3	2	2	1	1	1		1	3	3	2

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1 – CO5	CD1, CD7, CD 8
CD2	Tutorials/Assignments	CO1 – CO5	CD1 and CD9
CD3	Seminars		
CD4	Mini Projects/Projects		
CD5	Laboratory Experiments/Teaching Aids		
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets	CO1 – CO5	
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: ME 215 (Program Elective-I)
Course title: Composite Materials
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3
Class: B. Tech
Semester / Level: Fourth
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1	To present a comprehensive exposure to different composite materials
2	To lay the groundwork for various types and kinds of composite materials
3	To develop an intuitive understanding of Polymer, ceramic, metal based Composite materials.
4	To present a comprehensive exposure to different manufacturing and testing techniques for composites.
5	To present a wealth of real-world engineering examples to give students a feel for how composite materials are replacing the materials in all types of engineering products.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Correlate requirement of composite materials.
CO2	Understand applicability of composite materials under various conditions.
CO3	Characterize necessity of choice of various components of composite materials and their forms like filler, fibre, nano etc. with relative properties.
CO4	Apply various techniques for suitable composite material with required enhanced properties.
CO5	Evaluate the performance composite materials for engineering applications.

SYLLABUS

Module	Lectures/hour
Module -I **Introduction to Composite Materials:** Definition of composites, Classification of composites; General characteristics of reinforcement- classification, terminology used in fiber science, CMC, MMC and PMC.	8
Module –II **Polymer Matrix Composites:** Thermoplastic and thermosetting resins; Commonly used matrix reinforcement system;Fibre, Flake and particulate reinforced composites, Reinforcements used in PMC's- glass, carbon, aramids, boron, Roving's, yarns, fabrics, etc.; Thermoset matrices for aerospace components- polyesters, epoxies, phenolics,	8

vinyl esters, cyanate esters, etc.; Thermoplastic matrices for advanced composites- PEEK, polysulfones, polyimides, etc. concept of A stage, B stage and C stage resins; **Particulate and Fiber Filled Polymeric Composites**: Applications, Function of matrix, Function of fibres, Polymer-fibre interface, Factors influencing the performance of composite, Coupling agents, Bonding agents, short fibre composites, Theories of stress transfer, Analysis of short fibre composites, Critical fibre length, Rule of mixtures; **Continuous Fiber Polymeric Composites:** Analysis of long fiber composites, Longitudinal behavior of unidirectional composites; Failure mechanism and strength, Factors influencing longitudinal and transverse strength and stiffness, Halpin-Tsai equations for transverse modulus, Prediction of Poisson's ratio, Various failure modes.	
Module – III **Specialty Composites:** Composites for satellites and advanced launch vehicles, Design considerations PMC- for structural composites, Theory and application of ablatives, MMC- design, applications; Silicon carbide composites, design, processing and properties; **Carbon-Carbon Composites:** Matrix precursors, Manufacturing considerations, Multi directional reinforced carbon-carbon composites.	8
Module – IV **Nano composites:** Nano particle dispersion in polymer matrix, Polymer- nanoclay composites and polymer-carbon nano tubes composites. **Functionally graded and Hierarchical Composites**; Classification i.e., Natural and Man-made, Uniaxial and bi-axial property gradient, Application in various industrial sectors.	8
Module –V **Manufacturing Techniques:** Hand lay-up, Filament winding, Pultrusion, Resin transfer moulding, Processing science of reactive polymer composites, Process steps for production, Selection of processing conditions toolings, Equipments, Carbon-carbon composites, Processing, Thermal and mechanical properties, Quality control. **Testing of composites**: Raw material testing, Property evaluation at laminate level, NDT techniques; **Design and analysis of composite structures**: Macro mechanics of a lamina, Micro mechanics, Laminate analysis, FE model and analysis	8

Reference Books:

1. R.M. Jones, Mechanics of Composites, 2nd ed., Taylor & Francis, 1999.
2. T. G. Gutowski, (Ed.) Advanced Composites Manufacturing, John Wiley & Sons, New York 1997.
3. P.M. Ajayan, L. Schadler, P.V. Braun Nano Composite Science and Technology, Wiley VCH, 2003.
4. E. Fitzer, L.M. Manocha, Carbon Reinforcement and Carbon/Carbon Composites, SpringerVerlag, Heidelberg, New York, 1998.
5. K.K. Chawla, Ceramic Matrix Composites, Kluwer Academic Publishers, 2003.
6. N. Chawla, K.K. Chawla, Metal Matrix Composites, Springer-Verlag, 2006.
7. J.C. Seferis, L. Nicolais, (Eds.) The Role of the Polymeric Matrix in the Processing and Structural Properties of Composite Materials, Plenum Press, New York 1983

Gaps in the syllabus (to meet Industry/Profession requirements)
Various composite materials, their properties, and applications.

POs met through Gaps in the Syllabus
PO1-5

Topics beyond syllabus/Advanced topics/Design
Characterization of the composite materials.

POs met through Topics beyond syllabus/Advanced topics/Design
PO1-5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	1									1	3	2	--
CO2	3	2	1			1	2					1	3	2	--
CO3	3	2	2			1		2	1	1		1	3	2	--
CO4	3	2	2			1		2	1	1		1	3	2	--
CO5	3	3	2									1	2	2	3

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD	**Course Delivery methods**	**Course Delivery Method**	
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1-5	CD1
CD2	Tutorials/Assignments	CO1-5	CD2
CD3	Seminars	-	-
CD4	Mini projects/Projects	-	-
CD5	Laboratory experiments/teaching aids	-	-
CD6	Industrial/guest lectures	-	-
CD7	Industrial visits/in-plant training	-	-
CD8	Self- learning such as use of NPTEL materials and internets	-	-
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: ME 217(Program Elective-I)
Course title: Renewable Energy Resources
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 (L: 3, T: 0, P: 0)
Class schedule per week: 03
Class: B. Tech
Semester / Level: Fourth
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions imparting the students to:

1	To understand the difference between the non-renewable energy system and the renewable energy systems
2	To lay the groundwork for subsequent studies in the fields of renewable energy sources
3	To develop an intuitive understanding of the applications of different renewable energy sources like solar, wind, biomass, ocean thermal, geothermal etc.
4	To understand the working principles related to different renewable energy systems
5	To understand state of art renewable energy system used in industrial application.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Outline the various sources of energy
CO2	Understand the working principle of different solar thermal energy systems and Photo-voltaic system
CO3	Understand the working principle of wind energy conversion system
CO4	Demonstrate the working principles of different biomass system
CO5	Understand the working principles and applications of different renewable energy sources like solar, wind, biomass, ocean thermal, geothermal etc.

SYLLABUS

Module	Lectures/hour
Module -I Introduction, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Needs of renewable energy, Classification of Energy Resources, Conventional Energy Resources - Availability and their limitations; Non-Conventional Energy Resources – Classification, Advantages, Limitations, Comparison of Conventional and Non-Conventional Energy Resources, World Energy Scenario, Indian Energy Scenario.	8
Module –II Introduction, Solar Radiation, Solar Constant, Basic Sun-Earth Angles, Solar Radiation Geometry and its relation, Measurement of Solar Radiation,Principle of Conversion of Solar Radiation into Heat, Collectors(Flat Plate and Concentrating Collectors), Solar Water Heaters , Solar Cookers , Solar driers, Solar Still, Solar Furnaces, Solar Green Houses. Solar Photovoltaic, Solar Cell fundamentals, characteristics, classification, construction of module, panel and array. Solar PV Systems (stand-alone and grid connected), Solar PV Applications.	8
Module – III Introduction, Wind and its Properties, History of Wind Energy, Wind Energy Scenario – World and India. Basics of lift and drag, Basic principles of Wind Energy Conversion Systems (WECS), Classification of WECS, Parts of WECS, Derivation for Power in the wind, Electrical Power Output and Capacity Factor of WECS, Wind site selection consideration, wind farm, Advantages and Disadvantages of WECS.	8
Module - IV Introduction, Photosynthesis process, Biomass fuels, Biomass conversion technologies, Urban waste to Energy Conversion, Biomass Gasification, Biomass to Ethanol Production, Biogas production from waste biomass, factors affecting biogas generation, types of biogas plants, energy plantation, Biomass program in India.	8
Module –V Tidal Energy, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants. Ocean Thermal Energy Conversion (OTEC), Principle of OTEC system, Methods of OTEC power generation – Open Cycle (Claude cycle), Closed Cycle (Anderson cycle). Geothermal Energy, Resources of geothermal energy, Hydrogen and Storage, Fuel Cell Systems, Hybrid Systems.	8

Text books:

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 1996.
2. Rai. G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2011.
3. Twidell, J.W. & Weir, A., “Renewable Energy Sources”, EFN Spon Ltd., UK, 2006.

Reference books:

1. Sukhatme. S.P., “Solar Energy”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. Tiwari. G.N., Solar Energy – “Fundamentals Design, Modelling& Applications”, Narosa Publishing House, New Delhi, 2002.

3. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
4. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2009.

Gaps in the Syllabus (to meet Industry/Profession requirements)

1. Application of various energy heat storage in various renewable energy systems.
2. Application of state of art solar cells in various industrial applications.
3. Applications of geothermal energy in solar desalination system.

POs met through Gaps in the Syllabus: 1-4, 7, 11, and 13

Topics beyond syllabus/Advanced topics/Design

1. Design and Optimization of Hybrid PV-Wind Renewable Energy
2. Projected impacts of climate change on wind energy density in India.
3. Submerged PV Solar Panel for Swimming Pools.

POs met through Topics beyond syllabus/Advanced topics/Design: 1-4, 7, 11, and 13

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	2	1	1	1	2	2	1	1		1	3	2	1
CO2	3	2	2	2	1	1	2	2	1	1		1	3	2	1
CO3	3	2	2	2	1	1	2	2	1	1		1	3	2	1
CO4	3	2	2	2	1	1	2	2	1	1		1	3	2	1
CO5	3	2	2	2	1	1	2	2	1	1		1	2	2	1

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2 & CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, & CD8
CD3	Seminars	CO3	CD1, CD2, CD5, & CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD5, & CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2 & CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: PE 220 (Program Elective-I)
Course title: Industrial Statistics
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 (L: 3, T: 0, P: 0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: Fourth
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:

This course enables the students to:

1	Learn about the basic methods of statistics for data representation and its analysis by determining measures of central tendency; measures of dispersion; measures of skewness sand kurtosis.
2	Understand the properties and application of different probability distribution functions in statistics.
3	Learn useful techniques of statistics to draw inferences about the population based on sample(s).
4	Understand the statistical techniques used form odelling and analysis of experiments using ANOVA, design of experiments and regression analysis.
5	Learn about the different methods used for statistical process control.

Course Outcomes:

After the completion of this course, students will be able to:

CO1	Understand the properties of a distribution based on central tendency, dispersion, skewness sand kurtosis measures.
CO2	Understand the use of probability distribution functions in accordance with the problem.
CO3	Understand the basic concepts of sampling methods and the terminologies of Testing of Hypothesis.
CO4	Design and investigate the experiments using ANOVA, design of experiments and regression analysis.
CO5	Understand the application of different statistical process control tools in life problems.

SYLLABUS

Module	Lectures/hour
Module I: Descriptive Statistics Definition and Scope of Statistics; Classification of Data and Frequency Distribution; Graphical Representation of Data; Measures of Central Tendency; Measures of Dispersion; Measures of Skewness and Kurtosis.	8
Module II: Probability Theory Discrete Probability Distributions - Binomial Distribution, Poisson Distribution, Discrete Uniform and Hyper geometric Distributions, Geometric and Negative Binomial Distributions. Continuous Probability Distributions - Normal Distribution, Area Property of Normal Distribution, Continuous Uniform and Exponential Distributions, Gamma and Beta Distributions.	6
Module III: Statistical Inference Concepts of sampling methods - Sampling Theory and Sampling Distribution, Simple Random Sampling, Elementary Concepts of other Sampling Techniques. Test of significance - Testing of Hypothesis, Z – test and its applications, t – test and its applications, Chi – Square test and its applications, F – test and its applications.	8
Module IV: Statistical Techniques Analysis of Variance - Introduction to Analysis of Variance, No-way Analysis of Variance, One-way Analysis of Variance, Two-way Analysis of Variance. Design of Experiments - Online and Offline Quality Control, Quality Loss Function, DOE Process Steps; Orthogonal Array Selection and Utilization, S/N Analysis. Regression Modelling - Simple Linear Regression, Statistical Inference in Simple Linear Regression, Multiple Linear Regression, Selection of Variables and Testing Model Assumptions.	12
Module V: Statistical Process Control Basic concepts of statistical process control, Seven Magnificent SPC Tool – Flow charts, Histogram or stem-and-leaf plot, Check sheet, Run chart, Pareto chart, Cause-and-effect diagram, Scatter diagram. Advanced methods of SPC – Tests of randomness, Cumulative sum control chart, Multivariate SPC.	6

Text Book

1. Introduction to Statistical Quality Control, Douglas C. Montgomery,Wiley **(T1)**
2. Design and analysis of Experiments, Douglas C. Montgomery, Wiley**(T2)**
3. Fundamentals of quality control and improvement, A Mitra,Wiley

Reference Book

1. Modern Industrial Statistics, Ron S.Kenett, Wiley **(R1)**
2. Industrial Statistics, Pere Grima Cintas,Wiley**(R2)**
3. Design of Experiments using the Taguchi Approach, Ranjit K.Roy, Wiley**(R3)**

Gaps in the syllabus(to meet Industry/Profession requirements):

Control charts and acceptance sampling plans

POs met through Gapsin the Syllabus:

Topics beyond syllabus/ Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods:

CD1	Lecture by use of boards/ LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/ teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self-learning such as use of NPTEL materials and internets	√
CD7	Simulation	

Course Evaluation:

Direct Assessment-

Assessment Tool	%Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	%Distribution
Mid Semester Examination	25
Quizzes	10 +10
Assignment	5
End Semester Examination	**%Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz1	√	√			
Quiz2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment–

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes(Cos) on to Program Outcomes(POs) and Program Specific Outcomes (PSOs):

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3		1					1	1	3	3	2	3

CO2	3	2	1		2					1	2	2	3	1	3
CO3	3	3	3		2		1			1	1	3	3	2	3
CO4	3	2	1				1	1		1	2	2	3	1	3
CO5	3	2	1							1	2	2	3	1	3

1:Slight(Low)2: Moderate(Medium)3:Substantial (High)

Between Course Outcomes(Cos)and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD2, CD6
CO2	CD1,CD2, CD6
CO3	CD1,CD2, CD6
CO4	CD1,CD2, CD6
CO5	CD1,CD2, CD6

COURSE INFORMATION SHEET

Course code: ME 219 (Program Elective-I)
Course title: Non-Destructive Testing
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 (L: 3, T: 0, P: 0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: Fourth
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions imparting the students to:

1	Introduce the methods employed for non-destructive testing (NDT) of structures and materials.
2	Understand the importance, limitations and applications of different NDT techniques.
3	Identify the nature of a flaw and apply the theory of NDT for improving reliability of a component.
4	Apply the knowledge of Non-destructive testing to industrial applications.
5	Be aware of the developments and future trends in NDT.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Classify major NDT methods and inspect surface flaws in a component.
CO2	Inspect sub-surface defects/flaws and materials by using principles of magnetism and electromagnetism.
CO3	Apply the concepts of radiographic techniques for inspection of a component.
CO4	Evaluate internal discontinuities in a material accurately by using ultrasonic testing.
CO5	Select NDT techniques based on their employability for different specimen under testing.

SYLLABUS

ME-257 Non-Destructive Testing

Module	Lectures/hour
Module -I **Introduction to NDT and Visual Inspection and Liquid Penetrant Testing:** Introduction and Classification of NDT, Visual Inspection Methods, Dye Penetrant Testing (DPT), Basic Principle of DPT, Types of dye and method of application, DPT-Developer application, and Inspection.	8
Module –II **Magnetic Particle Testing (MPT) & Eddy Current Testing (ECT):** Basic definition of Magnetism & Principle of MPT, Magnetizing Techniques, Procedure & Equipment used for MPT, Applications & limitations of MPT. Principle & Instrumentation for ECT, Techniques used in ECT, Advanced ECT methods, Applications & limitations of ECT.	8
Module – III **Radiographic Testing:** 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, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography.	8
Module - IV **Ultrasonic Testing:** Basic Properties of Sound Beam, Ultrasonic Transducers, Inspection techniques, Flaw Characterization Techniques and Detection Equipment, Applications, Advantages & Limitations of Ultrasonic Testing.	8
Module –V **Comparison and Selection of NDT methods:** Defects in Materials, Selection of NDT Method, Selection of Instrumentation, Codes/Standards in NDT and Industrial Practices.	8

Textbooks:

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. ASNT, American Society for Non-Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 4, Radiographic Testing.

Gaps in the Syllabus (to meet Industry/Profession requirements)

1. Hands on application to various NDT techniques.
2. Identifying defects in materials using NDT practically and taking decision.

POs met through Gaps in the Syllabus: 1,2, 3, 4, 5, 7, 9 &12

Topics beyond syllabus/Advanced topics/Design

1. Acoustic emission testing.
2. Advanced ultrasonic testing.

POs met through Topics beyond syllabus/Advanced topics/Design: 1**,** 2, 3, 4 & 5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	1	1	2	1	-	-	-	1	3	3	1
CO2	3	3	3	2	1	1	2	1	-	-	-	1	3	3	1
CO3	3	3	3	2	1	1	2	1	-	-	-	1	3	3	1
CO4	3	3	3	2	1	1	2	1	-	-	-	1	3	3	1
CO5	3	3	3	2	1	1	2	1	-	-	-	1	3	3	1

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	**Course Delivery Methods**	**Course Outcome**	**Course Delivery Method Used**
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1 & CD2
CD2	Tutorials/Assignments	CO2	CD1 & CD2
CD3	Seminars	CO3	CD1 & CD2
CD4	Mini Projects/Projects	CO4	CD1 & CD2
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2 & CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: ME 292 (Open Elective-I)
Course title: Smart And New Materials
Pre-requisite(s): NIL
Co- requisite(s): NIL
Pre-requisite(s): None
Co- requisite(s):
Credits: 3 **(**L:3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: Fourth
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

1	To present a comprehensive exposure to various new engineering materials
2	To lay the groundwork for various smart materials and their applications
3	To develop an intuitive understanding of Electro-Rheological (Fluids) Smart Materials, Piezoelectric Smart Materials, Shape – Memory (Alloys) Smart Materials etc.
4	To present a wealth of real-world engineering examples to give students a feel for how new materials are applied in development of engineering products.

Course Outcomes

After the completion of this course, students will be:

CO1	Correlate requirement of smart and new materials.
CO2	Understand applicability of smart materials under various conditions.
CO3	Characterize necessity of development of new materials with better properties and cost-effective processes.
CO4	Apply various techniques for selection of suitable material
CO5	Evaluate the performance of new materials for engineering applications.

SYLLABUS

Module	Lectures/hour
Module I **Introduction and Historical Perspective** Classes of materials and their usage – Intelligent /Smart materials – Evaluation of materials Science – Structural material – Functional materials – Polyfunctional materials – Generation of smart materials – Diverse areas of intelligent materials –Primitive functions of intelligent materials – Intelligent inherent in materials –Examples of intelligent materials, structural materials, Electrical materials, biocompatible materials etc. – Intelligent biological materials – Bio-mimetics – Wolff's law– Technological applications of Intelligent materials.	5
Module II **Smart Materials and Structural Systems** The principal ingredients of smart materials – Thermal materials – Sensing technologies – Micro sensors – Intelligent systems – Hybrid smart materials – Analgorithm for synthesizing a smart material – Passive sensory smart structures–Reactive actuator based smart structures – Active sensing and reactive smart structures – Smart skins – Aero elastic tailoring of airfoils – Synthesis of future smart systems.	5
Module III **Electro-Rheological (Fluids) Smart Materials** Suspensions and electro-rheological fluids – Bingham-body model – Newtonian viscosity and non-Newtonian viscosity – Principal characteristics of electro rheological fluids – The electro-rheological phenomenon – Charge migration mechanism for the dispersed phase – Electro-rheological fluid domain – Electro-rheological fluid actuators– Electro-rheological fluid design parameter – Applications of Electro-rheological fluids.	10
Module IV **Piezoelectric Smart Materials** Background – Electrostriction – Pyro electricity – Piezoelectricity – Industrial piezoelectric materials – PZT – PVDF – PVDF film – Properties of commercial piezoelectric materials – Properties of piezoelectric film (explanation) – Smart materials featuring piezoelectric elements – smart composite laminate with embedded piezoelectric actuators – SAW filters.	10
Module V **Shape – Memory (Alloys) Smart Materials** Background on shape – memory alloys (SMA) Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol – Martensitic transformations – Austenitictrans formations – Thermoelastic martensitic transformations – Cu based SMA, chiral materials – Applications of SMA – Continuum applications of SMA fasteners – SMA fibers – reaction vessels, nuclear reactors, chemical plants, etc. – Micro robotactuated by SMA – SMA memorization process (Satellite antenna applications) SMA blood clot filter – Impediments to applications of SMA – SMA plastics – primary molding – secondary molding – Potential applications of SMA plastics.	10

Books

1. M.V. Gandhi and B.S. Thompson, Smart Materials and Structures Chapman and Hall, London, First Edition, 1992
2. T.W. Deurig, K.N.Melton, D.Stockel and C.M.Wayman, Engineering aspects ofShape Memory alloys, Butterworth –Heinemann, 1990
3. C.A.Rogers, Smart Materials, Structures and Mathematical issues, Technomic Publising Co., USA, 1989.
4. Brain Culshaw – Smart Structure and Materials Artech House – Borton. London-1996.

Gaps in the syllabus (to meet Industry/Profession requirements)
Various new and smart materials and their properties and applications.

POs met through Gaps in the Syllabus
PO1-5

Topics beyond syllabus/Advanced topics/Design
Manufacturing and processing techniques for lab and mass production.

POs met through Topics beyond syllabus/Advanced topics/Design
PO1-5

Course Delivery Methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Quiz1	√	√			
Mid Semester Examination	√	√			
Quiz2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	1	1	1	1	1	1	1	1	3	2	--
CO2	3	3	3	3	1	1	1	1	1			1	3	2	--
CO3	3	3	3	3	1	1	1	1	1			1	3	2	--
CO4	3	3	3	3	1	1	1	1	1	1	1	1	3	2	--
CO5	3	3	3	3	1	1	1	1	1			1	2	2	3

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		-	-
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		-	-
CD9	Simulation			

COURSE INFORMATIONSHEET

Course code: ME 293 (Open Elective-I)
Course title: Experimental Methods in Engineering
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 (L:3, T:0, P:0)
Class schedule per week: 3
Class: B.Tech
Semester/ Level: Fourth
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives
This course enables the students:

1.	Equip students with the knowledge of different experimental techniques used in thermal system.
2.	Provide the essential experimental background for design and data interpretation of the thermal systems.
3.	To understand various instruments used for data measurement in thermal systems.

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

CO1	Discuss experimentation techniques for various thermal systems.
CO2	Discuss various instruments used for measuring different properties significant for evaluation of performance of thermal systems and to carry out uncertainty analysis.
CO3	Appraise the computing facilities for measurement and acquisition of data
CO4	Apply the experimental knowledge for various thermal systems
CO5	Appraise advanced measurement techniques and systems

SYLLABUS

Module	Lectures/hour
Module I: Introduction: Experiments versus simulation, Experiments versus measurements, why conduct experiments, Details of an experimental set up, Global Versus local measurements; Static versus dynamic calibration, forward versus inverse measurements.	8
Module II: Basic Concepts in Measurements – Generalized Description of Measurement System. Operational Description of a General Measurement System and Elimination Methods of Interfering Inputs to the Desired Inputs. Null and Deflection Methods of Measurements, Analog, and Digital Measurements, Static and Dynamic Measurements. Accuracy, Precision, calibration traceability, time/frequency response, selection of instruments for measurements of physical quantities such as temperature, pressure, flow rate, sources of error.	8
Module III: Uncertainty analysis: Types of errors and uncertainties, statistical basis of uncertainty, propagation of uncertainties, codes for uncertainty analysis.	8
Module IV: Introduction to design of experiments (DOE): Concepts, methodology examples.	8
Module V: Optimization Techniques for Engineering Design Introduction: Historical development, Engg. Application, Statement and Problem definition, Classification and techniques of optimization, Classical optimization techniques. Linear programming: simplex algorithm, duality in LP, Decomposition principle, Transportation problem. Linear programming and fractional programming. Non-linear programming: Introduction, Formation of N.L.P Introduction and optical diagnostics: Image analysis and its application. Non-optical diagnostics: Sensors and Transducers; Data Sampling, Signal Conditioning and Acquisition. Examples of Transducer for Measurements.	8

Books:

1. Debin, E.O. Measurement systems – Application and Design, Tata McGraw Hill, New Delhi.
2. Holman, J.P. Experimental methods for Engineering, Tata McGraw Hill.
3. Bouker, A.H., and Lieberman, G.J. Engineering Statistics, Prentice Hall, New Jersey, 1972.

Gaps in the syllabus(to meet Industry/Profession requirements)
Designing the Mechanical System

Pos met through Gaps in the Syllabus: PO(1) to PO(3)

Topics beyond syllabus/Advanced topics/Design: Experimental approach

Pos met through Topics beyond syllabus/Advanced topics/Design: PO(1) to PO(5)

COURSE OUTCOME (CO)ATTAINMENTASSESSMENT TOOLS&EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Quiz1	√	√			
Mid Semester Examination	√	√			
Quiz2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery methods

	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Seminars
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Industrial/guest lectures
CD7	Industrial visits/in-plant training
CD8	Self-learning such as use of NPTEL materials and internets

Mapping between Objectives and Outcomes

Mapping of Course Outcomes on to Program Outcomes

Course Outcome	Program Outcomes				
	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	1	1
CO2	3	3	3	2	2
CO3	3	3	3	2	2
CO4	3	3	3	2	2
CO5	3	3	3	2	2

<34%=1, 34-66%=2,>66%=3

Mapping between Course Outcomes and Course Delivery method

Course Outcome	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD1, CD2, CD3
CO3	CD1, CD2 CD3, CD7
CO4	CD1, CD2, CD3, CD8
CO5	CD1, CD2, CD3, CD8

5th SEMESTER

COURSE INFORMATION SHEET

Course code: ME 301
Course title: IC Engines and Gas Turbines
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 (L:3, T:0, P:0)
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions imparting the students to:

1.	Make student understand the basic operating characteristics of internal combustion engines and differentiate the hypothetical and real operating conditions.
2.	Study the basic phenomena normal and abnormal combustion.
3.	Outline how the engine is made smoothly operable by means of fuel supply, cooling and lubrication.
4.	Analyze the performance and testing parameters of operating engines.
5.	Understand the operating of gas turbines and jet engines

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand working principle of IC Engines, operating cycles and differentiate hypothetical with real conditions.
CO2	Outline and examine the combustion phenomena in SI and CI engines and factors influencing combustion phenomena.
CO3	Understand and identify fuel injection, cooling and lubrication systems in I.C. engines.
CO4	Apply different methods for measuring engine performance and pollutants.
CO5	Analyze gas turbine and jet propulsion cycles.

Syllabus

Module	Lectures/hour
Module: 1 Introduction to I.C. Engine, SI and CI Engine, Air standard Otto and Diesel cycles, valve timing diagrams, Fuel-air Cycles and actual air cycle and their analysis.	10
Module –II Combustion in SI Engines: Combustion in S.I. engines, stages, ignition lag, factors affecting ignition lag, flame propagation and its factors, knocking and its factors, control of knock. Combustion in C.I. engines, stages of combustion, delay period and affecting	10

factors, detonation and affecting factors, control and comparison with knocking of S.I. engines.	
Module – III Elementary carburetor and its auxiliary devices, Choke jet ratio of a simple carburetor, MPFI system. Injection system of C.I. engines. Introduction to supercharging and its purpose. Engine Cooling: Introduction to air- and water-cooling systems. Lubrication: Objectives and Properties of lubricating oil, Mechanism of lubrication, Role of Additives.	8
Module - IV Testing and performance: Measurement of air, fuel consumption, indicated power, brake power, Morse test, Heat balance sheet, Performance parameter of S.I. and C.I. engine, performance map. Engine Emission and control: Engine emissions and their effects, gasoline and diesel emission, methods of measuring pollutants, controlling of engine emission.	8
Module –V Gas turbine and Jet Propulsion: Theory of gas turbine, thermodynamic analysis of Brayton cycle, and with regeneration, reheat, inter-cooling. Compressor and turbines isentropic efficiency, Analysis of cycle considering losses. Jet propulsion cycle, elementary idea of turbojet, Turbo-propulsion, ramjet and pulses jet, Classification of Rocket propulsion.	8

Textbooks:

1. Internal combustion engines by E.F.Obert.
2. Gas turbine Theory by Cohen Roger
3. Kohli P L., "Automotive Electrical Equipment", Tata McGraw Hill Publishing Co., Delhi, 2004
4. Robert N Brady Automotive Computers and Digital Instrumentation, Prentice Hall, Eagle Wood Cliffs, New Jersey, 1988.

Reference books:

1. A course in Internal Combustion Engines by M.L. Mathur and R.P. Sharma.
2. Internal Combustion by V. Ganeshan, McGraw Hill
3. Gas Turbine Jet and Rocket Propulsion by M.L.Mathur and R.P.Sharma
4. Spreadbury .F.G., Electrical Ignition Equipment, Constable & Co Ltd., London, 1962.

Gaps in the syllabus (to meet Industry/Profession requirements)

Combustion chamber design, Wankel engine, Stratified charge engine
POs met through Gaps in the Syllabus: PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design
EURO and BHARAT emission norms, BIS standards for testing and rating, Combustion chamber design
POs met through Topics beyond syllabus/Advanced topics/Design: PO1 TO PO7

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	2	2	1					1	1	1	1	1	1
CO2	3	2	3	3	1							1	2	2	2
CO3	3	3	3	3	2	2	2					2	2	3	3
CO4	3	3	3	3	2	1	2			1	1	2	2	3	3
CO5	3	2	3	3	1	1	1					1	1	1	1

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2 & CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, & CD8
CD3	Seminars	CO3	CD1, CD2, CD5, & CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD5, & CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2 & CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: ME 303
Course title: Mechanical Vibration
Pre-requisite(s): ME 101: Basics of Mechanical Engineering
Co- requisite(s): Nil
Credits: 3 L: 3, T: 0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To be able to obtain the model of vibratory systems of single, multi degrees of freedom system as well as continuous systems.
2	To perform modal analysis of different systems.
3	To understand the experimental procedures in vibration analysis.

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the basic elements of vibration models
CO2	Analyze multi degrees of freedom systems.
CO3	Solve the natural frequencies and mode shapes of a vibrating system.
CO4	Analyze the vibration of continuous systems.
CO5	Apply the knowledge of vibration in practical problems.

Syllabus

Module	Lectures/hour
Module –I Review of free and forced vibration analysis of single degree of freedom system with and without damping; different types of damping used in practice (Viscous damping, eddy current damping, structural damping, dry friction damping, non-contact damping methods); rotor unbalance; whirling of rotating shaft; base excited vibration.	8
Module –II Free vibration analysis of two and three degrees of freedom system; derivation of equation of motion; matrix formulation; influence coefficient; flexibility matrix; stiffness matrix; coordinate coupling; principal coordinates; orthogonality of modes; Lagrange's equation; Forced vibration analysis of two and three degrees of freedom system due to harmonic excitation; torsional vibration with two rotor masses.	8
Module – III Determination of natural frequencies and mode shapes of multi degrees of freedom system using exact method; Analysis of multi degrees of freedom system using numerical methods: Dunkerley's method, Holzer's method, Stodola's method, Rayleigh-Ritz method, Method of matrix iteration.	8
Module – IV Introduction to the vibration of continuous systems; Lateral vibration of string; Longitudinal vibration of bar; Torsional vibration of uniform shaft; Transverse vibration of beams having different types of supports (Euler- Bernoulli beam.)	8
Module –V Experimental methods in vibration analysis; vibration measuring Instruments (vibrometer, accelerometer); vibration testing equipments: different types of vibration exciters; signal generators; frequency measuring instruments; system identification from frequency response; vibration signature analysis and preventive maintenance.	8

Textbooks:

T1. Theory of Vibration with Applications: W. T. Thomson and Marie Dillon Dahleh, Pearson Education.

T2. Introductory Course on Theory and practice of Mechanical Vibrations by J.S.Rao and K. Gupta, Wiley Eastern Ltd.

Reference Book

R1. Mechanical vibrations by Thammaiah Gowda, Jagadeesha T and D V Girish, McGraw Hill.

Gaps in the syllabus (to meet Industry/Profession requirements)

Software application in vibration analysis.

POs met through Gaps in the Syllabus
PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design
Non- linear vibration
POs met through Topics beyond syllabus/Advanced topics/Design
PO1 TO PO5

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	1	1	1	1	1	1	1	1	3	2	2
CO2	3	3	3	3	1	1	1	1	1			1	3	2	2
CO3	3	3	3	3	2	1	1	1	1			1	3	2	2
CO4	3	3	3	3	2	1	1	1	1	1	1	1	3	2	2
CO5	3	3	3	3	3	1	1	1	1			2	2	2	2

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		-	-
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		-	-
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: ME 315
Course title: Heat and Mass Transfer
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 (L: 3, T: 0, P: 0)
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions imparting the students to:

1	Classify innumerable cases under heat transfer process.
2	Discover various laws and its application
3	Illustrate and solve mathematically the relations under various heat transfer modes.
4	Judge, solve and correlate heat transfer and flow parameters required for the performance studies and thermal design at industry level.
5	Classify, solve and correlate heat and mass transfer problems.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Identify and paraphrase the modes, laws and operating conditions of heat transfer problems investigating the steady and unsteady state conduction.
CO2	Recognize and articulately examine and analyze the heat transfer by use of fins and radiation surfaces.
CO3	Analyze, formulate and correlate the heat transfer parameters under forced and free convection.
CO4	Evaluate and modify heat transfer under various design of heat exchangers
CO5	Estimate and illustrate mass transfer problems.

Syllabus

Module	Lectures/hour
Module -I Basic concepts and laws of Heat Transfer, generalized heat conduction equation in cartesian; cylindrical and spherical coordinates; Contact thermal resistance; without internal heat generation for Simple and composite Plane wall, hollow cylinders and spheres; Critical thickness of insulation; variable thermal conductivity of plane wall; 1D steady state heat conduction for Plane wall, hollow cylinders and spheres; Transient heat conduction – lumped heat capacity analysis.	8
Module –II Extended surfaces (Fins): General equation, temperature distribution and heat transfer analysis, fin efficiency, effectiveness, variable area, circumferential fin. Radiation: Definition and laws of thermal radiation, black body and non-black surfaces, shape factor analysis, radiation heat transfer by electrical analogy approach, radiation shield, re-radiation surfaces.	8
Module – III Forced Convection: Governing Equations, Velocity and Thermal Boundary Layers, related dimensionless numbers, Empirical solutions of Laminar and Turbulent flow, flow past cylinder – External and Internal flows, Reynolds and Colburns analogies.	8
Module - IV Free convection: Boundary layer concept, Governing equations; Empirical solutions of Plates, cylinders and enclosed spaces. Combined free and forced convection. Boiling Heat transfer – Basic phenomenon and regimes.	8
Module –V Heat Exchanger: Classification, LMTD and NTU – effectiveness methods of analysis, correction factor, Fouling Factor, Single and multi-pass heat exchangers, Efficiency and Effectiveness. Mass Transfer: Introduction to Diffusion and Convective mass transfer, concentration, velocities and fluxes, Fick's law of diffusion and diffusion coefficient, species conservation equation, steady state diffusion through stationary media and equimolar counter diffusion.	8

Textbooks:

1. Heat and Mass Transfer by J.P. Holman, Tata McGraw Hill
2. Heat and Mass Transfer by Yunus A. Cengel and A. J Ghajar, Tata McGraw Hill
3. Fundamentals of Engineering Heat and Mass Transfer by R. C. Sachdeva, New Edge Science Ltd., New Delhi
4. Heat Transfer by S. P. Sukhatme, Universities Press

5. Data Book: Heat and Mass Transfer by C.P. Kothandraman

Reference Books:

1. Principles of Heat Transfer by F. Krieth and M. S. Bohn, Cengage Learning USA
2. Heat Transfer by Ghoshdashtidar, Oxford University Press.
3. Heat and Mass Transfer by P. K. Nag, McGraw Hill
4. Fundamentals of Heat and Mass Transfer by Incropera, Dewitt, Bergman and Lavine, John Wiley & Sons

Gaps in the Syllabus (to meet Industry/Profession requirements)

1. Application of various heat transfer zone under conduction, convection and radiation.
2. Application of heat exchangers.
3. Applications of heat transfer under external and internal flows.

POs met through Gaps in the Syllabus: 2, 3, 4, 9, 11, 12, 13,14

Topics beyond syllabus/Advanced topics/Design

1. Multi-dimensional heat transfer
2. Combined modes of heat transfer
3. Computational/numerical approach of heat transfer problems.
4. Heat transfer through non-conventional approach e,g, Peltier; Seeback; Solar; Gas Radiations etc.

POs met through Topics beyond syllabus/Advanced topics/Design: 2, 3, 4, 5, 6, 9, 11 &12

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	1			1					1	2	1	1	2
CO2	3	3	2	1	1	1					2	2	2	2	2
CO3	3	3	2	2	2	1					2	3	2	3	3
CO4	3	3	2	2	2	1					2	3	2	3	3
CO5	3	3	1			1					1	2	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2 & CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, & CD8
CD3	Seminars	CO3	CD1, CD2, CD5, & CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD5, & CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2 & CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: ME 302
Course title: Heat Transfer Lab
Co- requisite(s): Nil
Credits: 1.5 **(**L:0, T:0, P:3)
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To demonstrate the basic phenomenon of heat transfer.
2	To interpret the experimental results in a logical manner.
3	To develop innovative methodologies of solving heat transfer problems.
4	To compose precautionary measures while dealing with heat transfer equipment and problems.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Apply and demonstrate the basic laws of heat transfer under different modes.
CO2	Analyze problems involving steady state heat transfer.
CO3	Evaluate heat transfer coefficients under different modes.
CO4	Analyze heat exchanger performance under different conditions.
CO5	Assess the importance of heat transfer coefficients and transferring medium.

List of experiments

1. To determine thermal conductivity of an insulating powder.
2. To determine the forced convection heat transfer rate from a pin fin and compare the temperature distribution with the estimated values.
3. To determine the emissivity of a test plate.
4. To find the heat transfer coefficient for dropwise and filmwise condensation**.**
5. To find heat transfer coefficient for different air flow rates through a pipe.

6. To find heat transfer coefficient for a constant air flow rate through a pipe with variable heat input.
7. To find the heat transfer coefficient of a vertical cylinder in natural convection.
8. To compare the overall heat transfer coefficient under parallel and counter flow conditions in a shell and tube heat exchanger.
9. To determine the thermal conductivity of a viscous liquid.
10. To determine the free convection heat transfer rate from a pin fin and compare the temperature distribution with the estimated values.
11. To demonstrate the super thermal conductivity by means of heat pipe demonstrator.
12. To calibrate a temperature sensor in temperature measurement test setup.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive evaluation	60
End Sem Lab Examination Marks	40

Indirect Assessment –

1. Student Feedback
2. **Mapping of Course Outcomes onto Program Outcomes**

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	3	1	1	2	3	3	-	1	3	2	2
CO2	3	3	3	3	3	1	1	2	3	3	-	1	3	2	2
CO3	3	3	3	3	3	1	1	2	3	3	-	1	3	2	2
CO4	3	3	3	3	3	1	1	2	3	3	-	1	3	2	2
CO5	3	3	3	3	3	1	1	2	3	3	-	1	2	2	2

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

COURSE INFORMATION SHEET

Course code: ME 304
Course title: Internal Combustion Engines Lab.
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1.5 L:0, T: 0, P: 3
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To make student familiar with various types I.C. Engines and exhaust measurement systems.
2	To make the student confident how to perform experiments related I.C. Engine and measurements of exhaust emissions.
3	To study performance and combustion characteristics of various I.C. Engines.

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the procedure to conduct experiments related to Internal Combustion Engines and exhaust measurement systems
CO2	Understand various parameters influence the performance of the Internal Combustion Engines.
CO3	Analyze the observations made through experiments
CO4	Apply the experimental knowledge how to perform the experiments in different manner.
CO5	Predicting the sources of errors and minimizing them in the experiments

List of experiments:

1. Economic speed test on 4- stroke, 4- cylinder Ambassador Petrol Engine.
2. Energy auditing and volumetric efficiency of 4-stroke, 4-cylinder Maruti Zen Petrol Engine.
3. Economic load test on twin cylinder, 4- stroke Peter Kirloskar Diesel Engine.
4. Performance study on M.P.F.I. Petrol Engine using Morse test.
5. Performance study on 4-cylinder, 4-stroke Diesel Engine.
6. Combustion characteristics (P-θ) diagram for variable loads on Mahindra Diesel Engine.
7. Analysis of exhaust emission (NOx, CO) of Diesel Engine.
8. Analysis of Exhaust emission (NOx, CO) of petrol Engine.

9. Study of M.P.F.I./S.P.F.I./ Carburetor system.
10. Study of Wankel rotary Engine.
11. Study of open cycle gas turbine.
12. Port timing diagram of two- stroke, single- cylinder Diesel Engine.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive evaluation	60
End Sem Lab Examination Marks	40

Indirect Assessment –

1. Student Feedback on Faculty

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3				2							2	1	1	1
CO2	3	3			2		2	1	3	2	1	2	2	2	2
CO3	3	3	2	3		1	2	1	3	2		2	2	3	3
CO4	3	3	1	3	2	2	2	1	3	2	1	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3			2	1	1	1

COURSE INFORMATION SHEET

Course code: ME 306
Course title: Mechanical Engineering Lab II
Pre-requisite(s): Basic knowledge of Thermal, Solar and Fluid Flow
Co- requisite(s): NIL
Credits: 1.5 (L: 0, T: 0, P: 3)
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions imparting the students to:

1.	To present real world engineering examples of Thermal, Solar and Fluid Flow.
2.	To make student familiar with modern experimental setups for Thermal, Solar and Fluid Flow.
3.	To incorporate theoretical knowledge in experiments.
4.	To compare analytical results with experimental results.
5.	To comment on inherent physics (not considered in theoretical analysis) of the system.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Evaluate the various salient outputs in Thermosyphonic mode of flow at different radiation levels and speeds.
CO2	Analyze the various characteristics of different pumps under different conditions.
CO3	Evaluate Meniscus Fluctuations.
CO4	Determine various characteristics with PV Module.
CO5	Determine flow characteristics and pattern in a wind tunnel.

Syllabus

ME 306 Mechanical Engineering Lab II

List of Experiments:

1. Evaluate the overall Heat Transfer Coefficient (U_L), Heat Removal Factor (F_R) and Thermal Efficiency of the Collector (η) in Thermosyphonic mode of flow at different radiation level.
2. Evaluate the overall Heat Transfer Coefficient (U_L), Heat Removal Factor (F_R) and Thermal Efficiency of the Collector (η) in Thermosyphonic wind speed.
3. Determine the Centrifugal Fan Characteristics.
4. Determine and plot velocity distribution curves for all orifice conditions.
5. Determine and plot the performance characteristics of Gear Oil Pump operating at various flow rates and speed.
6. Determine the Miniscus Fluctuation by varying different parameters.
7. Determine the I.V. and P.V. Characteristics of PV Module with varying Radiation and Temperature level.
8. Determine the I.V. and P.V. Characteristics of Series and Parallel combination of PV Module.
9. Determine the effect of variation in the tilt angle and evaluate the voltage and current of PV Module Power.
10. Demonstrate Flow Visualization during a flow past a blunt body.
11. Determine the Pressure Distribution around a Cylinder kept in Cross Flow of air.
12. Determine the Hydrodynamic Boundary Layer over a flat plate.

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	60
End Sem Lab Examination Marks	40

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	3	1	1	1	1	1	1	2	3	2	2
CO2	3	3	3	3	3	2	1	1	2	2	2	2	3	3	3
CO3	3	3	3	2	3	1	1	1	1	1	1	2	2	3	3
CO4	3	3	3	3	3	2	1	1	2	2	2	2	2	2	3
CO5	3	3	3	3	3	2	2	2	2	2	2	2	3	2	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2 & CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, & CD8
CD3	Seminars	CO3	CD1, CD2, CD5, & CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD5, & CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2 & CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: ME 357(Program Elective - II)
Course title: Measurement and Instrumentation
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3, T:0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To present a comprehensive knowledge of different measurement and instrumentation technologies available and in practice in modern day industry.
2	To lay the foundation to understand the basic principles of operation of various sensors and transducers.
3	To develop the knowledge needed to justify and select any specific type of instrumentation needed for any industrial/domestic application.
4	To present real world engineering examples of measurements and instrumentation.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand the static and dynamic characteristics of instruments with the sources/causes of error and do the analysis.
CO2	Contrast the diverse types of transducers available in the modern industry with reference to its characteristics and select one for a given situation.
CO3	Evaluate the incoming signal and apply suitable filters or transformations to make it suitable for the next processing.
CO4	Understand the working principle of advanced measurement equipment used in metrology.
CO5	Appreciate different type of sensors available as a standard device in the domestic, industrial and special applications.

Syllabus

Module	Lectures/hour
Module -I Measurement systems, Static characteristics of instruments, Errors in measurements and its statistical analysis, Dynamic characteristics of instruments and measurement systems.	8
Module –II Primary sensing elements and transducers: Classification and characteristics of transducers, Mechanical devices, Electric transducer: Resistance, Inductance and Capacitance based, Thermal sensitive devices, Strain gauges, LVDT and RVDT, Synchros and Resolvers, Piezo-Electric, Hall effect, Optoelectronic devices, Semiconductor devices, Polarized light, Radiometry, Digital devices.	8
Module – III Signal conditioning: Op-Amp circuits, Differential amplifier, Amplitude modulation and demodulation, Filters and its types, Current sensitive circuits, A/D and D/A circuits. Display devices and recorders.	8
Module – IV Metrology: Measurement of length and angle, Dimensional measurements and standards, Gauges, Comparators, Interferometry, Optical flat, Measurement of area. Pressure measurements: Mechanical and Electromechanical Gauges, Viscosity and Ionization gauges.	8
Module –V Strain gauges, calibration, temperature compensation, and associated circuitry. Force, Torque and Power measurements, Velocity and vibration measurements, Flow measurements and Temperature measurements. Special measurements: Level, Density, Viscosity, Nuclear radiation, pH, Humidity, Open loop and closed loop control.	8

TEXTBOOKS:

T1. A. K. Sawhney and Puneet Sawney, Mechanical Measurements and Instrumentation and Control, Dhanpat Rai and Co., 2016
T2. R. K. Rajput, Mechanical Measurements and Instrumentation, S.K. Kataria& Sons, 2013
T3. Helfrickand Cooper, Modern Electronic Instrumentation & Measurement Techniques, PHI, 2011.

REFERENCE BOOKS:

R1. D. Patranabis, Sensors and Transducers, PHI, 2003.
R2. H. S. Kalsi, Electronic Instrumentation, McGraw Hill, 2017.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	2	2	2	-	-	-	-	-	-	-	3	2	-
CO2	3	3	2	3	3								3	2	-
CO3	3	3	3	3	3								3	2	-
CO4	3	3	3	2	3								3	2	-
CO5	3	3	3	3	3								2	2	-

2. Correlation Levels 1, 2 or 3 as defined below:
3. 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1-5	CD1, CD2, CD5,CD8
CD2	Tutorials/Assignments	CO1-5	CD1, CD2
CD3	Seminars		
CD4	Mini Projects/Projects		
CD5	Laboratory Experiments/Teaching Aids	CO1-5	CD1, CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets	CO1-5	
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: ME 349(Program Elective -II)
Course title: Turbomachinery
Pre-requisite(s): ME 203 Fluid Mechanics and Hydraulic Machines
Co- requisite(s): NIL
Credits: 3 L:3, T:0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To present a comprehensive and rigorous treatment of classical turbo machinery while retaining an engineering perspective.
2	To lay the groundwork for subsequent studies in such fields as analysis of various turbo machines and energy conversion systems and to prepare the students to effectively use Fluid mechanics and thermodynamics theory in the practice of turbo machinery in engineering.
3	To develop an intuitive understanding of turbo machinery by emphasizing the engineering and engineering arguments.
4	To present a wealth of real-world engineering examples to give students a feel for how turbo machinery theories are applied in engineering practice.

Course Outcomes

After the completion of this course, students will be:

CO1	Outline the fluid mechanics, thermodynamics concepts, system of control volume, to turbomachines
CO2	Apply the appropriate fundamental laws of fluid dynamics, thermodynamics to various turbomachines.
CO3	Analyze various turbomachines for energy transfer
CO4	Evaluate the performance of various turbomachinery components
CO5	Create optimum aerodynamic design/geometrical dimension of simple, complex turbomachinery components using conventional methods and modern tools.

Syllabus

Module	Lectures/hour
Module -I Introduction to turbomachines, classification of turbomachines, momentum, and moment of momentum theory applied to moving blades, change in total enthalpy and total pressure, velocity triangles for radial and axial flow turbomachines. Basic aero foil theory applied to axial flow blades, non-dimensional performance parameters, specific speed, flow coefficient and head coefficient.	8
Module –II Steam and gas turbines: Steam flow through nozzles, critical pressure ratio, and choking of nozzles, throat and exit areas for optimum discharge, impulse and reaction stage, flow of steam through turbine blades, velocity diagrams, stage and other efficiencies, condition for maximum efficiency of a single stage turbine, compounding of steam turbines. Axial flow gas turbines, turbine characteristics and performance, simple design calculations.	8
Module – III Centrifugal and Reciprocating compressors: Compressor components and their function, the compression process, work required, polytropic efficiency, pressure rise, slip, effect of blade shape, two-dimensional flow through impeller, vaned diffuser and volute casing, surging and choking of compressors, compressor performance and characteristic curves, simple design calculations.	8
Module – IV Axial flow compressors: Cascade analysis, vortex theory, work required, polytropic efficiency, pressure rise, degree of reaction, simple design calculations, surging and stalling of compressors, compressor performance and characteristic curves.	8
Module –V Fans and Blowers: Classification, construction and power requirement, pressure rise, efficiency calculations, applications in boilers, cooling towers, reversible fans and blowers, and other industrial applications, simple design calculations.	8

Textbooks:

T1. Turbines, Compressors & Fans, S. M. Yahya, Tata-McGraw Hill Co.
T2. An Introduction to energy conversion, Volume III - Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers (P) Ltd.
T3. Principles of Turbo Machinery, D. G. Shepherd, The Macmillan Company.

Reference Books:

R1. Fluid Mechanics and Thermodynamics of Turbomachinery, S. L. Dixon.
R2. Fundamentals of Turbomachinery, William W Perg, John Wiley & Sons, Inc.
R3. A Text book of Turbomechanics- M.S.Govindgouda&A.M. Nagaraj, M.M.Publications.

Online Resources:
http://nptel.ac.in/courses/112106200/18#
http://nptel.ac.in/courses/112106175/Module%204/Lecture%2034.pdf
http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-1.htm
http://nptel.ac.in/downloads/101101058/

Gaps in the syllabus (to meet Industry/Profession requirements)
Outline of various CFD softwares used in design and analysis of turbomachines.

POs met through Gaps in the Syllabus
PO1 TO PO5 & PO12

Topics beyond syllabus/Advanced topics/Design
Detailed analysis of different testing process.

POs met through Topics beyond syllabus/Advanced topics/Design
PO1 TO PO5&PO12

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1.Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	1							2	3	2	-
CO2	3	3	3	2	2							2	3	2	-
CO3	3	3	3	2	2							2	3	2	-
CO4	3	3	3	2	2				2	1	1	2	3	2	-
CO5	3	2	2	2	2				2	1	1	2	2	2	-

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1-5	CD1, CD2, CD5,CD8
CD2	Tutorials/Assignments	CO1-5	CD1, CD2
CD3	Seminars		
CD4	Mini Projects/Projects		
CD5	Laboratory Experiments/Teaching Aids	CO1-5	CD1, CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets	CO1-5	
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: PE 317 (Program Elective -II)
Course title: Advanced Welding Technology
Pre-requisite(s): PE 214:Metallurgical and Materials Engineering, PE 216:Foundry, Forming & Welding Technologies/PE-213 Manufacturing Processes
Co- requisite(s): Nil
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Learn about the fundamental principles, process parameters and application possibilities of solid-state welding and radiant beam welding processes
2	Learn about the fundamental principles, process parameters and application possibilities of hybrid welding and allied processes
3	Understand different techniques applied for different welding positions and welding conditions
4	Understand the use of welding symbols and design procedure for weld joints under different loading conditions
5	Learn about weldability of specific materials and welding applications

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

CO1	Classify solid-state welding and radiant beam welding processes and identify their advantages, limitations and application possibilities
CO2	Compare the fundamental principles, equipment, parameters and applications of different hybrid welding, thermal cutting and metal surfacing processes
CO3	Select appropriate techniques for different welding positions and welding conditions
CO4	Design weld joints for different loading conditions and to minimize weld distortion
CO5	Select appropriate welding techniques for different sets of materials for different welding applications

Syllabus

Module	Lectures/hour
Module 1: Solid state welding and radiant beam welding Fundamental principles, process parameters, machines and equipment, advantages, limitations and application possibilities of cold welding, diffusion welding, forge welding, friction and inertia welding, explosive welding, ultrasonic welding; Fundamental principles, process parameters, machines and equipment, advantages, limitations and application possibilities of electron beam welding and laser beam welding; principle of conduction mode and keyhole welding.	8
Module 2: Advanced welding and allied processes Laser arc hybrid welding - fundamental principles, hybrid laser GMAW process, hybrid laser GTAW process, hybrid laser PAW process, paraxial and coaxial arrangements, welding parameters, joint gap, joint configuration and edge preparation, weld quality and industrial applications. Thermal cutting processes – oxygen cutting, arc cutting, high energy beam cutting; metal surfacing – cladding, hard facing, build-up, buttering; metal spaying processes; soldering, brazing and braze welding.	8
Module 3: Welding positions and welding conditions Processes and conditions for welding in down hand or flat, horizontal, vertical and overhead positions; Welding in wind; welding at low ambient temperatures; welding in vacuum; welding in space; underwater welding processes.	8
Module 4: Residual stress, weld design, and pre/post heat treatments Principle of residual stress, types of residual stress, methods of identifying residual and the stress reliving methods. Numerical problems in residual stresses; principle of distortions, types of distortion, methods of the eliminating distortion. Types of welded joints, design of butt joints, lap joints, eccentrically loaded joints, welding symbols, estimation of preheat temperature and post heat temperature.	8
Module 5: Weldability of specific materials and welding applications Weldability of carbon steels, stainless steels, high alloy steels, cast iron, aluminium, copper and titanium; Application of welding in automobile industries, aerospace industries, ship building industries; concept of robotized welding and welding automation	8

Textbooks:

1. R .L. Little, Welding and Welding Technology, Tata McGrawHill**[T1]**
2. R.S. Parmar, Welding Processand Technology, Khanna Publishers[**T2]**
3. O.P. Khanna, Welding Technology, Dhanpat Rai Publication **[T3]**

Reference books:

1. H.B.CaryandS.C.Helzer,ModernWeldingTechnology,Pearson/PrenticeHall.[**R1**]
2. J.Lawrence,AdvancesinLaserMaterialsProcessing2e,WoodheadPublishing/Elsevier.**[R2]**
3. WeldingHandbook,9thed.,Vol.2,WeldingProcesses.AmericanWeldingSociety.[**R3**]

Gaps in the syllabus(to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/ Design:

Welding of polymers and composites, Simulation of welding process

POsmetthroughTopicsbeyondsyllabus/Advancedtopics/Design:POs1-4,12

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self-learning such as use of NPTEL materials and internets	√
CD7	Simulation	

Course Evaluation:

Direct Assessment-

Assessment Tool	**%Contribution during CO Assessment**
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	**%Distribution**				
Mid Semester Examination	25				
Quizzes	10 +10				
Assignment	5				
End Semester Examination	**%Distribution**				
End Semester Examination	50				
Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Semester Examination	√	√			
Quiz1	√	√			
Quiz2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment–

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes(Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	2	1								2	3	2	3
CO2	3	2	2	1	1							2	3	2	3
CO3	3	3	3	2	1							2	3	3	3
CO4	3	3	3	2	1					1		2	3	3	3
CO5	3	3	3	2	1							3	3	3	3

1:Slight(Low)2: Moderate(Medium)3:Substantial (High)

Mapping Between Course Outcomes(Cos)and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD2, CD3, CD6
CO2	CD1,CD2, CD3, CD6
CO3	CD1,CD2, CD3, CD6
CO4	CD1,CD2, CD3, CD6
CO5	CD1,CD2, CD3, CD6

COURSE INFORMATION SHEET

Course code: ME 351 (Program Elective -II)
Course title: Finite Element Methods
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To present a comprehensive treatment on finite element methods.
2	To lay the groundwork for subsequent studies in the fields of stress, strain, including the design aspects.
3	To develop an intuitive understanding of various mathematical techniques to solve the problems.
4	To be able to understand and tackle various problems under different loading conditions.

Course Outcomes

After the completion of this course, students will be able to:

CO1	To understand the fundamentals of Finite Element Methods.
CO2	To develop an intuitive understanding of finite element techniques by emphasizing the engineering arguments.
CO3	To apply the finite element methods for solving differential equations arising in solid and fluid mechanics.
CO4	To evaluate the stresses, strains in real-world examples related to mechanical engineering
CO5	To analyze the strength of the mechanical members.

Syllabus

Module	Lectures/hour
Module –I Overview of Engineering systems: Continuous and discrete systems. Introduction to finite element method.	8
Module –II Energy methods: Variational principles and weighted residual techniques (least square method, collocation, sub-domain collocation, Galerkin method) for one-dimensional equation, Rayleigh-Ritz Formulation.	8
Module – III Finite elements for one-dimension: linear element, continuous piecewise smooth equation, analysis of simply supported beam, matrix notation, direct stiffness matrix, global stiffness matrix.	8
Module – IV Finite elements for two-dimensions: Equivalence between energy formulation and Galerkin approach, discretization concepts, choice of elements, derivation of element shape functions (Lagrangian and Hermite) in physical coordinates, Iso-parameteric mapping, numerical integration.	8
Module –V Generate shape function and natural coordinates, solving finite element problems using code/software.	8

TEXTBOOKS:

T1. S.S. Rao, *The Finite Element Method in Engineering*, 5th Ed., Butterworth-Heinemann, 2012.

T2. T.R. Chandrupatla, A.D. Belegundu, *Introduction to Finite Elements in Engineering*, 3rd Ed., PHI Learning Pvt. Ltd, 2002.

T3. R.D. Cook, D.A. Malkus, M.E. Plesha, R.J. Witt, *Concepts and Applications of finite element analysis*, John Wiley & Sons, 4th edition, 2002.

REFERENCE BOOKS:

R1. D.L. Logan, *A First Course in Finite Element Method*, Fourth Ed., Cengage Learning, 2007.

Gaps in the syllabus (to meet Industry/Profession requirements)
Implementation of finite element methods in computer codes

POs met through Gaps in the Syllabus
PO1 TO PO6 & PO9

Topics beyond syllabus/Advanced topics/Design
NA

POs met through Topics beyond syllabus/Advanced topics/Design
PO1 TO PO6

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment –

1. Student Feedback

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	-	-	1	2	-	1	1	-	-	2	3	2	2
CO2	3	3	2	-	3	2	1	1	2	2	-	2	3	2	2
CO3	3	3	3	2	3	3	1	1	2	2	2	2	3	2	2
CO4	3	3	2	3	3	3	1	1	2	-	-	2	3	2	2
CO5	3	3	3	3	3	3	1	2	3	2	2	2	2	2	2

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors	CO-1-5	CD1
CD2	Tutorials/Assignments	CO-1-5	CD2
CD3	Seminars	-	-
CD4	Mini projects/Projects	-	-
CD5	Laboratory experiments/teaching aids	-	-
CD6	Industrial/guest lectures	-	-
CD7	Industrial visits/in-plant training	-	-
CD8	Self- learning such as use of NPTEL materials and internets	CO-1-5	CD8

COURSE INFORMATION SHEET

Course code: ME 353(Program Elective -II)
Course title: Computational Fluid Dynamics
Pre-requisite(s): ME 203: Fluid Mechanics and Hydraulic Machines
Co- requisite(s): Nil
Credits: 3 L: 3, T:0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

The primary objective of the course is to introduce the basic aspect of numerical approach of flow problems. It would cover issues like representation of mathematical formula; classification of flow problem; approximating it and its stability analysis.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Outline the governing equations.
CO2	Examine and Analysis of classification of PDE.
CO3	Analyze and formulate finite difference approximations.
CO4	Extent and formulate numerical schemes.
CO5	Evaluate applicability of numerical schemes.

Syllabus

Module	Lectures/hour
Module –I Governing equations; conservative and non-conservative forms of equations; models of flow.	8
Module –II Mathematical classification of Partial differential equations; Elliptic, Parabolic and hyperbolic equations; linear and non-linear PDE; initial and boundary conditions.	8
Module – III Basic aspects of discretization: finite difference approximations by forward, backward and central differencing up to fourth order accuracy.	8
Module – IV Consistency analysis; linearization; Explicit and Implicit Schemes, Error analysis.	8
Module –V Stability Analysis: Discrete Perturbation Stability Analysis; Von-Newmann Stability Analysis, Case study on Lid Driven Cavity problem.	8

Textbooks:

1. Computational Fluid Dynamics – The Basics with Applications (J. D. Anderson Jr.)
2. Computational Fluid Dynamics (J. D. Anderson)

Reference books

1. Computational Fluid Dynamics – Principles and Applications (J. Blazek)
2. Numerical Computation of Internal and External Flows (C. Hirsch)

Gaps in the syllabus (to meet Industry/Profession requirements)
Finite Volume approach

POs met through Gaps in the Syllabus
PO2, PO5, PO6 and PO10

Topics beyond syllabus/Advanced topics/Design
Numerical approach for Incompressible, compressible flows

POs met through Topics beyond syllabus/Advanced topics/Design
PO2, PO4, PO5, PO6, PO7 and PO12

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3		1	1	2	1	2						3	2	2
CO2	3	3	1	1	1	1	2						3	2	2
CO3	3	3	1	2	1	1	1		1			1	3	2	2
CO4	2	2	2	2	2	2	2		2	1		1	3	2	2
CO5	3	3	3	2	2	2	3	1	2	1	1	2	2	2	2

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO (1-5)	CD1
CD2	Tutorials/Assignments	CO (1-5)	CD2
CD3	Seminars	-	-
CD4	Mini projects/Projects	-	-
CD5	Laboratory experiments/teaching aids	-	-
CD6	Industrial/guest lectures	-	-
CD7	Industrial visits/in-plant training	-	-
CD8	Self- learning such as use of NPTEL materials and internets	CO (1-5)	CD8
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: ME 355(Program Elective -III)
Course title: Advanced Solid Mechanics
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3, T: 0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

To acquaint with the solution of advanced problems in mechanics of materials that are generally considered beyond the scope of basic course in the discipline.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Outline the basic concepts of three –dimensional stress and strain as well as three-dimensional Mohr's circle.
CO2	Analyze beam-column structure and column with energy methods
CO3	Analyze the stresses resulting from asymmetrical bending of straight beam and curved beams
CO4	Evaluate the torsion problems of non- circular bars.
CO5	Apply the concept of thermal elastic stress strain relation

Syllabus

Module	Lectures/hour
Module –I Review of basic concepts and equations in mechanics; Theory of 3D stress; Equilibrium equations in different types of coordinate systems; Stress transformation; Mohr's circle for stress in three dimensions; Principal stresses; Boundary conditions; Theory of 3D Strains; Strain transformation; Compatibility equations; Generalized Hooke's law.	9
Module –II Concept of elastic stability; Introduction to Beam-column: Equations, Beam-column with several concentrated loads, Beam-column with end couple; Buckling of columns by energy method, approximate calculation of critical load by energy method; Columns with variable cross sections.	8
Module – III Pure bending; Asymmetrical bending of straight beams; Inelastic bending of beam; Plastic bending; Plastic hinge; Plastic analysis of beams.	8
Module – IV Torsion of circular shaft; Torsion of bars of any cross-section; St. Venant's theory; Prandtl's method; Solutions for circular and elliptical cross-sections; Torsion of rectangular bar; Torsion of thin-walled tubes.	8
Module –V Thermal stress; Thermo elastic stress-strain relations; Analysis of stress in thin circular disks with symmetrical temperature variation, long circular cylinder when temperature is symmetrical about the axis, Spheres with purely radial temperature variation, curved beam due to thermal loading.	9

Textbooks:

1. Advanced Mechanics of Solid by L.S. Srinath, Tata Mc-Graw-Hill.
2. Advanced Mechanics of Materials by **Richard J. Schmidt** and **Arthur P. Boresi, Wiley.**
3. Mechanics of Materials by James M. Gere and Stephen P. Timoshenko, C B S Publishers & Distributors Pvt. Ltd.

Reference Books:

1. Theory of Elastic stability by S. Timoshenko & G. H. Gere.
2. Introduction to Solid Mechanics by I.H. Shames, J. M. Pitarresi, Prentice-Hall

Gaps in the Syllabus (to meet Industry/Profession requirements)
Airy's Stress function, Solution of Axisymmetric problems
POs met through Gaps in the Syllabus
PO1 TO PO5

Topics beyond Syllabus/Advanced topics/Design
Analysis of composite material

POs met through Topics beyond Syllabus/Advanced topics/Design
PO1 TO PO5

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	1	2	1	1		1	1		2	3	2	1
CO2	3	3	2	3	2	1	1	1	2			2	3	2	1
CO3	3	3	2	3	2	1	1	1	2			2	3	2	1
CO4	3	3	3	3	2	1	1	1	2			2	3	2	1
CO5	3	3	3	3	2	1	1	1	2			2	2	2	1

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		-	-
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		-	-
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: ME 377(Program Elective -III)
Course title: Mechatronics
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3, T: 0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives
This course enables the students:

1	To present a comprehensive treatment on Mechatronics and Real time interfacing.
2	To lay the groundwork for subsequent studies in the fields of sensors, actuators and digital technologies
3	To develop an intuitive understanding of various microcontrollers and automated systems for system design
4	To be able to understand and tackle various problems of conventional approach to design and solve case studies with robotics and automation

Course Outcomes
After the completion of this course, students will be:

CO1	Understand the importance of mechatronics and its application in real world.
CO2	To know for the latest design considerations and concepts in new products
CO3	Analyze different systems and take challenges to design newer technology
CO4	Able to understand the different components like drives and sensors
CO5	Outline the concepts changes done and what are the needs and advantages of implementing Mechatronics.

Syllabus

Module	Lectures/hour
Module -I Introduction: Definition of Mechatronics, Mechatronics in manufacturing products and design, Review of fundamentals of electronics, Gates and K map Minimization, JK Flip Flop	8
Module –II Signal Conditioning: Mechatronics elements, Data Conversion Devices, Sensors and transducers, Microsensors, Signal processing Devices, Relays, Comparators, Filters, Timers, Transfer Systems, PLC's programming	8
Module – III Processors Controllers and Drives: Microprocessors, Microcontrollers, Drives, Linear motion bearings, cams and ball screws, PID controllers, Closed Loop and Open loop	8
Module - IV Actuators: Servo motors, Stepper motors, Hydraulic actuators, Flow, Pressure and Direction control valves, Pneumatic Actuators, Distribution and conditioning of Compressed air, system components and graphic representations	8
Module –V CNC Technology and Robotics: CNC Machines and Part programming, Real time Systems, Industrial Robotics, Case Studies	10

Text book:

1. Introduction to Mechatronics and Measurement System by David G. Alciatore, Michael B. Histamd, McGraw Hill.
2. Mechatronics by Bolton, Pearson Education

Reference books:

1. Mechatronics System Design by Devdas and Shetty, Pearson Education
2. CNC TECHNOLOGIES BY HMT LTD MGH

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	-	-	1	2	-	1	1	-	-	2	3	2	3
CO2	3	3	2	-	3	2	1	1	2	2	-	2	3	2	3
CO3	3	3	3	2	3	3	1	1	2	2	2	2	3	2	3
CO4	3	3	2	3	3	3	1	1	2	-	-	2	3	2	3
CO5	3	3	3	3	3	3	1	2	3	2	2	2	2	2	3

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		CO 1-5	CD5
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		CO3, CO5	CD8
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: PE 318(Program Elective -III)
Course title: Rapid Prototyping and Tooling
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1	Understand technology used in rapid prototyping and tooling.
2	Recognize importance of rapid prototyping in advance manufacturing process.
3	Acquireknowledge,techniquesandskillstoselectrelevantrapidprototypingandtoolingprocess .
4	Comprehendthepotentialofrapidprototypingandtoolingindifferentindustrialsectors.
5	Illustrated3Dprinting technology for Rapid prototyping and tooling

Course Outcomes

After the completion of this course, students will be able to:

CO1	Explain rapid prototyping and tooling for manufacturing complex geometries.
CO2	Identify and solve problems related to rapid prototyping and tooling.
CO3	Select suitable process and materials for rapid prototyping and tooling
CO4	Distinguish technique of CAD and reverse engineering for geometric transformation in rapid prototyping and tooling.
CO5	Determinepartorientation,applysuitableslicingalgorithmandgeneratetoolpathforminimum build time.

Syllabus

Module	Lectures/hour
Module 1: Introduction Evolution, basic principle, concept, procedure and need of rapid prototyping and tooling, Classification of rapid prototyping and tooling processes (Additive/Subtractive/Deformative), Classifications of materials used for Rapid prototyping and tooling, Industrial applications of rapid prototyping and tooling, most commonly used processes for rapid prototyping.	8
Module 2: Processes used for rapid prototyping and tooling Stereolithography Apparatus (SLA), Fused Deposition Modeling (FDM), Selective Deposition Lamination (SDL), Laminated Object Manufacturing (LOM), Ultrasonic Consolidation, Laser Engineered Net Shaping (LENS), Electron Beam Free Form Fabrication (EBFFF), Selective Laser Sintering (SLS), Electron Beam Melting	8

(EBM). Convectional Tooling vs Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect rapid tooling methods.	
Module 3: CAD for rapid prototyping and tooling Preparation of 3D-CAD model in STL format, Reverse engineering, Reconstruction of 3D- CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and generation of codes for tool path.	8
Module 4: Constructions of manipulator systems for rapid prototyping and tooling Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors, Energy delivery systems, Material delivery systems.	8
Module 5: Post processing in rapid prototyping and tooling Support material removal, Surface texture improvement, Accuracy improvement, Aesthetic improvement, Property enhancements using non-thermal and thermal techniques.	8

Textbooks:

1. Chua C.K.,LeongK.F.,andLimC.S.,"Rapidprototyping:Principlesandapplications",Third Edition, World Scientific Publishers, 2010.[T1]
2. Gebhardt A., "Rapidprototyping",HanserGardenerPublications,2003.[T2]
3. Ian Gibson, "Software Solutions for Rapid Prototyping", Professional Engineering Publishing Limited, UK, 2002.[T3]

Reference books:

1. LiouL.W.andLiouF.W.,"RapidPrototypingandEngineeringapplications:Atoolboxfor prototype development", CRC Press,2007.[R1]
2. KamraniA.K.andNasrE.A.,"RapidPrototyping:Theoryandpractice",Springer,2006.[R2]
3. HiltonP.D.andJacobsP.F.,"RapidTooling:TechnologiesandIndustrialApplications",CRC press,2000.[R3]

Gaps in the Syllabus(to meet Industry/Profession requirements):
Rapid Freeze Prototyping

POs met through Gaps in the Syllabus:
POs1,2,5

Topics beyond Syllabus/Advanced topics/Design:
Rapid Tooling Injection Molded Prototypes

POs met through Topics beyond Syllabus/Advanced topics/Design:
POs1,8,12

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self-learning such as use of NPTEL materials and internets	√
CD7	Simulation	

Course Evaluation:

Direct Assessment-

Assessment Tool	%Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	%Distribution
Mid Semester Examination	25
Quizzes	10 +10
Assignment	5
End Semester Examination	**%Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz1	√	√			
Quiz2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment–

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) on to Program Outcomes(POs) and Program Specific Outcomes (PSOs):

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	1	2		3	2		1	1	1			1	2	1	2
CO2	1	3	1	2					2			1	2	2	2
CO3	1		2	1		1			1				3	1	3
CO4		2	2	1	2		1		1	2			3	1	3
CO5	1	3		1	1		1		2	1		1	2	2	3

1:Slight(Low)2: Moderate(Medium)3:Substantial (High)

Mapping Between Course Outcomes(Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD2, CD6
CO2	CD1,CD2, CD6
CO3	CD1,CD2, CD6
CO4	CD1,CD2, CD6
CO5	CD1,CD2, CD6

COURSE INFORMATION SHEET

Course code: ME367 (Program Elective -III)
Course title: Industrial Tribology
Pre-requisite(s): - Nil
Co- requisite(s): - Nil
Credits: 3 L:3, T:0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1	Understand of basic principles of tribology and its role in engineering.
2	Apply concepts of wear, friction and lubrication for industrial significance and economic aspects.
3	Understand in detail necessity of tribology and lubrication in real world.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Describe role of tribology in engineering.
CO2	Analysis of contact surfaces phenomenon and friction.
CO3	Identification of wear type and quantification.
CO4	Description and understanding of lubrication mechanisms.
CO5	Implementation of industrial applications of tribology and lubrication.

Syllabus

Module	Lectures/hour
Module -I **Tribology** Introduction and historical background, nature of engineering surfaces, Role of tribology in MEMS/NEMS, factors influencing tribological phenomena. Engineering surfaces- Surface characterization, Computation of surface parameters, Surface measurement techniques, Introduction to micro and nano tribology, Industrial significance and economic aspects.	7
Module –II **Contact of engineering surfaces** Hertzian and non-hertzian contact. Contact pressure and deformation in non-conformal contacts, Genesis of friction, friction in contacting rough surfaces, sliding and rolling friction, Various laws and theory of friction. Atomic scale understanding of friction, Surface forces (van der Waals, electrostatic, hydrogen bonding etc.), stick-slip phenomenon, friction anisotropy.	8
Module – III **Wear** Wear and wear types, Mechanisms of wear - Adhesive, abrasive, corrosive, erosion, fatigue, fretting, etc., Wear of metals and non-metals. Wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage, wear controlling techniques.	8
Module - IV **Lubrication** Lubricant composition, lubricant types, physical and chemical properties, effect of temperature and pressure on viscosity, additive role and types, elements of lubrication, Lubrication regimes- Boundary Lubrication, Mixed Lubrication, Hydro dynamic lubrication.	8
Module –V **Industrial applications** Solution of tribological problems and recent developments, an overview of engineering materials having potential for tribological application, rolling element bearings, gears, crank shafts, piston rings, cylinder liners etc.	8

Textbooks

1. M. Hutchings, Tribology: Friction and Wear of Engineering Materials, Edward Arnold, 1992.
2. K. C. Ludema, Friction, Wear, Lubrication: A Textbook in Tribology, CRC Press, 1996.
3.R. D. Arnell, P. Davies, J. Halling, and T. Whomes, Tribology Principles and Design Applications, MacMillan, 1991.

Reference Books

1. G Bayer, Mechanical wear prediction and prevention- Marcel Dekkar. Inc., New York.
2. B. Bhushan, Principles and Applications of Tribology, Willey –IEEE, 1999.
3. P. Sahoo. Industrial Tribology, Tata McGraw Hill.

Web links

1. www.tribology-abc.com
2. www.ltu.se/tfm/me
3. www.skf.com
4. www.statoillubricants.com
5. www.stle.org
6. www3.imperial.ac.uk/tribology

Course Outcome (CO) Attainment Assessment Tools & Evaluation ProcedureDirect Assessment

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	2	2	2	3						1	3	2	1
CO2	3	3	2	2	2	3						1	3	2	1
CO3	3	3	3	2	2	2						1	3	2	1
CO4	3	2	3	2	2	2						1	3	2	1
CO5	3	2	3	2	3	2						1	2	2	1

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods			
CD	**Course delivery methods**	**Course outcome**	**Course delivery method**
CD1	Lecture by use of boards/LCD projectors	CO1-5	CD1
CD2	Tutorials/Assignments	CO1-5	CD2
CD3	Seminars	-	-
CD4	Mini projects/Projects	-	-
CD5	Laboratory experiments/teaching aids	-	-
CD6	Industrial/guest lectures	-	-
CD7	Industrial visits/in-plant training	-	-
CD8	Self- learning such as use of NPTEL materials and internets	-	-
CD9	Simulation	-	-

COURSE INFORMATION SHEET

Course code: ME 392(Open Elective -II)
Course title: Renewable Energy Sources
Credits: 3 (L: 3, T: 0, P: 0)
Class schedule per week: 03
Class: B. Tech
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions imparting the students to:

1.	To understand the difference between the non-renewable energy system and the renewable energy systems
2.	To lay the groundwork for subsequent studies in the fields of renewable energy sources
3.	To develop an intuitive understanding of the applications of different renewable energy sources like solar, wind, biomass, ocean thermal, geothermal etc.
4.	To understand the working principles related to different renewable energy systems
5.	To understand state of art renewable energy system used in industrial application.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Outline the various sources of energy
CO2	Understand the working principle of different solar thermal energy systems and Photo-voltaic system
CO3	Understand the working principle of wind energy conversion system
CO4	Demonstrate the working principles of different biomass system
CO5	Understand the working principles and applications of different renewable energy sources like solar, wind, biomass, ocean thermal, geothermal etc.

Syllabus

Module	Lectures/hour
Module -I Introduction, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Needs of renewable energy, Classification of Energy Resources, Conventional Energy Resources - Availability and their limitations; Non-Conventional Energy Resources – Classification, Advantages, Limitations, Comparison of Conventional and Non-Conventional Energy Resources, World Energy Scenario, Indian Energy Scenario.	8
Module –II Introduction, Solar Radiation, Solar Constant, Basic Sun-Earth Angles, Solar Radiation Geometry and its relation, Measurement of Solar Radiation, Principle of Conversion of Solar Radiation into Heat, Collectors, (Flat Plate and Concentrating Collectors), Solar Water Heaters , Solar Cookers , Solar driers, Solar Still, Solar Furnaces, Solar Green Houses. Solar Photovoltaic, Solar Cell fundamentals, characteristics, classification, construction of module, panel and array. Solar PV Systems (stand-alone and grid connected), Solar PV Applications.	8
Module – III Introduction, Wind and its Properties, History of Wind Energy, Wind Energy Scenario – World and India. Basics of lift and drag, Basic principles of Wind Energy Conversion Systems (WECS), Classification of WECS, Parts of WECS, Derivation for Power in the wind, Electrical Power Output and Capacity Factor of WECS, Wind site selection consideration, wind farm, Advantages and Disadvantages of WECS.	8
Module - IV Introduction, Photosynthesis process, Biomass fuels, Biomass conversion technologies, Urban waste to Energy Conversion, Biomass Gasification, Biomass to Ethanol Production, Biogas production from waste biomass, factors affecting biogas generation, types of biogas plants, energy plantation, Biomass program in India.	8
Module –V Tidal Energy, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants. Ocean Thermal Energy Conversion (OTEC), Principle of OTEC system, Methods of OTEC power generation – Open Cycle (Claude cycle), Closed Cycle (Anderson cycle). Geothermal Energy, Resources of geothermal energy, Hydrogen and Storage, Fuel Cell Systems, Hybrid Systems.	8

TEXTBOOKS:

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 1996.
2. Rai. G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2011.
3. Twidell, J.W. & Weir, A., “Renewable Energy Sources”, EFN Spon Ltd., UK, 2006.

REFERENCE BOOKS:

1. Sukhatme. S.P., “Solar Energy”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. Tiwari. G.N., Solar Energy – “Fundamentals Design, Modelling& Applications”, Narosa Publishing House, New Delhi, 2002.
3. Freris. L.L., “Wind Energy Conversion Systems”, Prentice Hall, UK, 1990.

4. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2009.

Gaps in the Syllabus (to meet Industry/Profession requirements)

1. Application of various energy heat storage in various renewable energy systems.
2. Application of state of art solar cells in various industrial applications.
3. Applications of geothermal energy in solar desalination system.

POs met through Gaps in the Syllabus: 1-4, 7, 11, and 13

Topics beyond Syllabus/Advanced topics/Design

1. Design and Optimization of Hybrid PV-Wind Renewable Energy
2. Projected impacts of climate change on wind energy density in India.
3. Submerged PV Solar Panel for Swimming Pools.

POs met through Topics beyond Syllabus/Advanced topics/Design: 1-4, 7, 11, and 13

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	2	1	1	1	2	2	1	1		1	3	2	1
CO2	3	2	2	2	1	1	2	2	1	1		1	3	2	1
CO3	3	2	2	2	1	1	2	2	1	1		1	3	2	1
CO4	3	2	2	2	1	1	2	2	1	1		1	3	2	1
CO5	3	2	2	2	1	1	2	2	1	1		1	2	2	1

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1	CD1, CD2 & CD8
CD2	Tutorials/Assignments	CO2	CD1, CD2, CD5, & CD8
CD3	Seminars	CO3	CD1, CD2, CD5, & CD8
CD4	Mini Projects/Projects	CO4	CD1, CD2, CD5, & CD8
CD5	Laboratory Experiments/Teaching Aids	CO5	CD1, CD2 & CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course Code: ME 393 (Open Elective -II))
Course Title: Elements of Hydel and Thermal Power Plants
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits:03 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: FIFTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions imparting the students to:

1	Classify different types of hydel power plants
2	Solve and correlate different measurements needed in the designing of hydel power plants
3	Demonstrate different types of steam generators and its components
4	Familiarize with different coal handling systems
5	Analyze and solve various problems in draught systems

Course Outcomes

At the end of the course, students will be able to:

CO1	Understand the concept of power generation by hydro energy.
CO2	Analyze the various measurements required in designing of hydel power plants
CO3	Understand the types, components, and auxiliaries of the steam generators
CO4	Understand the major systems of a coal handling facility from coal delivery to the generating units
CO5	Analyze the draught systems and classify different types of condensers

Syllabus

MODULE	LECTURE HOURS
Module – I **Hydel Power plants:** Introduction, Classification of Hydropower plants, Pump Storage power plants, Combine Hydro and Steam turbine Power Plants, essential features of Hydro-electric power plants.	**8**
Module – II **Components of Hydro- electric power plants:** Hydraulic turbines, draft tube, Surge Tanks. Run- off measurements, Hydrograph and Flow duration curve, Mass curve.	**8**
Module – III **Thermal Power Plants:** General layout of thermal power plant, Site selection, Major components. Steam Generators: Boiler mounting and accessories, Different types of super-heaters, Re-heaters, economizers, Air preheaters, Methods of superheat control, Corrosion in boilers and its prevention.	**8**
Module – IV **Coal & Ash Handling Systems:** Coal handling storage of coal, Burning systems, Pulverized fuel handling systems, Unit and central systems, Pulverized mills- ball mill, Bowl mill, Ball &race mill, Impact or hammer mill, Pulverized coal burners, Oil burners. Necessity of ash disposal with respect to state and central pollution control rules, Mechanical, Hydraulic, pneumatic and steam jet ash handling system, Dust collection and its disposal, Mechanical dust collector, Electrostatic precipitator.	**8**

Textbooks:

1. Power Plant Engineering: by Arora & Domkundwar, Dhanpatrai Publication (2016).
2. Power Plant Engineering by P. K. Nag, Tata McGraw Hill Publishing Company Ltd. (2017).
3. Power Plant Engineering by P.C. Sharma, S.K. Kataria & Sons (2015).

Reference Books:

1. Power Plant Engineering: by F.T. Morse. Van Nostrand Reinhold; 3rd edition (1953).
2. Power Plant Technology: by M.M.E. Wakil, McGrawHill Publication (1988).

Gaps in the Syllabus (to meet Industry/Profession requirements)
Analysis of various components of thermal and hydel power plants

POs met through Gaps in the Syllabus
PO1 TO PO5

Topics beyond Syllabus/Advanced topics/Design
Design various components of thermal and hydel power plants

POs met through Topics beyond Syllabus/Advanced topics/Design
PO1 TO PO5

Course Delivery Methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internet
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment –

1.Student Feedback on Faculty

2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	2	1	2	3	3	1	2	1	3	2	1	2
CO2	3	3	3	3	1	2	3	2	1	2	2	3	3	1	3
CO3	3	3	2	2	1	2	3	3	1	2	1	3	2	1	2
CO4	3	3	2	2	1	2	2	3	1	2	1	3	3	1	3
CO5	3	3	3	3	1	2	2	2	1	2	2	3	3	1	3

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1-5	CD1
CD2	Tutorials/Assignments	CO1-5	CD2
CD3	Seminars	-	-
CD4	Mini projects/Projects	-	-
CD5	Laboratory experiments/teaching aids	-	-
CD6	Industrial/guest lectures	-	-
CD7	Industrial visits/in-plant training	-	-
CD8	Self- learning such as use of NPTEL materials and internets	-	-
CD9	Simulation	-	-

6th SEMESTER

COURSE INFORMATION SHEET

Course code: ME 311
Course title: Computer Aided Design
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 2, T: 0, P: 0
Class schedule per week: 02
Class: B. Tech.
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1.	To understand the fundamentals of computer aided design.
2.	To generate the Synthetic Curves.
3.	To learn transformation techniques for design and drawing of mechanical parts.
4	To develop skills for solid modelling.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand the concept of solid modeling and transformation techniques.	
CO2	Understand how to transfer data in CAD system.	
CO3	Apply the knowledge to generate surface patches, synthetic surfaces.	
CO4	Understand how to generate different curves.	
CO5	Apply the knowledge for solid modelling.	

Syllabus

Module	Lectures/hour
Module -I Introduction to CAD; Product life cycle; Input/output devices; Different Coordinate systems; Basic features available in CAD systems; 3D Modeling and viewing; Modeling aids and tools offered by CAD systems.	5
Module –II Representation of lines, curves; Line and Curve generation algorithm: DDA, Bresenham's algorithms.	5
Module – III Analytic Curves; Synthetic Curves: Concept of continuity, cubic spline curve, Bezier curve, B-Spline curve and NURBS.	5
Module - IV Geometric Transformations; Translation, Scaling, Reflection, Rotation, Mappings of Geometric Models; Projections, Animations.	5
Module –V Introduction to assembly modeling, IGES, STEP & DXF data exchange format	5

TEXT BOOKS:

1. Mastering CAD/CAM by Ibrahim Zeid, Tata McGraw-Hill
2. CAD/CAM Principles and Applications by P.N. Rao, Tata McGraw-Hill

REFERENCE BOOKS:

1. CAD/CAM: Computer Aided design and Manufacturing by Mikell Groover and Zimmer,Pearson Education
2. Computer Graphics by Donald Hearn and M. Pauline Baker, Prentice Hall of India Pvt. Ltd. Delhi

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	-	-	1	2	-	1	1	-	-	2	3	3	3
CO2	3	3	2	-	3	2	1	1	2	2	-	2	3	3	3
CO3	3	3	3	2	3	3	1	1	2	2	2	2	3	3	3
CO4	3	3	2	3	3	3	1	1	2	-	-	2	3	3	3
CO5	3	3	3	3	3	3	1	2	3	2	2	2	3	3	3

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1-5	CD1, CD2 , CD5,CD8
CD2	Tutorials/Assignments	CO1-5	CD1, CD2
CD3	Seminars		
CD4	Mini Projects/Projects		
CD5	Laboratory Experiments/Teaching Aids	CO1-5	CD1, CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets	CO1-5	
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: ME 305
Course title: Automobile Engineering
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To know the basics of automobile in general
2	To understand the working of different automotive systems and subsystems
3	To update the latest developments in automobiles

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the principles of Electrical and Electronic systems in an automobile.
CO2	Able to access the performance of an automobiles.
CO3	Identify and understand the different power transmission systems in an automobile
CO4	Able to understand different braking and steering systems.
CO5	Developastrongbaseforunderstandingthecurrentandfuturedevelopmentsinthe automobile industry

Syllabus

Module	Lectures/hour
Module -I Automotive Electrical and Electronics System: Introduction to electrical system, Battery and Cranking Motor, The charging circuit, the starting and ignition system, Electronically assisted ignition system, Capacitive discharge ignition, Distributor-less ignition, Sensors and applications in automobiles, Pressure sensors, temperature sensors, Position sensors, Lambda sensors, Air flow sensors, Knock sensors, Actuators, Solenoids, stepper motors.	8
Module –II Mechanics of Motor Vehicle: Power for propulsion, rolling, air and grade resistance, traction and tractive effort, road performance curves, Acceleration, gradeability and draw par pull , calculation of maximum acceleration, maximum tractive effort and reactions for different drives.	8

Module – III Power Transmission Systems: General Arrangement of clutch, friction clutch, gear box, torque transmission. Fluid flywheel, sliding, constant and synchromesh type gear box, epicyclic gear box, live axle transmission, rear engine vehicles, type of axles, axle less transmissions, four wheel drive, torque converter, turbo transmitter converter, automatic transmission, Borg-Warner transmission, Automatic control.	8
Module - IV Drive Lines, Brakes and tyres: Universal Joint, Propeller shaft, Live rear axle, final drive, torque reaction, thrust systems, differentials, wheel bearing, front Axle and rear axle, Steering Mechanism and carriage unit, primary construction, Ackerman linkage, centre point steering, Axle construction, wheel alignments, independent and dead axle suspension, frame design, types and action of springs and dampers, chassis lubrication, Brakes, functions and methods of operation, types, linkages, hydraulic mechanism servo and power brakes, types of tyres and tubes.	8
Module –V Modern Technology and Microprocessors in Automobiles: Introduction to hybrid vehicles, components, applications, Introduction to electrical components used in hybrid and electric vehicles, configurations, introduction to energy storage requirements in hybrid and electric vehicles, battery based energy storage, fuel cell based energy storage, hybridization of different energy storage devices, Microprocessor and Microcomputer controlled devices in automobiles, instrument cluster, Voice warning system, travel information system, keyless entry system.	8

TEXT BOOKS:

T1. Automotive Mechanic by W.H. Course.
T2. Automotive Mechanics by Heitner.
T3. Electric and Hybrid Vehicles: Design and Fundamental by Iqbal Hussein
T4. Modern Electrical Equipment of Automobiles by Judge A.W

REFERENCE BOOKS :

R1. The Motor Vehicles by D.S. Newton and Steeds.
R2. Fundamental of motor vehicle technology by Hillier and Peter Coobes.
R3. Propulsion System for Hybrid Vehicle by John M. Miller.
R4. Automotive Electrical Equipments by Kohli P L

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	3	1		1	1	1		1	3	2	2
CO2	3	3	3	2	3		1	1	1	2	1	1	3	2	2
CO3	3	3	3	3	3		1		2	2	1	1	3	2	2
CO4	3	3	3	3	3		1		2	2	1	1	3	2	2
CO5	3	3	3	3	3		1		2	2	1	1	3	2	2

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors	CO-1-3	CD1
CD2	Tutorials/Assignments	CO-1-3	CD2
CD3	Seminars	CO3	CD3
CD4	Mini projects/Projects		-
CD5	Laboratory experiments/teaching aids	-	-
CD6	Industrial/guest lectures	-	-
CD7	Industrial visits/in-plant training	-	-
CD8	Self- learning such as use of NPTEL materials and internets		
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: ME 307
Course title: Robotics Engineering
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To present a comprehensive and rigorous treatment of different robot types.
2	To lay the mathematical background which is required to understand the mechanical design of different industrial robots used in modern industry.
3	To develop an intuitive understanding of the limitations of various robots and its safe handling.
4	To present real world engineering examples to demonstrate how a robot system is applied in engineering practice.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Outline the design of various industrial robotic systems and build up the foundation for understanding its mechanical design.
CO2	Acquire and apply the knowledge of forward and inverse kinematics to serial robot system and develop schemes to implement various space trajectories.
CO3	Analyse forward and inverse dynamics of serial chain robotic system and obtain its equation of motion.
CO4	Evaluate inverse kinematic transformations for parallel robot platforms and understand the working of aerial and wheeled robots.
CO5	Create or analyse standard industrial robot designs and understand advanced techniques used in industrial robotic applications like system identification, force control, and redundant degrees-of-freedom robotic systems.

Syllabus

Module	Lectures/hour
Module -I Introduction to Robotics Engineering. Degrees of Freedom for Open and Closed loop systems, Serial robot kinematics: Transformation matrices and homogeneous coordinates, Composite rotation matrix, Rotation about an arbitrary axis, Euler angle representation. Links, Joints and their parameters, Denavit-Hartenberg representation, Forward kinematics.	8
Module –II Inverse kinematics of serial robot: Geometrical and Algebraic Approach. Velocity analysis: Jacobian matrix, Acceleration analysis. Role of Jacobian in robot Statics. Gravity compensation. Trajectory planning: Cartesian and Joint space trajectories, Cubic, cosine, quintic and cycloidal trajectories, Path primitives: Line and Circle in space, Point to point and Continuous path trajectories.	9
Module – III Dynamics of serial robots: Lagrange-Euler formulation, Newton Euler approach, Motion equations of a manipulator. Inverse and Forward dynamics approaches.	8
Module - IV Parallel robot structures, Inverse kinematics of parallel robots, 3-RPS, 6-RPS and 6-RUS structures. Forward kinematics of parallel robot approaches, Introduction to Wheeled mobile robot and Ariel robot subsystems.	9
Module –V Classical Industrial robot systems, PUMA, and SCARA configurations, Robotic system integration, Industrial applications of robotics: Case studies. Advanced concepts: Compliant structures and Force control applications, Redundant systems and associated challenges, System Identification.	8

TEXT BOOKS:

T1. Subir Kumar Saha, Introduction to Robotics, TMH, New Delhi, 2014.
T2. John J. Craig, Introduction to Robotics, Pearson Education, 2011.
T3. J. P. Marlett, Parallel Robots, Springer, 2006.

REFERENCE BOOKS:

R1. Dilip K. Pratihar, Fundamentals of Robotics, Narosa Publishing House, 2016.
R2. KS Fu, C. S. G Lee, R. Gonzalez, Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill Education, 1987.
R3. Bruno Siciliano and OussamaKhatib, Handbook of Robotics, Springer, 2016.
R4. Saeed B. Niku, An Introduction to Robotics Analysis, Systems, Applications, Prentice-Hall, 2001.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment:

1. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	2	2	2	2	2	-	-	-	-	-	-	-	3	2	2
CO2	3	2	3	2	2								3	2	2
CO3	3	2	3	2	2								3	2	2
CO4	3	2	3	2	2								3	2	2
CO5	3	2	3	3	3								2	2	2

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors	CO 1 – 5	
CD2	Tutorials/Assignments	CO 1 – 5	
CD3	Seminars		
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		

MC 300 SUMMER TRAINING

COURSE INFORMATION SHEET

Course code: ME 308
Course title: Robotics and Automation Lab.
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1.5 L: 0, T: 0, P: 3
Class schedule per week: 03
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To give a hands-on experience in a rigging an industrial pneumatics and electro-pneumatics circuit.
2	To be acquainted with standard industrial robot, its sub-systems and prepare a demonstration of a simple programmed task.
3	To create a simple robot simulation using MATLAB / SimMechanics for controlling its position.

Course Outcomes (CO)

After the completion of this course, students will be:

CO1	Understand the technical specification of a robot and extract its kinematic parameters.
CO2	Calibrate and program a standard industrial robot and evaluate its error.
CO3	Select proper components and create a typical pneumatic and electro-pneumatic circuit.
CO4	Understand the various systems required to program a PLC and create a simple demonstration.
CO5	Use a simulation tool to analyse the control behaviour of a robot controller.

List of experiments:

1. Introduction to Industrial Robot (KUKA KR5 Arc): Frames, Safety, Teach Pendant, etc.
2. Identification of DH Parameters of KUKA KR5 Arc Robot from Technical Specifications and physical and software verification using Robo-Analyzer.
3. End-effect or tool calibration and manual/CAD verification.
4. Robot Workspace/Base Calibration.
5. Robot programming for a pick and place operation.
6. Pneumatic Circuit Design for Automated Single Cylinder Reciprocating action.
7. Reciprocating Single Cylinder action using Electro-Pneumatic circuit.
8. Sequential Double Cylinder Reciprocating action using Electro-Pneumatic circuit.
9. PLC: Introduction to Ladder Logic Programming.
10. Programming PLC for Pick and Place Task.
11. Using MATLAB/Sim Mechanics for perform mechanical simulation.
12. Create and simulate a 2R robot in MATLAB/SimMechanics and control its position.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive evaluation	60
End Sem Lab Examination Marks	40

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	3	3	3	2	1		2	2			3	2	-
CO2	3	2	3	3	3	2	1		2	2			3	2	-
CO3	3	2	3	3	3	2	1		2	2			3	2	-
CO4	3	2	3	3	3	2	1		2	2			3	2	-
CO5	3	2	3	3	3	2	1		2	2			2	2	-

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

COURSE INFORMATION SHEET

Course code: ME 310
Course title: Automobile Engineering Lab
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1.5 L: 0, T: 0, P: 3
Class schedule per week: 03
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To make student familiar with various automobile systems and parts
2	To study of function and operation of various automobile systems and parts

Course Outcomes

After the completion of this course, students will be:

CO1	Understandtheproceduretoconductexperimentsrelatedtoautomobilesystemsand parts
CO2	Understandvariousparametersinfluencetheperformanceoftheautomobilesystems and parts.
CO3	Analyze the observations made through experiments
CO4	Applytheknowledgehowtoperformtheexperimentsindifferentsystemsofan automobile.
CO5	Identify, understand and solve the various problems related to an automobile

List of experiments:

1. To study the construction details and general principles of two- stroke and four stroke CI and SI engines.
2. To study the fuel system of engines (carburetor and injector, injection pump, fuel pump, MPFI, SPFI and CRDi).
3. To study the engine lubrication and cooling system.
4. To study the super charging, electrical system and equipment's of an automobile.
5. To study the clutch, gearbox, torque converters.
6. To study the universal joint, back axle construction, propeller shaft and differential.
7. To study the mechanical hydraulic Servo and power operated braking systems.
8. To study the front axle, steering geometry and wheel alignment of a 4 wheel vehicle.
9. To study the springs, torsion bars, independent suspension and shock absorbers (coil leaf and dampers).
10. To study the tyres and wheel balancing.
11. Performance of a power steering system.
12. To study the charging and ignition system of an automobile.
13. Assembly and disassembly of 6-cylinder Diesel engine.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive evaluation	60
End Sem Lab Examination Marks	40

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	ProgramOutcomes(POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	3	2	1	1	1	1	2	1	1	2	3	2	2
CO2	3	2	3	3	1	1	2	1	2	2	1	2	3	2	2
CO3	3	3	2	3	2	2	2	1	3	2	1	2	3	2	2
CO4	3	3	2	3	2	2	2	1	3	2	1	2	3	2	2
CO5	3	3	2	3	2	2	2	1	3	2	1	2	3	2	3

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

COURSE INFORMATION SHEET

Course code: ME 363(Program Elective-IV)
Course title: Vehicle Dynamics
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3, T:0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To understand longitudinal, lateral and vertical dynamics of vehicle
2	To construct mathematical models for the analysis of vehicle motion
3	To analyse kinematics and dynamics of tyres
4	To design vehicle with less noise and vibration
5	To evaluate handling of vehicles

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate various principles related to motion of the vehicle
CO2	Design tyres and other vehicle components
CO3	Evaluate handling of vehicle
CO4	Construct mathematical models for different motions of vehicle
CO5	Evaluate forces, moments and kinematic quantities involved in the motion of vehicle

Syllabus

Module	Lectures/hour
Module -I **Longitudinal dynamics:** An introduction to vehicle dynamics, Vehicle Load Distribution – Acceleration and Braking -Brake Force Distribution, Braking Efficiency and Braking Distance - Longitudinal dynamics of a Tractor-Semi Trailer.	7
Module –II **Tire mechanics and a simple tire model:** An Introduction: Mechanical Properties of Rubber - Slip, Grip and Rolling Resistance - Tire Construction and Force Development – Contact Patch and Contact Pressure Distribution, Lateral Force Generation - Ply Steer and Conicity -Tire Models – Magic Formula - Classification of Tire Models and Combined Slip.	12
Module – III **Lateral Dynamics:** Bicycle Model - Stability and Steering Conditions -Understeer Gradient and State space Approach – Handling Response of a Vehicle - Mimuro Plot for Lateral Transient Response - Parameters affecting vehicle handling characteristics.	7
Module - IV **Vehicle Handling and Vertical Dynamics:** Subjective and Objective Evaluation of Vehicle Handling, Rollover Prevention - Half Car Model - Quarter Car Model.	8
Module –V **Vehicle Vibration**: Basics of vibration, Lagrange's method and dissipation function, Bicycle, car and body pitch mode, Full car vibrating model, Suspension optimization.	8

Text books:

1. H. B. Pacejka, Tyre and Vehicle Dynamics, Elsevier, 2nd Ed.
2. R. N. Jazar, Vehicle Dynamics: Theory and Application, Springer.
3. T. D. Gillespie, Fundamentals of Vehicle Dynamics, Society of Automotive Engineers.
4. K. Popp and W. Schiehlen, Ground vehicle Dynamics, Springer-Verlag Berlin Heidelberg.

Reference books:

1. J. Reimpell, H. Stoll, and J. W. Betzler, The Automotive Chassis: Engineering Principles,

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	3	1		1	1	1		1	3	2	1
CO2	3	3	3	2	3		1	1	1	2	1	1	3	2	1
CO3	2	3	2	1	2			1				1	3	2	1
CO4	3	3	3	3	3				2	2		1	3	2	1
CO5	3	3	3	3	3				1			1	2	2	1

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		-	-
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		-	-
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: ME365 (Program Elective-IV)
Course title: Design of Mechanisms
Credits: 3 (L:3, T:O, P:O)
Class schedule per week: 3
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

1	To be able to understand the kinematics of planar mechanisms.
2	To synthesize a mechanism graphically and analytically.
3	To analyze the velocity, acceleration, and forces in a mechanism.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand and obtain the mobility of planar and space mechanism.
CO2	Synthesize graphically a four-bar mechanism for motion, path, and function generation
CO3	Synthesize analytically a four-bar mechanism for motion, path, and function generation
CO4	Find the velocity, and accelerations in a mechanism
CO5	Perform the Forces and moment balancing of linkages

Syllabus

Module	Hours
Module-I Introduction to Mechanisms and number synthesis: Plane and space mechanisms, Equivalent linkage, Mobility and range of movement, Four and six link mechanisms.	**8**
Module-II Kinematic Synthesis: (Graphical methods) Motion generation with two and three prescribed points, Path generation with three and four points, Function generation with three precession points, The Overlay Method.	**8**
Module- III Kinematic Synthesis: (Analytical Methods) Complex number modelling in kinematic synthesis, The Dyad, Motion path and function generation with three prescribed points, Freudenstein' s equation for three-point function generation, Loop-closer equation technique.	**8**
Module- IV Curvature theory: Fixed and moving centrode, Velocity and Acceleration, Inflection points and inflection circles, The Euler-Savary Equation	**8**
Module-V Dynamics of Mechanisms: Kinetostatics using matrix method, Lagrange equation of motion, Force and moment balancing of linkages	**8**

Text books:

1. G. N. Sandor and A. G. Erdman, Advanced Mechanism Design: Analysis and Synthesis - Volume 2, Prentice Hall, New Jersey.
2. R. S. Hartenberg and J. Denavit, Kinematic Synthesis of Linkages, McGraw-Hill Book Company.
3. A. Ghosh and A. K. Mallik, Theory of Mechanisms and Machines, East West Press.

Reference book:

1. A. G. Erdman, G. N. Sandor and S. Kota, Mechanism Design: Analysis and Synthesis - Volume 1, Prentice Hall, New Jersey.

Gaps in the syllabus (to meet Industry/Profession requirements)

Software application in mechanism design.

POs met through Gaps in the Syllabus

PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design

Advanced synthesis of space mechanisms

POs met through Topics beyond syllabus/Advanced topics/Design

PO1 TO PO5

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√				√
End Semester Examination	√	√	√		√
Quiz (s)	√	√	√		
Assignment	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	2	1	1	1	1	1	1	1	1
CO2	3	3	3	3	1	1	1	1	1			1
CO3	3	3	3	3	2	1	1	1	1			1
CO4	3	3	3	3	2	1	1	1	1	1	1	1
CO5	3	3	3	3	3	1	1	1	1			2

Mapping Between COs and Course Delivery (CD) methods

CD	Course Delivery methods		Course Outcome	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		-	-
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		-	-
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: PE324 (Program Elective-IV)
Course title: Surface Engineering and Laser Additive Manufacturing
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3, T:0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	Understandthescienceandimportanceofsurfaces,surfacedependentpropertiesofengineering solids
2	Learn about appropriate testing procedures to evaluate surface dependent engineering properties
3	Acquire fundamentals and practices of various surface engineering techniques to improve Surface dependent engineering properties of metallic, ceramic and polymeric solids
4	Get familiar with directed energy beam techniques (laser, ion, and electron beams)and in particular laser assisted surface engineering and material processing
5	Develop an understanding of laser assisted additive manufacturing techniques and its application

Course Outcomes

After the completion of this course, students will be able to:

CO1	Classify and relate various surface degradation and surface-initiated failure mechanisms of engineering solids occurring under different service conditions.
CO2	Analyze the importance, relative advantages and limitations and overall scope Of application of various surface engineering methods
CO3	Compare and contrast different surface modification and coating technologies from various perspectives of applicability, economy, efficiency, and scopes of further improvement
CO4	Analyze real life surface failure problems(case studies) and prescribe the correct surface engineering solution
CO5	Explore the applications potential of laser additive manufacturing of engineering Components, flexibility, advantages, limitations, current status and future developments awaited

Syllabus

Module1: Structure of Solids; Surface Dependent Engineering Properties [4]

Introduction to structure of solids: structure, morphology, energy, types and classification. Surface dependent engineering properties: physical, chemical and mechanical–their definition, origin and importance.

Module2:Mechanisms of Surface Degradation and Failures [8]

Common surface-initiated engineering degradation/ failures and their mechanism: wear, friction, fatigue, corrosion, oxidation.

Importance of surface engineering (SE), Classification and scope of surface engineering of alloys and components, Methods and principles of surface modification of materials; Strengthening mechanism of engineering materials–metallic and non-metallic.

Module3:Surface Modification and Surface Coating Techniques [16]

Conventional surface modification methods: shot peening, flame and induction hardening, carburizing, nitriding, diffusion aided surface alloying Surface coating techniques by chemical/ electro-chemical routes: electro/ electroless deposition, anodizing, galvanizing, etc.

Surface coating by physical routes: thermal/plasma spray, physical/chemical vapor deposition, sputtering, etc.

Module4:Advanced Surface Modification Techniques [6]

Advanced surface modification methods: laser, plasma, ion and electron beam assisted surface engineering.

Module5:Laser Additive Manufacturing [6]

Additive manufacturing vis-à-vis subtractive manufacturing, Advantages and challenges, recent trend and innovation, laser assisted additive manufacturing of polymers, metals and alloys, characterization and testing.

Text and Reference Books:

1. Surface Engineering for Wear Resistances (Introduction and classification of Wear), By:K.G. Budinski, PrenticeHall, Englewood Cliffs,1988[T1]
2. CorrosionEngineering(classificationofCorrosion),By:M.G.Fontana, M.C.GrawHill,N. York, 1987 [T2]
3. Materials Science and Engineering by W.D.Callister
4. Introduction to Surface Engineering and Functionally Engineered Materials, by Peter Martin, WILEY, 2011
5. Surface Engineering of Metals: Principles, Equipment, Technologies, by: Tadeusz Burakowski, Tadeusz Wierzchon, CRC Press, 1988

6. Surface Engineering for Corrosion and Wear Resistance, by J R Davis, ASM International,2001
7. Additive Manufacturing by Andreas Gebhardt and Jan-Steffen Hötter,Springer,2016
8. Additive Manufacturing of Metals by John O.Milewski,Springer,2017

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	√
CD5	Industrial visits/in-plant training	√
CD6	Self-learning such as use of NPTEL materials and internets	√
CD7	Simulation	

Course Evaluation:

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	%Distribution
Mid Semester Examination	25
Quizzes	10 +10
Assignment	5
End Semester Examination	**%Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√	√		
Quiz1	√	√			
Quiz2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes(COs) on to Program Outcomes(POs) and Program Specific Outcomes (PSOs):

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	2	3	2	1	1	1	1	1	3	2	3	3
CO2	3	3	3	2	3	2	1	1	1	1	1	3	2	3	3
CO3	3	3	3	2	3	2	1	1	1	1	2	3	3	3	3
CO4	3	3	3	3	3	2	1	1	1	1	1	3	3	3	3
CO5	3	3	3	2	3	2	1	1	1	1	1	3	3	3	3

1: Slight(Low) 2: Moderate(Medium) 3:Substantial (High)

Mapping Between Course Outcomes(COs) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1,CD2, CD 6
CO2	CD1,CD2, CD 6
CO3	CD1,CD2, CD 6
CO4	CD1,CD2, CD 6
CO5	CD1,CD2, CD 6

COURSE INFORMATION **SHEET**

Course code: ME359 (Program Elective-IV)
Course title: Power Plant Engineering
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3, T:0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To have clear understanding of different power plant technologies.
2	To be able to select an appropriate type of plant for given requirement under different situations.
3	To be able to select the suitable components/equipment/accessories for proper functioning of power plant
4	To understand the operational requirements and do the economic analysis of power plant.

Course Outcomes

After the completion of this course, students will be:

CO1	Classify the different power plants with their applications and future trends.
CO2	Understand the different components of Thermal power plant and evaluate the heat balance.
CO3	Distinguish between Diesel, Gas Turbine and Hydraulic power plant
CO4	Illustrate the working of nuclear power plants and Nonconventional power plants.
CO5	Analyze the power plant economics and determine the best possible combinations of power plant, depending on requirement.

Syllabus

Module	Lectures/hour
Module -I Introduction: Principal types of power plants, special features, Advantages and Limitations. Elements of Modern Power Station, Importance of central power station, Review of electricity generation and energy scenario in Indian as well as world context. Application and future trend of developments.	8
Module –II **Thermal Power Plants:** Major components, fuels and their properties, storage, preparation, handling and burning, Ash handling and dust collection, Air pre-heater, Feed water treatment plants, insulation, Heat balance of power plant, Modern development in steam boiler.	8
Module – III **Diesel and Gas Turbine Power Plants:** Introduction, various system required for operation of Diesel Power Plant. Components of gas turbine power plant, different arrangements, optimum design of Gas turbine unit for combined cycle plant, comparative study of diesel and gas turbine plants. **Hydraulic Power Plants:** Different types of hydraulic power plants, rain fall and run-off measurements and plotting of various curves for estimating power available with or without storage.	8
Module - IV **Nuclear Power Plants:** Nuclear Reactors, Types of reactors, Pressurized water reactors, boiling heater reactors, Heavy water-cooled and moderated (CANDU) reactor, Gas-cooled reactors, Liquid metal cooled reactors, Indian Nuclear power installations. **Non-Conventional Power Plants:** Geothermal power plants, Tidal power plants, Wind power plants, solar power plants	8
Module –V **Combined operation of different power plants:** Introduction, Advantages of combined working, load division between power stations, storage type hydro-electric power plant in combination with steam plant, Instrumentation and control. **Economic Analysis:** Difference between Base load and peak load plants, Different terms and definitions, Performance and operating characteristics of power plants, Load division, Tariff method for Electrical Energy.	10

Text Books:

1. Power Plant Engineering: by F.T. Morse.
2. P. K. Nag, Power Plant Engineering, Tata McGraw-Hill, 2008.
3. Power Plant Technology: by M.M.E. Wakil, McGraw Hill Publication.

Reference Books:

1. Power Plant Engineering: by Arora & Domkundwar, Dhanpatrai Publication
2. Power Plant Engineering: by K.K. Ramalingam, Scitech Publications.

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	1	1	2	1	1	1	1	1	3	2	-
CO2	3	3	3	3	1	1	2	1	1	1	1	1	3	2	-
CO3	3	3	3	3	1	1	2	1	1	1	1	1	3	2	-
CO4	3	3	3	3	1	1	2	1	1	1	1	1	3	2	-
CO5	3	3	3	3	1	1	2	1	1	1	1	1	2	2	-

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		-	-
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		-	-
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: ME369 (Program Elective-IV)
Course title: Gas Dynamics
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3, T:0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To present a comprehensive and rigorous treatment of classical gas dynamics theories and jet propulsion devices while retaining an engineering perspective.
2	To lay the groundwork for subsequent studies in such fields as analysis of various gas dynamics and jet propulsion energy conversion systems and to prepare the students to effectively use gas dynamics and jet propulsion theory in the practice of engineering.
3	To develop an intuitive understanding of gas dynamics and jet propulsion by emphasizing the engineering and engineering arguments.
4	To present a wealth of real world engineering examples to give students a feel for how gas dynamics and jet propulsion is applied in engineering practice.

Course Outcomes

After the completion of this course, students will be:

CO1	Outline the concepts of thermodynamics and fluid flow to gas dynamics and jet propulsion systems .
CO2	Apply the appropriate fundamental laws of thermodynamics and fluid flow to various and jet propulsion systems .
CO3	Analyse various gas dynamics and jet propulsion problems.
CO4	Evaluate the performance of various das flow and jet propulsion systems.
CO5	Create design of simple gas flow devices and jet propulsion systems using conventional methods and modern tools.

Syllabus

Module	Lectures/hour
Module -I Fundamental of Gas Dynamics-energy equation, stagnation state and stagnation properties, bulk modulus of elasticity, sound velocity, Mach number, Mach angle, Bernoulli equation, isentropic flow with variable area , flow with variable area in adiabatic processes, area ratio as a function of Mach number, flow through convergent nozzles, divergent nozzle, numerical examples	8
Module –II Flow with Normal Shock Waves- development of a normal shock wave, governing equations, mach number downstream of the normal shock wave, static pressure ratio across the shock, temperature ratio across the shock, density ratio across the shock (or) Rankine-Hugoniot equation, stagnation pressure ratio across the shock, change in entropy across the shock, impossibility of rarefaction shock wave, strength of a shock wave, numerical examples.	8
Module – III Fanno flow: Fanno curves, Fanno flow equations, solution of Fanno flow equations, variation of flow properties, change of entropy, variation' of mach number with duct length. Rayleigh flow: Rayleigh line, constant entropy lines, constant enthalpy lines, general equations in Rayleigh flow process, Rayleigh flow relations, variation of flow properties, maximum heat transfer. numerical examples.	8
Module - IV Jet Propulsion: Turbo jet, turbo prop engine, pulse jet engine, entropy relations and efficiencies of a turbo jet engine, thrust, propulsive, thermal and overall efficiencies, specific fuel consumption, specific thrust and specific impulse, effect of altitude, effect of forward speed, thrust augmentation, numerical examples.	8
Module –V Comparison between air breathing engines and rocket engines, classification of rocket engines, solid propellant rockets, liquid propellant rockets, hybrid rockets, mono propellants, fuel, oxidizer, properties of liquid and solid propellants, restricted burning, thrust and specific impulse, specific propellant consumption, weight flow coefficient, thrust coefficient, impulse to weight ratio, propulsive, thermal, overall efficiency, application of rocket engines, numerical examples.	10

TEXT BOOKS:

T1. Gas Dynamics and Jet Poropulsion, S.L. Somasundaram,, New Age International Publishers.
T2. Aircraft Propulsion and Gas Turbine Engines, Ahmed F. El-Sayed, CRC Press.
T3. Fundamentals of Compressible Flow, S. M. Yahya, New Age International Publishers.
T4. Fundamentals of Gas Dynamics, V. Babu, Ane Books India.

REFERENCE BOOKS:

R1. Fluid Mechanics, Fundamentals and Applications(S I Unit), Youns A. Cengel and John M. Cimbala, Tata Mc-Graw Hills Education Pvt. Ltd.
R2. Rocker Propulsion Elements, G. P. Sutton, John Wiley, NY.
R3. Elements of Gas Dynamics, H.W. Liepmann and A. Roshko, Dover Publications, New York.

Online Resources:

http://nptel.ac.in/courses/112103021/
http://nptel.ac.in/courses/112106166/

http://nptel.ac.in/courses/112106056/

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	1							2	3	2	2
CO2	3	3	3	2	2							2	3	2	2
CO3	3	3	3	2	2							2	3	2	2
CO4	3	3	3	2	2				2	1	1	2	3	2	2
CO5	3	2	2	2	2				2	1	1	2	2	2	2

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors	CO-1-5	CD1
CD2	Tutorials/Assignments	CO-1-5	CD2
CD3	Seminars	-	-
CD4	Mini projects/Projects	-	-
CD5	Laboratory experiments/teaching aids	-	-
CD6	Industrial/guest lectures	-	-
CD7	Industrial visits/in-plant training	-	-
CD8	Self- learning such as use of NPTEL materials and internets	CO-1-5	CD8

COURSE INFORMATION SHEET

Course code: ME 373(Program Elective -V)
Course title: Hydraulic and Pneumatic Control
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To present a comprehensive and rigorous treatment of classical fluid power systems.
2	To lay the groundwork to appreciate the fundamental principles, design and operation of hydraulic and pneumatic components, systems and their application in recent industrial automation.
3	To develop an intuitive understanding of fluid power system by emphasizing the engineering aspects of such design.
4	To present real world engineering examples to give students a feel for how a fluid power system is applied in engineering practice.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Outline the operation of a typical hydraulic and pneumatic systems, its advantages and limitations, associated standard components and its types, governing laws and its basic construction.
CO2	Understand hydraulic control circuits and its components and evaluate its flow, pressure and losses due to friction.
CO3	Design and analyse hydraulic circuits for various standard applications.
CO4	Understand pneumatic control circuits, its components, governing laws and design standard circuits for various pneumatic applications. Analyse pneumatic circuits and estimate for the losses.
CO5	Apply the knowledge of logic controllers and create fluid power system circuits using PLC, perform troubleshooting of hydraulic and pneumatic circuits safely and know advanced technologies of modern fluid power systems.

Syllabus

Module	Lectures/hour
Module -I Introduction to hydraulic and pneumatic systems, advantages and limitations, general layout of components. ISO symbols. Standard tubing sizes. Types of hydraulic fluids and its properties. Governing laws, Power, energy and flow rate calculations. Basic types and constructions of hydraulic pumps and actuators.	8
Module –II Distribution system, Sizing and flow rate requirements, Connectors and couplings. Basics of hydraulic flow in pipes, Hydraulic circuit analysis, flow and pressure measurement, losses due to friction. Control components in hydraulic systems, pressure, flow, direction control valves, Servo valves, Fuses, shock absorbers, and switches.	9
Module – III Hydraulic circuit design and analysis, Single and double acting cylinder operation, regenerative circuit, pump unloading circuit, double pump hydraulic system, automatic cylinder sequencing, synchronizing and reciprocating circuit, speed control, braking, transmission systems, Mechanical and Hydraulic servo system.	7
Module - IV Air preparation and components, Properties of air, Gas laws, Compressors, Conditioners, control valves, pneumatic actuators, vacuum systems, and accumulators. Pneumatic circuit design and analysis, energy losses. Electro pneumatics: control of cylinders using pressure and limit switches, reciprocating, sequencing, sorting and regenerative circuits. Counting, timing and servo systems.	9
Module –V Programmable Logic Controllers, Introduction to Boolean algebra, Fluidic devices: Sensors, and control of fluid power systems, Nozzle flapper systems, stroke reading cylinders, Moving Part Logic (MPL) control systems, safety, maintenance and troubleshooting of hydraulic and pneumatic systems, filters, strainers, regulators, lubricators, reservoir, problems caused due to contamination and wear, air trapping, and temperature.	7

TEXT BOOKS:

1. Anthony Esposito, Fluid Power with applications, Pearson Education, 1997.
2. John Watton, Fundamental of Fluid power control, Cambridge University press, 2009.
3. Fluid Power Engineering, M GalalRabie, McGraw Hill, 2009.

REFERENCE BOOKS:

1. Andrew Parr, Hydraulics and Pneumatics, A Technician's and Engineer's Guide, Butterworth-Heinemann, 2011
2. Ilango Sivaraman, Introduction to Hydraulics and Pneumatics, PHI Learning Pvt. Ltd., 2017. Sundaram K. Shanmuga, Hydraulic and Pneumatic Controls, S. Chand, 2006.
3. Majumdar, S.R., “Oil Hydraulics Systems- Principles and Maintenance”, Tata McGraw Hill, 2001
4. Majumdar, S.R., “Pneumatic Systems – Principles and Maintenance”, Tata McGraw Hill, 2007.
5. Srinivasan. R, "Hydraulic and Pneumatic Control", IInd Edition, Tata McGraw - Hill Education

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	2	2	2	3	2								3	2	2
CO2	3	3	3	2	2								3	2	2
CO3	3	3	3	3	3								3	2	2
CO4	3	2	2	3	2								3	2	2
CO5	3	3	3	3	2								2	2	2

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1-5	CD1, CD2 , CD5,CD8
CD2	Tutorials/Assignments	CO1-5	CD1, CD2
CD3	Seminars		
CD4	Mini Projects/Projects		
CD5	Laboratory Experiments/Teaching Aids	CO1-5	CD1, CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets	CO1-5	
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: ME 375(Program Elective-V)
Course title: Power Gear Train
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

A.	To identify the speed ratios for a given automobile gearbox.
1	To determine the epicyclic gear trains with number of gears on Sun, ring and planetary gears in each gear train.
2	To choose gear materials with respect to the service conditions and design by taking into account tooth load, contact stress and surface durability.
3	To determine the number of gears on main, lay shaft and idler gear shaft and work out the no of teeth on various gears to provide the desired speed ratios from the given power source..

Course Outcomes

After the completion of this course, students will be:

CO1	Describe the various parameters of a helical gears, straight Bevel gears, Worm and Worm wheel set and gearbox.
CO2	Apply the appropriate fundamental laws of gears to find the design tooth load using factor of safety and effective tooth load using velocity factor and tangential tooth load
CO3	Analyse the number of teeth on various gears to provide the desired speed ratios.
CO4	Evaluate the module of gear-wheel tooth from beam strength and wear strength.
CO5	Create optimum design of a gear box for the given power source to execute the work after taking into account the virtual number of teeth, tooth load and the different strength.

Syllabus

Module	Lectures/hour
Module -I Gear Drive: Principle of Transmission and Conjugate Action, Gear Materials, Spur Gear, Types of Gear Teeth, Beam Strength of Spur Gear, Effective tooth load, Contact stress and surface Durability	5
Module –II Helical Gears: Parameters of a Helical Gear, Virtual number of teeth on Helical Gears, Force components on a tooth of Helical Gear, Different strengths of Helical Gear tooth.	5
Module – III Straight Bevel Gears: Bevel Gear basic rack, spiral Bevel gears, Virtual no of teeth, Force analysis of Bevel gears, beam strength of Bevel gear tooth, wear strength of Bevel gear tooth, effective tooth load on Bevel gear, Spotts's Equation for dynamic tooth load.	10
Module - IV Worm and Worm Wheel Set: Parameters of Worm gear set, Worm gear proportions, Force analysis in Worm and wheel set, Effect of rubbing velocity on friction in Worm wheel drive, Materials, Temperature rise of lubricating, Beam and wear strengths of worm wheel set.	10
Module –V Gearbox: Introduction, Resistance to vehicle motion, Types of gearboxes, sliding-mesh gear box, contact-mesh gearbox, synchromesh gearbox, epicyclic gearbox, Wilson gearbox, overdrive, five speed sliding mesh gearbox. Spread sheet applied to the design of Gear train, Gear train diagnostics based on noise and vibration. Case studies of power gear train in Automobiles & Overhead Cranes.	10

TEXT BOOKS :
T1. Machine Design by U. C. Jindal.

REFERENCE BOOKS :
R 1. Julian Happian-Smith, Introduction to Modern Vehicle Design, Butterworth Heinemann..

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	2	2	3	2	2	2	1	1	3	2	3
CO2	3	2	2	1	1	1	2					1	3	2	3
CO3	3	2	2	2	1	1	1					1	3	2	3
CO4	3	2		3	2	2	2		1		1	1	3	2	3
CO5	3	2	1	3	3	3	3	1	1	1	2	1	2	2	3

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors	CO-1-5	CD1
CD2	Tutorials/Assignments	CO-1-5	CD2
CD3	Seminars	-	-
CD4	Mini projects/Projects	-	-
CD5	Laboratory experiments/teaching aids	-	-
CD6	Industrial/guest lectures	-	-
CD7	Industrial visits/in-plant training	-	-
CD8	Self- learning such as use of NPTEL materials and internets	CO-1-5	CD8

COURSE INFORMATION SHEET

Course code: PE 348(Program Elective-V)
Course title: Engineering Optimization
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Learn about various optimization techniques used in Engineering
2	Formulate an Engineering problem in form of an optimization problem
3	Understand specialized problems such as dynamic programming problem
4	Understand the simple and classical methods of solving an engineering optimization problem
5	Understand some heuristics and metaheuristic approaches for solving the optimization problems

Course Outcomes:
After the completion of this course, students will able to:

CO1	Prepare optimization problem formulation from an engineering problem
CO2	Execute simplex method to solve a linear programming problem
CO3	Apply dynamic programming methods to solve a dynamic problem
CO4	Choose a proper optimization technique to solve a non-linear optimization problem
CO5	Understand heuristics and meta-heuristics to solve an optimization problem

Syllabus

Module 1: Introduction to optimization and Liner Programming [10]

Introduction, Statement of an optimization problem, Classifications, Linear programming problems: formulation, graphical solution, simplex method, Big M and Two-phase method.

Module 2: Dynamic Programming Problems [6]

Introduction and network representation of dynamic programming problem, Forward and backward recursion method for solution, Mathematical formulation of dynamic programming recursions.

Module 3: Non-Linear Optimization-I – One dimensional optimization methods [9]

Unimodal function, Elimination Methods: Unrestricted search, Exhaustive search, Dichotomous search, Interval having method, Fibonacci method, Golden section method, Interpolation Methods: Newton method, Quasi Newton method, Secant method.

Module 4: Non-Linear Optimization -II – Classical optimization techniques [7]

Single variable optimization, Multiple variable optimizations with no constraints, Multiple variable optimizations with equity constraints, multiple variable optimization with inequity constraints.

Module 5: Heuristics and Metaheuristics for solving Optimization problems [8]

Reasons for using heuristic and metaheuristic approaches, Types of search approaches, Steepest Ascent and Steepest Descent method, Local search heuristics: SWAP, INSERT, genetic crossover, Metaheuristics: Genetic Algorithm, Ant Colony Optimization, Simulated Annealing.

Textbook:

1. S.S. Rao, Engineering Optimization: Theory and Practise, Wiley-Interscience Publications.**(T1)**
2. K. Deb, Optimization for Engineering Design: Algorithms and Examples, PHI publications. **(T2)**

Reference Books:

1. Wayne L. Winston, Operations Research: Applications and Algorithms, Duxbury Press**(R1)**
2. Hamdy A. Taha, Operations Research: An Introduction, Prentice Hall PTR, Pearson**(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):

Integer programming, goal programming, multi-objective optimization

POs met through Gaps in the Syllabus:

POs 1-3, 12

Topics beyond syllabus/Advanced topics/Design:

Multi Objective Optimization, Advanced Operations Research

POs met through Topics beyond syllabus/Advanced topics/Design:

POs 1, 3, 5, 7, 12

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	√

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	1	1		1					2	3	3	2	1
CO2	3	2	2			1	1	1	2		3	3	3	2	3
CO3	3	2	3			1	1	1	2		3	3	3	2	3
CO4	3	2	3			1	1	1	2		3	3	3	2	3
CO5	3	3	2	2	3			1	2		2	3	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD6
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: ME 361(Program Elective-V)
Course title: Combustion
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To present an importance of combustion in an engineering perspective.
2	To develop an intuitive understanding of physics of combustion by emphasizing the engineering and engineering arguments.

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the basic concepts of combustion with its thermodynamic approach.
CO2	Analyze the kinetics of combustion.
CO3	Analyze the concept of Flames.
CO4	Analyze the concept of ignition
CO5	Analyze the Combustion Generated Pollution & its Control.

Syllabus

Module	Lectures/hour
Module -I **Introduction:** Importance of combustion, combustion equipment hostile fire problems, pollution problems arising from combustion. **Thermodynamics of Combustion:** Enthalpy of formation, enthalpy of reaction, heating values, first and second law analysis of reacting systems, chemical equilibrium, equilibrium composition, adiabatic and equilibrium flame temperature.	9
Module –II **Kinetics of Combustion:** Law of mass action, reaction rate, simple and complex reactions, reaction order and molecularity, Arhenius Law, activation energy, Chain reaction steady state and partial equilibrium approximations. Chain explosion, Explosion limits and oxidation characteristics of hydrogen, carbon monoxide and hydrocarbons.	8
Module – III Flames: Premixed Flames: structure and propagation of flames in homogeneous gas mixtures; simplified Rankine Hugoniot relations; properties of hugoniot curve; analysis of deflagration and detonation branches, properties of Chapman Jouguet wave. Laminar flame structure; theories of flame propagation and calculation of	9

flame speeds, flame speed measurements. Stability limits of laminar flames; flammability limits and quenching distance; bumer design. Mechanisms of flame stabilization in laminar and turbulent flows; flame quenching. Diffusion flames; comparison of diffusion with premixed flame. Combustion of gaseous fuel jets Burke and shumann development.	
Module - IV **Burning of Condensed Phase:** General mass burning considerations, combustion of fuel droplet in a quiescent and convective environment. Introduction to combustion of fuel sprays. Ignition: Concepts of ignition, chain ignition, thermal spontaneous ignition, forced ignition.	8
Module –V **Combustion Generated Pollution & its Control:** Introduction, nitrogen oxides thermal fixation of atmospheric nitrogen prompt NO, thermal NOx formation and control in combustors Fuel NOx and control , post-combustion destruction of NOx, Nitrogen dioxide carbon monoxide oxidation -quenching , hydro carbons, sulphur oxides	8

Text books:

1. An Introduction to Combustion, concepts and applications by S. R.Turns, McGraw Hill (2000).
2. Principles of Combustion by K. K. Kuo, John Wiley (2005).

Reference books:

1. Combustion Physics by C.K. Law, Cambridge University Press (2010).
2. Combustion Theory by F.A., Williams Addison Wesley (2007).

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	1	1	3	1	-	-	-	1	3	2	2
CO2	3	3	3	3	1	1	3	1	-	-	-	1	3	2	2
CO3	3	3	3	3	1	1	3	1	-	-	-	1	3	2	2
CO4	3	3	3	3	1	1	3	1	-	-	-	1	3	2	2
CO5	3	3	3	3	1	1	3	1	-	-	-	1	2	2	2

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		-	-
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		-	-
CD9	Simulation			

COURSE INFORMATION SHEET

Course Code: ME391 (Open Elective -III)
Course Title: Elements of Nuclear and Diesel Power plants
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 03 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions imparting the students to:

1. Familiarize with nuclear fuels and its various applications.
2. Classify various types of nuclear reactors with its working.
3. Identify and investigate the safety features of nuclear power plants.
4. Classify the types of diesel engines and its applications with its auxiliaries.
5. Evaluate the performance of diesel power plants.

Course Outcomes

At the end of the course, students will be able to:

CO1. Understand the applications of nuclear energy and manufacturing of nuclear fuel.
CO2. Develop an understanding of power generation through nuclear energy.
CO3.Select the safety features in the nuclear power plants by analyzing past nuclear accidents.
CO4.Develop an understanding of power generation through diesel engine power plants.
CO5.Analyze various performance parameters of diesel engine power plants.

Syllabus

MODULE	(NO. OF LECTURE HOURS)
Module – I **Introduction To Nuclear Engineering:** Introduction, Various Energy Sources, Why Nuclear power, Medicinal and Societal applications of Nuclear Energy. Nuclear fission and Nuclear Fusion, Types of Nuclear Reactions, Initiation of Nuclear reactions, Nuclear stability, Life of Nuclear Fuel.	**8**
Module – II **Nuclear Power Plants:** Introduction, Fermi pile Experiment, Major Components of nuclear power plants. Classifications of Nuclear reactors, Nuclear Breeding, Breeder reactors, Nuclear Materials.	**8**
Module – III **Nuclear Safety Systems:** Safety objectives, Shutdown systems in PWR,BWR,PHWR, Reactivity Worth of shutdown system, Operating Environment, Grouping of safety systems, Heat Removal systems, Emergency Core Cooling, Containment and subsystem, Site selection and Rejection criterion.	**8**
Module – IV **Introduction to Diesel power plants:** Introduction, Applications, Types of Diesel Engines used for Diesel power Plants, Different Systems of diesel power plants, Supercharging.	**8**
Module – V Performance of diesel power plants, Advantages and disadvantages of diesel power plants over Nuclear and Thermal power plants.	**8**

Text books:

1. Nuclear reactor Safety- principles and concept by G. Vaidyanathan, Yes Dee Publishing, (2017).
2. Power Plant Engineering: by Arora & Domkundwar, Dhanpatrai Publication (2016).
3. Power Plant Engineering by P. K .Nag, Tata McGraw Hill Publishing Company Ltd. (2017).

Reference books:

1. Nuclear Reactor Engineering by Samuel Glasstone, CBS Publishers & Distributors (2004).
2. Introduction to Nuclear Engineering by John R. Lamarsh, Pearson Education India (2014).
3. Power Plant Engineering: by F.T. Morse. Van Nostr and Reinhold; 3rd edition (1953).

Gaps in the syllabus (to meet Industry/Profession requirements)

Design of Nuclear power plants

POs met through Gaps in the Syllabus

PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design
Nuclear materials and safety mechanisms

POs met through Topics beyond syllabus/Advanced topics/Design
PO1 TO PO5

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	2	3	3	2	1	2	3	1	1	2	1	3	3	1	2
CO2	2	3	3	3	1	2	3	1	1	2	2	3	3	1	3
CO3	2	3	2	3	1	2	3	1	1	2	1	3	3	1	3
CO4	2	3	2	2	1	2	2	1	1	2	1	3	3	1	2
CO5	2	3	3	3	1	2	2	1	1	2	2	3	3	1	3

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors	CO1-5	CD1
CD2	Tutorials/Assignments	CO1-5	CD2
CD3	Seminars	-	-
CD4	Mini projects/Projects	-	-
CD5	Laboratory experiments/teaching aids	-	-
CD6	Industrial/guest lectures	-	-
CD7	Industrial visits/in-plant training	-	-
CD8	Self- learning such as use of NPTEL materials and internets	-	-
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: ME 394 (Open Elective-III)
Course title: Elements of Modal Analysis
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 (L:3, T:0, P:0)
Class schedule per week: 03
Class: B. Tech
Semester / Level: SIXTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions imparting the students to:

1.	To understand the basics of the linear algebra relevant to the modal analysis.
2.	To familiarize with the modelling of single and multi-degree vibratory systems and understand their frequency response function.
3.	To introduce experimental methods in modal analysis and learn digital signal processing of measurements.
4.	To teach estimation and extraction of modal parameters (natural frequencies, damping and mode shapes) from measured data.
5.	To introduce construction of mathematical models from extracted modal parameters.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Get familiar with theoretical and practical aspects of modal analysis
CO2	Estimate the frequency response function of vibratory system and predict the mode shape along with its corresponding frequency.
CO3	Evaluate the digital signal and perform post-processing of measurements. Recognize and articulately examine the sensor-actuator selection and placement.
CO4	Gain the ability to reconstruct mathematical models describing the structure based on modal analysis.
CO5	Apply the knowledge of modal analysis in understanding the dynamics of vibrating structures.

Syllabus

Module	Lectures/hour
Module: 1 **Introduction to modal analysis:** Overview of modal analysis**,** Mathematical preliminaries: Matrix operations, matrix decomposition, eigenvalue problems, Laplace transformation, Fourier series, and state space concept.	10
Module –II **Modal analysis of undamped single and multi-degree of freedom system (SDOF and MDOF):** Frequency response function (FRF) of SDOF/MDOF, normal modes, orthogonality, properties of FRF.	10
Module – III **Modal testing considerations:** Actuators and sensors in modal testing, Actuator/sensor placement considerations, Digital signal processing considerations: Fourier transformation, concept of aliasing, leakage, windowing, filtering, and averaging.	8
Module - IV **Modal analysis methods:** Peak picking, circle fit and Rational fraction polynomials methods, Mode indicator functions (MIF), Modal assurance criterion (MAC).	8
Module –V **Application of Modal analysis:** Illustration of modal analysis using software, system identification, impact testing, controllability and observe ability.	8

Textbooks

1. Modal analysis: Theory and Practice, D.J. Ewins, Research Studies Press Ltd, England, 2000.
2. Theoretical and experimental modal analysis, N. Maia and J. Silva, Wiley Publications, 1997
3. Theory of Vibration with Applications, W. T. Thomson and Marie Dillon Dahleh, Pearson Education, 2008.

References books

1. Mechanical Vibration, William J. Palm III, John Wiley & Sons, Inc., 2016.
2. Modal Analysis, Jimin He and Zhi-Fang Fu, Butterworth-Heinemann Publications, 2001.
3. Vibration: Fundamentals and Practice, Clarence W. de Silva, CRC press New York, 1999.
4. Vibration testing: Theory and Practice, Kenneth G. McConnel, John Wiley & Sons, Inc, New York, 1995.

Gaps in the syllabus (to meet Industry/Profession requirements)

Dynamic sub-structuring, Model updating, Advanced curve fitting for modal parameter extractions

POs met through Gaps in the Syllabus: PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design

Testing of structures, Software application in vibration analysis

POs met through Topics beyond syllabus/Advanced topics/Design: PO1 TO PO5

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	2	2	1					1	1	1	1	1	1
CO2	3	2	3	3	1							1	2	2	2
CO3	3	3	3	3	2	2	2					2	2	3	3
CO4	3	3	3	3	2	1	2			1	1	2	2	3	3
CO5	3	2	3	3	1	1	1					1	1	1	1

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1-5	CD1
CD2	Tutorials/Assignments	CO1-5	CD2
CD3	Seminars		
CD4	Mini Projects/Projects		
CD5	Laboratory Experiments/Teaching Aids		
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets		
CD9	Simulation		

7th SEMESTER

COURSE INFORMATION SHEET

Course code: ME 401
Course title: Refrigeration and Air conditioning
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SEVENTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To present a comprehensive and rigorous treatment of refrigeration and air conditioning for an engineering perspective.
2	To lay the foundation for subsequent studies in conventional and nonconventional refrigeration system to prepare the students to effectively use it in the practice of engineering.
3	To develop an intuitive understanding of refrigerant and psychrometry to emphasizing it on refrigeration and air conditioning application and its improvements.
4	To present a wealth of real world engineering examples to give students a feel for how refrigeration and air conditioning is applied in engineering practice.

Course Outcomes

After the completion of this course, students will be:

CO1	Outline the concepts of refrigeration, air-conditioning and application of air refrigeration system in aeroplane.
CO2	Outline basic knowledge, electrical system and interpret vapour compression system and its application in multi pressure, multi evaporator and cascade system with different refrigerant.
CO3	Analyse different air conditioning systems and economic application.
CO4	Specify, interpret psychometric relations and cooling load for refrigeration and air conditioning system.
CO5	Outline the concepts of ice plant, cold storage and food preservative plant.

SYLLABUS

Module	Lectures/hour
Module -I Introduction about Refrigeration- Definition of various terms, Method of refrigeration, Air refrigeration system, Bell-Coleman cycle, Introduction about Air craft Air-conditioning, Evaporative cooling system, Boot strap cooling system, Regenerative cooling system, Reduced ambient system.	8
Module –II Analysis of vapour compression cycle, Modifications to basic cycle, Multi pressure system, Multi-evaporator system and Cascade system, properties of refrigeration, Selection of refrigeration, Discussion of components of VC system, Servicing, Vacuumizing and charging of refrigerant, Electrical and electronics control of air conditioning system and its fault detection.	8
Module – III Vapour Absorption Refrigeration system and its applications, Thermo-electric Refrigeration system, Steam jet Refrigeration system, magnetic refrigeration, vortex and pulse tube refrigeration system.	8
Module - IV Psychrometry- Definition for properties, Introduction to cooling load calculations, Comfort conditions, Effective temperature concept, properties of moist Air-Gibbs Dalton law, Specific humidity, Relative humidity, Enthalpy, Psychometric of Air-conditioning Process, Mixing of air stream.	8
Module –V Air-conditioning system- Discuss about the central plant with direct evaporator and chiller applications, ice plant, Refrigerators, Food preservation, IQF technique freeze drying and Cold storage.	8

Text book:

1. Arora, C.P., Refrigeration and Air Conditioning, 3nd ed., Tata McGraw-Hill, 2010.

Reference books:

1. Stoecker, W.F. and Jones J.W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 1986.
2. Dossat R.D., Principle of Refrigeration, 4th ed., Prentice-Hall, 1997.
3. Manohar Prasad, Refrigeration and Air Conditioning, New Age International, 2004.
4. Jones W.P., "Air conditioning engineering." 5th edition, Elsevier Butterworth-Heinemann, 2001.

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	2	2		1		2	1		1	1		2	3	2	2
CO2	2	2	3	2	1	3	3	2	1	2	2	2	3	2	2
CO3	1	1	3	1	2	3	3	2	1	2		2	3	2	2
CO4	2	2	1	2	3	3	2	2	2	2	1	2	3	2	2
CO5	1	1	3	2	1	3	3			2	1	2	2	2	2

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

CD Code	**Course Delivery Methods**	**Course Outcome**	**Course Delivery Method Used**
CD1	Lecture by use of Boards/LCD Projectors	CO1-5	CD1, CD2 , CD5,CD8
CD2	Tutorials/Assignments	CO1-5	CD1, CD2
CD3	Seminars		
CD4	Mini Projects/Projects		
CD5	Laboratory Experiments/Teaching Aids	CO1-5	CD1, CD8
CD6	Industrial/Guest Lectures		
CD7	Industrial Visits/In-plant Training		
CD8	Self- learning such as use of NPTEL Materials and Internets	CO1-5	
CD9	Simulation		

COURSE INFORMATION SHEET

Course code: MT 204
Course title: Constitution of India
Credits: NC **(**L: 2, T:0, P: 0)
Class schedule per week: 2
Class: B. Tech.
Semester / Level: SEVENTH
Branch: Mechanical Engineering

Course Objectives:
This course enables the students:

1.	To describe the importance and role of Constitution of India
2.	To resolve the social problems and issues.
3.	To maintain and bolster the unity and integrity in the society.
4.	To formulate and design policies in accordance with the constitutional provisions.

Course Outcomes

After the completion of this course, students will be:

CO1	Outline the need and importance of the Indian constitution.
CO2	Explain the fundamental rights and duties of the citizens of India.
CO3	Relate appropriate constitutional provisions with relevant social issues
CO4	Describe the role of different departments of government.
CO5	Criticize the Government policies and programmes designed for the society at large.

Syllabus

Module 1: Introduction to the Constitution of India, Salient Features of the Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

[8]

Module 2: Union and State Executives: President and Prime Minister, Council of Ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha. Governor: Role and Position, Chief Ministers and Council of ministers.

[8]

Module 3: The Indian Judicial System – The Supreme Court and The High Court's – composition, Jurisdiction and functions, The Role of the Judiciary.

[8]

Module 4: Local Government- District's Administration: Role and Importance, The Panchayatas –Gram Sabha, Constitution and Composition of Panchayatas, Constitution and Composition of Municipalities

[8]

Module 5: Miscellaneous- Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

[8]

Suggested Readings

1. The Constitution of India by "Ministry of Law India" Kindle Edition
2. Constitutional History of India by Prof. M.V.PYLEE- S.Chand Publishing
3. Indian Administration by Avasti and Avasti-Lakshmi Narain Agarwal Educational Publishers. 2017 edition.
4. Introduction to the Constitution of India by D D Basu by Lexis Nexis: 20th edition.
5. Constitution of India V. N. Shukla's EBC ExplorerEdition13th,2017

Course Delivery methods
1.Lecture by use of boards/LCD projectors/OHP projectors
2.Tutorials/Assignments
3.Seminars
4.Miniprojects/Projects
5.Laboratoryexperiments/teaching aids
6.Industrial/guest lectures
7.Industrialvisits/in-plant training
8.Self- learning such as use of NPTEL materials and internets
9.Simulation

Course Outcome(CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	**%Contribution during CO Assessment**
Mid Sem Examination Marks	25
End Sem Examination Marks	50
Assignment/Quiz(s)	15

AssessmentCompoents	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Mid Sem Examination Marks	√	√			
End Sem Examination Marks	√	√	√	√	√
Assignment	√	√	√		

Indirect Assessment–

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes on to Program Outcomes

Course Outcome	Program Outcomes(POs)												Program Specific Outcomes(PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1						3	3	3	3	3		2	1	1	1
CO2						3	3	2	3	3		2	1	1	2
CO3						1	3	3	3	3		2	1	1	1
CO4						3	2	2	3	3		2	1	1	1
CO5						3	3	3	3	3		1	1	1	1

Correlation Levels 1, 2 or3 as defined below:

1:Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Mapping Between COs and Course Delivery(CD)methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course DeliveryMethod**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1
CD2	Tutorials/Assignments		CO2	CD1
CD3	Seminars		CO3	CD1,CD2
CD4	Mini projects/Projects		CO4,	CD1,CD2
CD5	Laboratory experiments/teaching aids		CO5	CD1,CD3,CD6
CD6	Industrial/guest lectures			
CD7	Industrial visits/in-plant training			
CD8	Self-learning such as use of NPTEL materials and internets			
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: ME 404
Course title: Refrigeration and air conditioning lab
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 1.5 L: 0, T: 0, P:3
Class schedule per week: 03
Class: B. Tech
Semester / Level: SEVENTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To evaluate and analyse the different refrigeration and air conditioning machine.
2	To familiarize the students to perform experiments related to refrigeration machine and equipment.
3	To study and evaluate performance analysis of refrigeration and air conditioning machine ; and look prospects of alternative source of input.

Course Outcomes

After the completion of this course, students will be:

CO1	Understand the procedure to conduct experiments of refrigeration and air conditioning machines.
CO2	Understand various parameters influence the performance of the refrigeration and air conditioning machines.
CO3	Analyze the observations made through experiments and evaluate the machine performance.
CO4	Apply the experimental knowledge how to perform the experiments and study parameters for further improvements.
CO5	Able to find out the different energy sources for refrigeration and air conditioning machines.

List of experiments:

1) Comparative study of vapour compression system and vapour absorption system
2) To evaluate the coefficient of performance of vapour absorption system with load and without load
3) To evaluate the coefficient of performance of vapour absorption system with different heating system (gas and electricity) and comparative energy analysis.
4) To evaluate coefficient of performance of thermoelectric cooler
5) Performance study of cooling using peltier effect by varying flow rate of water in cooling and heating side.
6) Performance evaluation of vapour compression test rig
7) Performance evaluation of variable load refrigeration test rig

8) Performance evaluation of variable load refrigeration system by varies flow rate through expansion valve/capillary
9) Measurement of relative humidity using psychometre.
10) Study of the effect of the flow rate of fan in room humidity
11) Study of electrical and electronics connection of air conditioning system and fault detection.
12) Study of prospect of solar energy in refrigeration and air conditioning industry.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive evaluation	60
End Sem Lab Examination Marks	40

Indirect Assessment –

1. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	2					2	1	2	2	2		2	3	3	3
CO2	2	2				2	2	1	2	2	1	2	3	3	3
CO3	2	2				2	2	1	3	2	1	2	3	3	3
CO4	2	2	1	2		2	2	1	3	2	1	2	3	3	3
CO5	1		2	2		3	2	2	3	2	1	2	2	3	3

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

COURSE INFORMATION SHEET

Course code: ME406
Course title: Computer Aided Design and Drafting Lab
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 1.5 L: 0, T: 0, P: 3
Class schedule per week: 03
Class: B. Tech
Semester / Level: SEVENTH
Branch: Mechanical Engineering
Name of Teacher:
Course Objectives

This course enables the students:

1	To understand the importance of CAD in solving the various engineering problems.
2	To develop the 2D and 3D models of different component for better understanding and examination.
3	To analyze the different physical aspects of complex machine parts through modelling and simulation.

Course Outcomes

After the completion of this course, students will be:

CO1	Discuss and familiarization of modelling software AUTOCAD.
CO2	Analyzing and modelling of different complex geometry in auto cad.
CO3	Develop the expertise in modelling using software CREO.
CO4	Analyzing and modelling of different assembly drawing.
CO5	Develop the model in ANSYS and simulate different practical problems to reduce the error.

List of experiments:

1. Understanding of Auto CAD.
2. Practice of command in auto cad like units, limits, grid, line, pline, donut, polygon, chamfer, fillet, offset, text, detext.
3. Draw the part drawing in auto cad without dimensioning using different commands.
4. Draw the dimensional complex geometry like stuffing box using commands in auto cad.
5. Understanding of CREO.
6. Draw the 3D drawing using CREO of different components and show its plan, elevation and side view.
7. Draw the parts and assembly drawing of foot step bearing and steering wheel.
8. Draw the parts and assembly drawing of clutch plate and knuckle joint.
9. Understanding of ANSYS and create the solid models.
10. Determination of deflection and stresses in 2D and 3D trusses.
11. Determination of deflection and stresses in different beams at different conditions.
12. Steady state heat analysis of plane and axi-symmetric components.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Progressive evaluation	60
End Sem Lab Examination Marks	40

1. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	3	1	1	1	1	1	1	2	3	3	3
CO2	3	3	3	3	3	2	2	1	2	2	2	2	3	3	3
CO3	3	3	3	2	3	1	1	1	1	1	1	2	3	3	3
CO4	3	3	3	3	3	2	2	1	2	2	2	2	3	3	3
CO5	3	3	3	3	3	2	2	2	2	2	2	2	2	3	3

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

ME400M MINOR PROJECT

Total Credit 3

ME400M - MINOR PROJECT Total Credit-3

Course Outcomes

After the completion of this course, students will be

CO1	Able to formulate a practical problem in real life to explore for its possible solution after suitable review of literature.
CO2	Able to analysis the given problem and safest suitable solution on the bans of background engineering knowledge
CO3	Able to synthesize the outcome of the problem and validate findings on the basis of experimentation
CO4	Able to produce scientific content in the form of report writing as per the standard norms
CO5	Able to inculcate the learning from the curriculum to bring new ideas to solve various problems faced by common people.

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	1	1	1	1	1	1	1	1	3	2	-
CO2	3	3	3	3	1	1	1	1	1			1	3	2	-
CO3	3	3	3	3	1	1	1	1	1			1	3	2	-
CO4	3	3	3	3	1	1	1	1	1	1	1	1	3	2	-
CO5	3	3	3	3	1	1	1	1	1			1	2	2	-

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

COURSE INFORMATION SHEET

Course code: ME 409(Program Elective -VI)
Course title: Industrial Management
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SEVENTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To present the principles associated with basics of industrial management and to apply these principles in the day to day life.
2	To understand the Human Resource Management and to equip students with the process of man power planning, recruitment, industrial relations and administration.
3	The course aims at material requirements, resource planning and inventory management.
4	To introduce the basic tools and techniques required in modern financial management.
5	To understand the philosophy of total quality management and ways of its implementation in the organisation.

Course Outcomes

After the completion of this course, students will be:

CO1	Able to solve various basic problems in the field of engineering and management.
CO2	Able to know various processes in manpower planning, organizational and welfare measures.
CO3	Understand the factors influencing decisions related to inventory, purchase, plant location, layout and Material Handling Systems
CO4	Able to know the estimation and formulations of projects capital investment, projects costing, financing and profitability.
CO5	Able to know the quality control aspects in planning, systems, management, assurance and improvement techniques.

Syllabus

Module	Lectures/hour
Module –I Introduction to Industrial management, Brief history of industries in India, Brief definition of management, organization and administration, characteristics of management, functions of management , Principles of management, Nature of management, levels of management, managerial skills, managerial roles, Forms of Organization, Forms of ownerships, concept of Globalization.	8
Module –II Strategic importance of HRM, Objectives of HRM, challenges to HR professionals, Role, Responsibilities and competencies of HR professionals, HR department operations, Human Resource Planning - objectives and process, human resource information system. Talent acquisition, recruitment and selection strategies, career planning and management, training and development, investment in training program, executive development.	9
Module – III Materials Management- Objectives, Inventory – functions, types, associated costs, inventory classification techniques. Stores Management and Stores Records. Purchase management, duties of purchase manager, associated forms. Concepts of production system, Production planning and control, Work and time study, Plant location, Factors affecting the plant location, comparison of rural and urban sites, methods for selection of plant. Plant Layout – Objectives, types of production, types of plant layout – various data analyzing forms-travel chart. Material handling, Job decision & project management using PERT & CPM, Inspection and Quality control, forecasting and line balancing.	8
Module – IV Capital Structure, Fixed & working capital, Role of Securities and Exchange Board of India (SEBI), function of money market and capital Market, sources of finance. Introduction to capital budgeting, Techniques of capital budgeting. Break even analysis - assumptions, importance, Cost-Benefit analysis, CVP graph, Project Management, Project network analysis, CPM, PERT and Project crashing and resource Leveling.	8
Module –V Definition of quality, goalpost view of quality, continuous improvement definition of quality, types of quality – quality of design, conformance and performance, phases of quality management, Juran's and Demings view of quality, Quality Management Assistance Tools: Ishikawa diagram – Pareto Analysis – Pokka Yoke (Mistake Proofing).Quality circles, TQM, Kaizen, Five S (5S), Six sigma Quality Management Standards (Introductory aspects only)- The ISO 9001:2000 Quality Management System Standard- The ISO 14001:2004. Environmental Management System Standard- ISO 27001:2005 Information Security Management System.	9

Text Books:

1. O. P. Khanna, Industrial Engineering and Management, Dhanpatrai publications.
2. L.C. Jhamb, Savitri Jhamb, Industrial Management – I, Everest Publishing House.
3. Buffa E.S, Modern Production and Operational Management, John Wiley & Sons.

Reference Books:

1. Production, Planning and Inventory Control by S.L. Narasimhan, D.W. McLeavey, P.J. Billington, Prentice Hall.
2. Production Systems: Planning, Analysis and Control by J.L. Riggs, Wiley.
3. Production, Operations Management by Panneerselvam. R. , Prentice Hall of India Pvt Ltd.
4. Operation Management by Nigel Slack, Stuart Chambers, Robert Johnston, Pearson Education.

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback .

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	2	1	1	3	2	2	3	3	3	2	3	3	3	3	3
CO2	1	1	1	3	1	1	3	3	3	2	3	3	3	3	3
CO3	1	1	1	3	1	1	3	3	3	2	3	3	3	3	3
CO4	1	1	1	3	1	1	3	3	3	2	3	3	3	3	3
CO5	1	1	1	3	1	1	3	3	3	2	3	3	3	3	3

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping between COs and Course Delivery (CD) methods

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors	CO-1-5	CD1
CD2	Tutorials/Assignments	CO-1-5	CD2
CD3	Seminars	-	-
CD4	Mini projects/Projects	CO-1-5	CD4
CD5	Teaching aids	-	-
CD6	Industrial/guest lectures	-	-
CD7	Industrial visits/in-plant training	CO-1-5	CD7
CD8	Self- learning such as use of NPTEL materials and internets	CO-1-5	CD8

COURSE INFORMATION SHEET

Course code: ME479 (Program Elective-VI)
Course title: Advanced Heat Transfer
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SEVENTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	Provide a fundamental understanding of analytic and numerical methods used to solve heat transfer problems
2	Understand the usage of tables and charts to determine properties for problem solutions
3	To develop the skill to develop models of real processes and systems and draw conclusions
4	Apply scientific and engineering principles to analyze and design thermo fluid aspects of engineering systems

Course Outcome

After the completion of this course, students will be:

CO1	Apply the concepts to solve complex conduction problems
CO2	Analyze the different fin shapes.
CO3	Compare the correlations for different Convection flow problems.
CO4	Examine the boiling and condensation parameters.
CO5	Analyze the mass transfer equations.

SYLLABUS

Module	Lectures/hour
Module -I Basic concepts and laws of Heat Transfer, Two-Dimensional Steady-State Conduction, Method of Separation of Variables, Conduction Shape Factor and the Dimensionless Conduction Heat Rate, Finite-Difference Equations, Transient Conduction: General Lumped Capacitance Analysis, Plane Wall with Convection, Radial Systems with Convection, Semi-Infinite Solid, Objects with Constant Surface Temperatures or Surface Heat Fluxes, Periodic Heating, Finite-Difference Methods	10
Module –II Extended surfaces (Fins), Fins of Non-uniform Cross-Sectional Area, circumferential fins. Radiation: Fundamental Concepts, radiation heat transfer by electrical analogy approach, Shape factor, Triangular enclosure, Applications.	6
Module – III Convection Boundary Layers, Boundary Layer Equations, Normalized Boundary Layer Equations, Boundary Layer Analogies, Flat Plate in Parallel Flow, Cylinder in Cross Flow, Sphere, Flow Across Banks of Tubes, Impinging Jets, Packed Beds, Convection Correlations: Noncircular Tubes and the Concentric Tube Annulus, Turbulent Flow in Circular Tubes, Flow in Small Channels, Combined Free and Forced Convection.	8
Module - IV Boiling and Condensation, Dimensionless Parameters, Boiling Modes, Pool Boiling, Pool Boiling Correlations, Forced Convection Boiling, Condensation: Physical Mechanisms, Laminar Film Condensation on a Vertical Plate, Turbulent Film Condensation, Film Condensation on Radial Systems, Condensation in Horizontal Tubes, Drop wise Condensation.	8
Module –V Mass Transfer: Introduction to Diffusion and Convective mass transfer: Significant parameters in convective mass transfer, application of dimensional analysis to Mass Transfer, Analogies among mass, heat, and momentum transfer, Convective mass transfer correlations, Mass transfer between phases, Simultaneous heat and mass transfer.	10

TEXT BOOKS:

1. Fundamentals of Heat and Mass Transfer by Incropera, F. P. and De Witt, D. P
2. Heat and Mass Transfer by P.K. Nag
3. Fundamentals of Engineering Heat and Mass transfer by R. C. Suchdeva
4. Heat and Mass Transfer by Yunus A. Cengel.
5. Data Book: Heat and Mass Transfer by C.P. Kothandraman

REFERENCE BOOKS:

1. Whitaker, S., Fundamental Principles of Heat Transfer, New York, Pergammon, 1997
2. Heat and Mass Transfer by F. Kids
3. Heat and Mass Transfer by J.P. Holman

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	2	1	1		2			3	3	2	2
CO2	3	3	3	3	2	1	1		2			3	3	2	2
CO3	3	3	3	3	2	1	1		2			3	3	2	2
CO4	3	3	3	3	2	1	1		2			3	3	2	2
CO5	3	3	3	3	2	1	1		2			3	2	2	2

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		-	-
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		-	-
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: ME 481(Program Elective-VI)
Course title: Theory of Elasticity
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 L: 3, T: 0, P: 0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SEVENTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To present the fundamentals of the theory of elasticity.
2	To lay the groundwork for subsequent studies in the fields of stress, strain, and various mathematical methods.
3	To develop an intuitive understanding of various mathematical techniques to solve the problems.
4	To be able to understand and formulate various problems under different loading conditions.

Course Outcomes

After the completion of this course, students will be able to:

CO1	To understand the fundamentals of Stresses, Strains, and Energy Equations.
CO2	To develop an intuitive understanding of the theory of elasticity.
CO3	To apply the concepts with suitable assumptions on mechanical members using boundary conditions.
CO4	To evaluate the stresses, strains in real-world examples related to mechanical engineering
CO5	To analyse the simple mechanical elements.

SYLLABUS

Module	Lectures/hour
Module - I Fundamentals of stress and strain: Introduction; Body force, surface force and stress vector; The state of stress at a point; Principal stresses; Mohr's circle; Stress invariants; Octahedral stresses; Hydrostatic and deviator stresses; The state of strain at a point; Cubical dilatation; Principal Strains; Generalised Hooke's law.	8
Module – II Derive governing equations of equilibrium; Boundary value problems; Equilibrium equations in cylindrical coordinates; Compatibility Equations.	8
Module – III Methods of Solution of Elasticity Problems – Plane Stress-Plane Strain Problems; Polar coordinates; Axisymmetric problems.	8
Module - IV Two dimensional problems: Airy's stress functions in rectangular coordinates; Investigation of Airy's Stress function for simple beam problems	8
Module – V Energy methods: Castigliano's theorem; approximate solution using Ritz method. Applications of energy methods to various problems.	10

TEXT BOOKS:

1. S.P Timoshenko, J.N. Goodier, *Theory of Elasticity*, 3rd Ed., McGraw-Hill Book Company, 1970.

REFERENCE BOOKS:

1. L.S. Srinath, *Advanced Mechanics of Solids*, 3rd Ed., Tata McGraw-Hill Ed. Pvt. Ltd., 2009.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	-	-	1	2	-	1	1	-	-	-	3	2	2
CO2	3	3	2	-	3	2	1	1	2	1	-	-	3	2	2
CO3	3	3	3	2	3	2	1	1	2	1	1	-	3	2	2
CO4	3	3	2	3	3	3	1	1	2	-	-	1	3	2	2
CO5	3	3	3	3	3	3	1	2	2	2	1	1	2	2	2

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors	CO-1-5	CD1
CD2	Tutorials/Assignments	CO-1-5	CD2
CD3	Seminars	-	-
CD4	Mini projects/Projects	-	-
CD5	Laboratory experiments/teaching aids	-	-
CD6	Industrial/guest lectures	-	-
CD7	Industrial visits/in-plant training	-	-
CD8	Self- learning such as use of NPTEL materials and internets	CO-1-5	CD8

COURSE INFORMATION SHEET

Course code: ME483(Program Elective-VI)
Course title: Non-Linear Dynamics and Chaos
Credits: 3 (L:3, T:O, P:O)
Class schedule per week: 3
Class: B. Tech
Semester / Level: SEVENTH
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To introduce the concepts of non-linear dynamics and its applications.
B.	To analyze a non-linear system for Bifurcations, limit cycles, and stability.
C.	To understand the chaos with Lorenz equations.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Understand the geometric way of fixed points and stability.
CO2	Apply the knowledge of non-linear dynamics to find the bifurcations in the system
CO3	Analyze the two-dimensional linear and non-linear systems
CO4	Evaluate the limit cycles of non-linear systems
CO5	Understand chaos using Lorenz equations

Syllabus

Module	Hours
Module-I Introduction to non-linear dynamics, One dimensional systems, Geometric Way of Thinking, Fixed Points and Stability, Linear Stability Analysis, Existence and Uniqueness, Impossibility of Oscillations	**8**
Module-II Bifurcations: Saddle-Node Bifurcation, Transcritical Bifurcation, Pitchfork Bifurcation, Overdamped Bead on a Rotating Hoop, Imperfect Bifurcations and Catastrophes, Uniform Oscillator, Nonuniform Oscillator, overdamped pendulum.	**8**
Module- III Two-dimensional linear and non-linear systems, phase portraits, phase plane, Fixed Points and Linearization, Conservative Systems, Pendulum	**8**
Module- IV Limit cycles, van der Pol oscillator, Lyapunov Functions, Poincaré-Bendixson Theorem, Liénard Systems, Weakly Nonlinear Oscillators	**8**
Module-V Introduction to Chaos, Lorenz equations, Simple properties of Lorenz equations, Chaos on a strange attractor, Lorenz map	**8**

Text books:

1. Strogatz, S. H. (2018). *Nonlinear dynamics and chaos: With applications to physics, biology, chemistry, and engineering*. CRC press.
2. Thompson, J. M. T., & Stewart, H. B. (2002). *Nonlinear dynamics and chaos*. John Wiley & Sons.

Gaps in the syllabus (to meet Industry/Profession requirements)

A rigorous mathematical treatment for non-linear vibrations.

POs met through Gaps in the Syllabus

PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design

Numerical computations.

POs met through Topics beyond syllabus/Advanced topics/Design

PO1 TO PO5

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√				√
End Semester Examination	√	√	√		√
Quiz (s)	√	√	√		
Assignment	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	1	1	1	1	1	1	1	1	3	2	2
CO2	3	3	3	3	1	1	1	1	1			1	3	2	2
CO3	3	3	3	3	2	1	1	1	1			1	3	2	2
CO4	3	3	3	3	2	1	1	1	1	1	1	1	3	2	2
CO5	3	3	3	3	3	1	1	1	1			2	2	2	3

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		-	-
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		-	-
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: PE 406 (Program Elective-VI)
Course title: Non-Conventional Machining Processes
Pre-requisite(s): PE 327 Machining Science and Machine Tools/PE 213 Manufacturing Processes
Co- requisite(s): NIL
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: B. Tech
Semester / Level: SEVENTH
Branch: Mechanical Engineering

Course Objectives:

This course enables the students to:

1	Learn about the different non-conventional machining processes and theiroperational characteristics
2	Learn about the basic construction of the different non-conventional machines, andabout the tools, equipment and consumable required
3	Understand the effects of different process parameters on part quality, and how the parameters are to be controlled
4	Study different empirical, analytical and theoretical approach for analysis ofmaterial removal for different processes.
5	Learn about the developments of different hybrid non-conventional machiningtechniques

Course Outcomes:

After the completion of this course, students will able to:

CO1	Explain the fundamental principles, techniques, equipment, applications, advantages and limitations of different non-conventional machining processes.
CO2	Find solutions for meeting demand of machining hard-to-machine materials, producing complex shape and size with greater product accuracy and surface finish
CO3	Analyse the influence of process parameters on part quality
CO4	Explain the developments and operation potential of different hybrid non-conventional machining techniques
CO5	Select appropriate non-conventional machining technique based on workmaterials used and the part features to be produced

SYLLABUS

Module 1: Introduction and mechanical processes (AJM, WJM, AWJM, USM) [8]

Need and classifications of non-conventional Machining Processes

Fundamental principles, application possibilities, process parameters, schematic layout of machine and operational characteristics of Abrasive Jet Machining (AJM), Water Jet Machining (WJM) and Abrasive Water Jet Machining (AWJM); calculation of materialremoval rate (MRR) for ductile and brittle materials in AJM;

Fundamental principles, application possibilities, process parameters, schematic layout of machine and operational characteristics of Ultrasonic Machining (USM); Calculation of MRR in USM by empirical approach, Cook's model, Shaw theory.

Module 2: Chemical and electrochemical processes (ChM, ECM) [8]

Fundamental principles, application possibilities, process parameters, operational characteristics and tooling of Chemical Machining (ChM); Chemical Milling, Photochemical Milling, Electro-polishing;

Fundamental principles, application possibilities, process parameters, schematic layout of machine and operational characteristics of Electrochemical Machining (ECM); electrolytes; electrochemistry of ECM; kinematics and dynamics of ECM, Effect of heat and hydrogen bubble generation; design of tool shape, electrolyte flow and insulation, surface finish and accuracy.

Module 3: Thermal processes (EDM, WEDM) [8]

Fundamental principles, application possibilities, process parameters, schematic layout of machine and operational characteristics of Electro Discharge Machining (EDM); mechanicsof EDM; theories of material removal in EDM; types of EDM; dielectric fluid; electrodematerial; pulse generation; flushing techniques, effects on material surface, surface finish andaccuracy; dry EDM; Operation principles, applications, process parameters of Wire Electro Discharge Machining (WEDM)

Module 4: Thermal Processes (LBM, EBM, PAM, IBM) [8]

Fundamental principles, application possibilities, process parameters, schematic layout of machine and operational characteristics of Laser Beam Machining (LBM); types of lasers andlasing process; mechanics of LBM; surface finish and accuracy;

Fundamental principles, application possibilities, process parameters, schematic layout of machine and operational characteristics of Electron Beam Machining (EBM), and Plasma Arc Machining (PAM), Ion Beam Machining (IBM).

Module 5: Hybrid Machining Processes [8]

Fundamental principles, applications and operational characteristics of Electrochemical Grinding, Electro discharge Grinding, Electrochemical Discharge Machining and Electrochemical Discharge Grinding, Abrasive Electro discharge Machining, EDM with Ultrasonic Assistance, Ultrasonic-Assisted ECM, Laser-Assisted ECM, Laser-Assisted Oxygen cutting.

Text books:

1. P. C. Pandey and H. S. Shan, Modern Machining Processes, Tata McGraw-Hill **[T1]**
2. P. K. Mishra, Non-conventional Machining, Narosa Publishing House **[T2]**
3. Hassan El-Hofy, Advanced Machining Processes, McGraw-Hill **[T3]**

Reference books:

1. Ghosh and A.K. Mallik, Manufacturing Science, Affiliated East- West Press **[R1]**
2. Bhattacharyya, New Technology, The Institution of Engineers (India) **[R2]**
3. M P. Groover, Fundamentals of Modern Manufacturing, John Wiley & Sons, Inc. **[R3]**

Gaps in the syllabus (to meet Industry/Profession requirements):

Hands-on exposure on non-conventional machining processes

POs met through Gaps in the Syllabus:

POs 1-5, 12

Topics beyond syllabus/Advanced topics/Design:

Machining and super-finishing in sub-micron level

POs met through Topics beyond syllabus/Advanced topics/Design:

POs 1-5, 12

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√	√		
Quiz 1	√	√	√		
Quiz 2	√	√	√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and ProgramSpecific Outcomes (PSOs):

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	1								3	3	2	3
CO2	3	3	3	3	1							3	3	2	3
CO3	3	3	3	2	1							3	3	2	3
CO4	3	3	3	2								3	3	2	3
CO5	3	3	3	3	1							3	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: PE 413(Program Elective-VI)
Course title: AI and Data Analytics
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 L:3 T:0 P:0
Class schedule per week: 3
Class: B. Tech
Semester / Level: SEVENTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives:

This course enables the students to:

1	Learn about basic tools of AI and the application areas
2	Understand the concept of ML and various tools under it
3	Gain knowledge on fuzzy logic and practical applications
4	Know about data science and its applications in business and decision making
5	Learn and apply data analytics tools like R and Python

Course Outcomes:

After the completion of this course, students will able to:

CO1	Apply ML tools to various engineering and management problems
CO2	Develop fuzzy systems for inference using Matlab simulation app
CO3	Develop ANN based deep learning models for practical problems
CO4	Implement data pre-processing like cleaning, sorting, reduction, etc.
CO5	Apply various data analytics tools using software or programming

SYLLABUS

Module 1: Fundamental of AI **[7]**

AI Concepts, terminology and application areas, Components and tools of AI, Comparison offeatures and characteristics of AI systems with biological systems, Examples of real-life practical application of AI, Societal impact and Ethical issues

Module 2: Machine Learning (ML) **[8]**

ML techniques overview, Decision trees, classification and clustering as ML tools, Artificial Neural Network (ANN), Supervised, unsupervised and reinforced learning, Perceptron and back propagation, Deep learning, Applications and real-life examples

Module 3: **Fuzzy Logic and Applications** **[8]**

Introduction to fuzzy set theory, Fuzzy set properties and operations, Linguistic variables, Fuzzy

rules, Fuzzy quantifiers, Fuzzy logic, Mamdani and Sugeno Fuzzy Inference Systems (FIS), Matlab© simulations, Examples of real-life applications of fuzzy systems

Module 4: Introduction to Data Science **[7]**

Introduction, Types of data, Big data, Data Pre-processing, Knowing data, Data cleaning, Data reduction, Data transformation, Data discretization -Visualization and Graphing, Application of Python© programming, Numerical examples

Module 5: Data Analytics **[10]**

Data Analytics Process, Qualitative verses Quantitative Analysis, Data Analysis and Data Mining, Business Analytics, Types of Data Analytics: Diagnostic Analysis, Predictive Analysis, Prescriptive Analysis, Statistical Analysis (Descriptive and Inferential), Text Analysis, Examples and Application of R and Python© programming,

Text Book

1. S. Rajasekaran and Vijayalakshmi Pai, Neural Networks, Fuzzy Systems andEvolutionary Algorithms: Synthesis and Applications, PHI, India **(T1)**
2. Ajit Kumar Roy and Pradip Kumar Choudhury, Applied Big Data Analytics, ISBN-13 : 978-1512347180 **(T2)**
3. Russell, Norvig, Artificial Intelligence: A Modern Approach, Third edition, PrenticeHall, 2010 **(T3)**

Reference Book

1. Bharti Motwani, Data Analytics Using Python, Wiley, India **(R1)**
2. Garret Grolemund and Hadley Wickham, R for Data Science, ISBN-13: 978-1491910399 **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√	√		
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and ProgramSpecific Outcomes (PSOs):

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	3	2	1	1	1	1	3	1	2	3	3
CO2	3	3	3	2	3	2	1	1	1	1	3	1	2	3	3
CO3	3	3	3	2	3	2	1	1	1	1	3	1	2	3	3
CO4	3	3	3	2	3	2	1	1	1	1	3	1	2	3	3
CO5	3	3	3	2	3	2	1	1	1	1	3	1	2	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: ME 489 (Open Elective-IV)
Course title: Mechatronics and its applications
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 L:3, T: 0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SEVENTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To present a comprehensive treatment on Mechatronics and Real time interfacing.
2	To lay the groundwork for subsequent studies in the fields of sensors, actuators, and digital technologies
3	To develop an intuitive understanding of various microcontrollers and automated systems for system design
4	To be able to understand and tackle various problems of conventional approach to design and solve case studies with new product development.

Course Outcomes

After the completion of this course, students will be:

1.	Understand the importance of mechatronics and its application in real world.
2.	To know for the design aspects and automation concepts in new products
3.	Analyze different systems and take challenges to design newer digital products
4.	Able to model components and products through 3D printing
5.	Outline the concepts changes done and what are the needs and advantages of implementing Mechatronics.

SYLLABUS

Module	Lectures/hour
Module -I **Basics of Mechatronics:** Definition of Mechatronics, Mechatronics in product design, Fundamentals of electronics, Gates and K map Minimization, JK Flip Flop, Microcontrollers	8
Module –II **Digital Inputs and Output Conditioning**: Basic Operations in Signal conditioning, Amplification, Filtering, Digital Inputs and Outputs, A to D and D to A converters, Voltage Regulators	8
Module – III **Sensors and Actuators:** Sensor Design, Fundamental Sensors and Interface Circuits, Light Sensors, Strains, Temperature, Magnetic Field, Proximity, Position, Acceleration, Force, Pressure, Actuators**,** Servo motors, Stepper motors, Hydraulic actuators, Flow, Pressure and Direction control valves, Pneumatic Actuators	8
Module - IV **Rapid Prototyping**: Introduction, Solid Modeling Tools, Electrical system Rapid Prototyping, 3D RP Techniques, SLA, SLS, FDM, Soft Mold Castings	8
Module –V **Electro pneumatic & electrohydraulic systems using relay logic circuits.:** Programmable Logic Controllers (PLC) based control system, programming languages & instruction set, ladder logic, functional blocks, structured text, and applications. Human Machine Interface (HMI) & Supervisory Control and Data Acquisition System (SCADA); motion controller, applications of RFID technology and machine vision.	8

Text book:

1. Introduction to Mechatronic Design ,Carryer, Ohline, Kenny, Pearson
2. Introduction to Mechatronics and Measurement System by David G. Alciatore, Michael B. Histamd, McGraw Hill.
3. Mechatronics by Bolton, Pearson Education

Reference books:

1. Mechatronics System Design by Devdas and Shetty, Pearson Education
2. CNC Technologies By Hmt Ltd MGH

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	-	-	1	2	-	1	1	-	-	2	3	2	3
CO2	3	3	2	-	3	2	1	1	2	2	-	2	3	2	3
CO3	3	3	3	2	3	3	1	1	2	2	2	2	3	2	3
CO4	3	3	2	3	3	3	1	1	2	-	-	2	3	2	3
CO5	3	3	3	3	3	3	1	2	3	2	2	2	2	2	3

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods				
CD	**Course Delivery methods**		**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors/OHP projectors		CO1-5	CD1
CD2	Tutorials/Assignments		CO1-5	CD2
CD3	Seminars		-	-
CD4	Mini projects/Projects		-	-
CD5	Laboratory experiments/teaching aids		CO 1-5	CD5
CD6	Industrial/guest lectures		-	-
CD7	Industrial visits/in-plant training		-	-
CD8	Self- learning such as use of NPTEL materials and internets		CO3, CO5	CD8

COURSE INFORMATION SHEET

Course code: ME 497(Open Elective-IV)
Course title: Industrial Robotics and Automation
Pre-requisite(s): NIL
Co- requisite(s): NIL
Credits: 3 L:3, T:0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: SEVENTH
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

1	To present a comprehensive and rigorous treatment of different robot types and its kinematic analysis.
2	To lay the mathematical background which is required to understand the mechanical design of different industrial robots used in modern industry.
3	To develop an intuitive understanding on various control techniques andspace trajectories of robotics.
4	To present real world engineering examples to demonstrate how a robot system is applied in engineering practice and various industry.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Outline various types of industrial robotic systems and build up forward and inverse kinematics analysis of the serial robot.
CO2	Outline of various equipment and power drive systems, which are associated to operate the robotic and acquire knowledge on workspace of manipulator.
CO3	Analyse the velocity and acceleration analysis of serial chain robotic systemand introduce the Jacobian matrix. Also, develop schemes to implement various space trajectories.
CO4	Design various control techniques to control the robot manipulator motion.
CO5	Create or analyse standard industrial robot design and understand various robot programming languages. Also, evaluate the performance of the Industrial robots.

Syllabus:

MODULE: I Industrial robot anatomy: Robot classification and its application in industry, Robot subsystems, Serial and Parallel robot, Links and Joints, Degrees of Freedom (DoF), Position and orientation of a rigid body, Co-ordinate transformation, Homogeneous transformation, Denavit and Hartenberg (DH) Parameters, Introduction to Forward and Inverse kinematics of serial robot.

(9 Lectures)

MODULE: II Actuators and Sensors: Joint actuating system, transmission, servomotors, power amplifiers, power supplies. Actuators, Electric and hydraulic drives, Sensors: Position, Velocity, Force, Range, and Vision sensors.
Robot Workspace: Workspace of manipulator, Type of workspaces, Workspace of a two link serial manipulator.

(8 Lectures)

MODULE: III Velocity analysis: The Jacobian matrix, Link velocities, Jacobian computation, Acceleration analysis, Role of Jacobian in statics, Singularities.
Trajectory planning: Cartesian and Joint space trajectories, Cubic, Quintic polynomial.

(8 Lectures)

MODULE: IV Controls Theory: Different control techniques, Transfer Function, State space representation, Proportional control, Integral control, Proportional plus Derivative control, PID control, Properties of dynamic model, effect of friction, actuator's rotor inertia, Joint controllers.

(8 Lectures)

MODULE: V Industrial automation applications, Robot cell design and control, Methods of programming: Robot languages, Lead-through programming, Point-to-point and motion interpolation. Performance analysis of Industrial robots, Economic, Social and Safety aspects in automated industrial environment.

(8 Lectures)

TEXT BOOKS:

1. S. K. Saha, Introduction To Robotics, Tata McGraw-Hill Education, 204.
2. M. P. Groover, M. Weiss, R. N. Nagel, N. G. Odery, A. Dutta, Industrial Robotics, McGraw Hill Education, 2015.
3. John J. Craig, Introduction to robotics mechanics and control, Pearson Education India, 2009.
4. S.B. Niku, Introduction to robotics: analysis, control, applications. John Wiley & Sons 2020.

REFERENCE BOOKS:

1. R. K. Mittal, I. J. Nagrath, Robotics and Control, McGraw Hill Education, 2016
2. M. W. Spong, M. Vidyasagar, Robot Dynamics and Control, Wiley Student Edition, 2013.

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Assignment	5
End Semester Examination	50

Indirect Assessment:

1. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	2	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO2	3	3	3	3	2								3	2	2
CO3	3	3	3	3	3								3	2	2
CO4	3	3	3	3	3								3	2	2
CO5	3	3	3	3	2								2	2	2

Correlation Levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between COs and Course Delivery (CD) methods			
CD	**Course Delivery methods**	**Course Outcome**	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors	CO 1 – 5	
CD2	Tutorials/Assignments	CO 1 – 5	
CD3	Seminars		
CD4	Mini projects/Projects		
CD5	Laboratory experiments/teaching aids		
CD6	Industrial/guest lectures		
CD7	Industrial visits/in-plant training		
CD8	Self- learning such as use of NPTEL materials and internets		

8th SEMESTER

ME400 -RESEARCH PROJECT/INDUSTRIAL INTERNSHIP

Total Credit-10

Course Outcomes

After the completion of this course, students will be

CO1	Able to formulate a practical problem in real life to explore for its possible solution after suitable review of literature.
CO2	Able to analysis the given problem and safest suitable solution on the bans of background engineering knowledge
CO3	Able to synthesize the outcome of the problem and validate findings on the basis of experimentation
CO4	Able to produce scientific content in the form of report writing as per the standard norms
CO5	Able to inculcate the learning from the curriculum to bring new ideas to solve various problems faced by common people.

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	1	1	1	1	1	1	1	1	3	2	-
CO2	3	3	3	3	1	1	1	1	1			1	3	2	-
CO3	3	3	3	3	1	1	1	1	1			1	3	2	-
CO4	3	3	3	3	1	1	1	1	1	1	1	1	3	2	-
CO5	3	3	3	3	1	1	1	1	1			1	2	2	-

Correlation Levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)