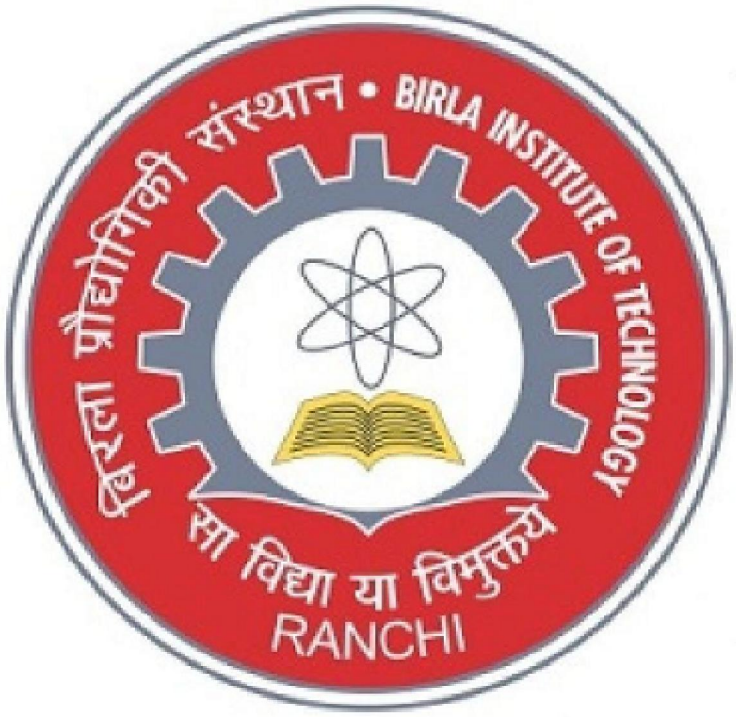
BIRLA INSTITUTE OF TECHNOLOGY



CHOICE BASED CREDIT SYSTEM(CBCS) CURRICULUM

(Effective from Academic Session: Monsoon 2018)

B. Tech.

DEPARTMENT OF MECHANICAL ENGINEERING

Institute Vision

To become a Globally Recognised 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

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

Department Vision:

To become an internationally recognized Centre of excellence in academics, research and technological services in the area of Mechanical Engineering and related inter-disciplinary fields.

Department Mission

- Imparting strong fundamental concepts to students and motivate them to find innovative solutions to engineering problems independently
- Developing engineers with managerial attributes capable of applying latest technology with responsibility
- Creation of congenial atmosphere and excellent research facilities for undertaking quality research by faculty and students
- To strive for more internationally recognized publication of research papers, books and to obtain patent and copyrights
- To provide excellent technological services to industry

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 Team Work**: 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 develop capability to understand the fundamentals of Science and Electrical & Electronics Engineering for analysing the engineering problems with futuristic approach.
2. To foster a confident and competent graduate capable to solve real life practical engineering problems
   fulfilling the obligation towards society.
3. To inculcate an attitude for identifying and undertaking developmental work both in industry as well as in academic environment with emphasis on continuous learning enabling to excel in competitive participations at global level.
4. To nurture and nourish effective communication and interpersonal skill to work in a team with a sense of ethics and moral responsibility for achieving goal.

(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 team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

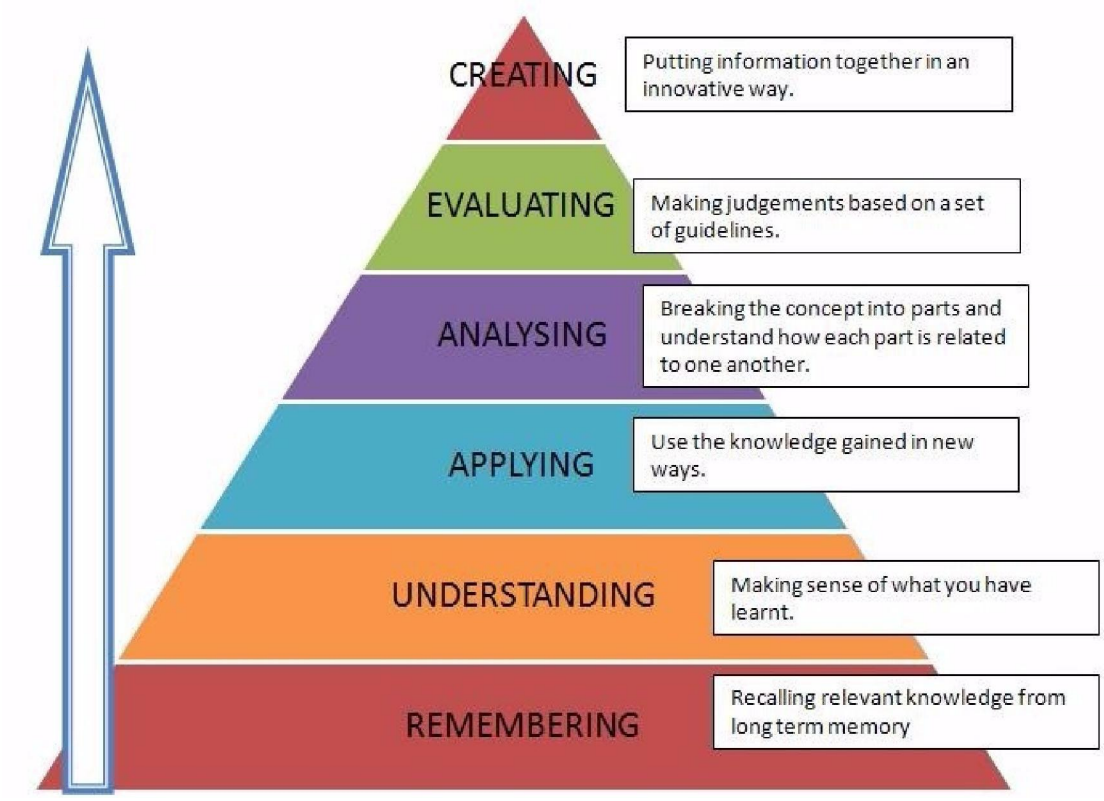
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

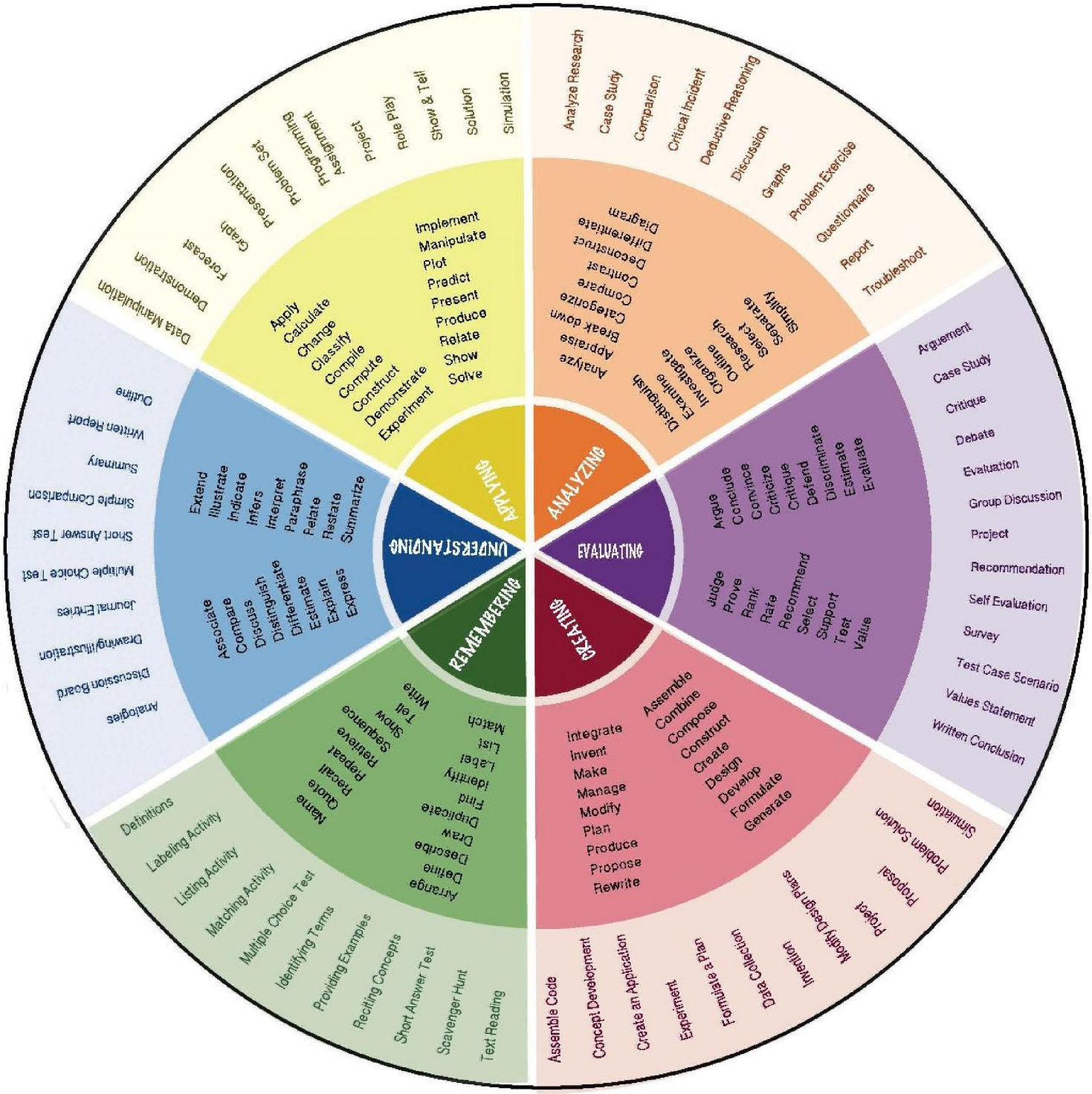
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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

B. Tech. MECHANICAL ENGINEERING COURSE

SYLLABUS(3rd SEMESTER)

DEPT OF MECHANICAL ENGINEERING

BIT MESRA, RANCHI

COURSE INFORMATION SHEET

Course code: MA 203
Course title: Numerical Methods
Pre-requisite(s): NIL
Co- requisite(s): –-NIL
Credits: L: 2 T: 0 P: 0 C: 2
Class schedule per week: 2 Lectures
Class: B Tech
Semester / Level: 2
Branch: ALL
Name of Teacher:
Course Objectives: This course enables the students to

1.	derive appropriate numerical methods to solve algebraic and transcendental equations
2.	derive appropriate numerical methods to solve linear system of equations
3.	approximate a function using various interpolation techniques
4.	to find the numerical solution of initial value problems and boundary value problems

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

CO 1	solve algebraic and transcendental equation using an appropriate numerical method arising in various engineering problems
CO 2	solve linear system of equations using an appropriate numerical method arising in computer programming, chemical engineering problems etc.
CO 3.	Approximate a function using an appropriate numerical method in various research problems
CO 4	evaluate derivative at a value using an appropriate numerical method in various research problems
CO 5	solve differential equation numerically

Syllabus

MA 203 **Numerical Methods** **2-0-0-2**

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. [05L]

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 eigenvalues. [05L]

Module III: Interpolation

Lagrange's interpolation, Newton's divided differences interpolation formulas, inverse interpolation, interpolating polynomial using finite differences. [05L]

Module IV: Differentiation and Integration

Differentiation using interpolation formulas, Integration using Newton-Cotes formulas: Trapezoidal rule, Simpson's rule [05L]

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. [05L]

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

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

COURSE INFORMATION SHEET

Course code: CE101
Course title: **Environmental Science**
Pre-requisite(s):
Co- requisite(s):
Credits: L: 2 T: 0 P: 0
Class schedule per week: 2
Class: B. Tech
Semester / Level: I
Branch: All

Course Objectives
This course enables the students:

1	To develop basic knowledge of ecological principles and their applications in environment.
2	To identify the structure and composition of the spheres of the earth, the only planet sustaining life.
3	To analyse, how the environment is getting contaminated and probable control mechanisms for them.
4	To generate awareness and become a sensitive citizen towards the changing environment.

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

1	Able to explain the structure and function of ecosystems and their importance in the holistic environment.
2	Able to identify the sources, causes, impacts and control of air pollution.
3	Able to distinguish the various types of water pollution happening in the environment and understand about their effects and potential control mechanisms.
4	Able to judge the importance of soil, causes of contamination and need of solid waste management.
5	Able to predict the sources of radiation hazards and pros and cons of noise pollution.

SYLLABUS

Module 1. Ecosystem and Environment

Concepts of Ecology and Environmental science, ecosystem: structure, function and services, Biogeochemical cycles, energy and nutrient flow, ecosystem management, fate of environmental pollutants, environmental status and reports on climate change.

(8L)

Module 2: Air Pollution

Structure and composition of unpolluted atmosphere, classification of air pollution sources, types of air pollutants, effects of air pollution, monitoring of air pollution, control methods and equipment for air pollution control, vehicular emissions and control, indoor air pollution, air pollution episodes and case studies.

(8L)

Module 3: Water Pollution

Water Resource; Water Pollution: types and Sources of Pollutants; effects of water pollution; Water quality monitoring, various water quality indices, water and waste water treatment: primary, secondary and tertiary treatment, advanced treatments (nitrate and phosphate removal); Sludge treatment and disposal.

(8L)

Module 4: Soil Pollution and Solid Waste Management

Lithosphere – composition, soil properties, soil pollution, ecological & health effects, Municipal solid waste management – classification of solid wastes, MSW characteristics, collection, storage, transport and disposal methods, sanitary landfills, technologies for processing of MSW: incineration, composing, pyrolysis.

(8L)

Module 5: Noise pollution & Radioactive pollution

Noise pollution: introduction, sources: Point, line and area sources; outdoor and indoor noise propagation, Effects of noise on health, criteria noise standards and limit values, Noise measurement techniques and analysis, prevention of noise pollution; Radioactive pollution: introduction, sources, classification, health and safety aspects, Hazards associated with nuclear reactors and disposal of spent fuel rods-safe guards from exposure to radiations, international regulation, Management of radioactive wastes.

(8L)

Text books:

1. A, K. De. (3rd Ed). 2008. Environmental Chemistry. New Age Publications India Ltd.
2. R. Rajagopalan.2016.Environmental Studies: From Crisis to Future by, 3rd edition, Oxford University Press.
3. Eugene P. Odum. 1971. Fundamentals of Ecology (3rd ed.) -. WB Sunders Company, Philadelphia.
4. C. N. Sawyer, P. L. McCarty and G. F. Parkin. 2002. Chemistry for Environmental Engineering and Science. John Henry Press.

5. S.C. Santra. 2011. Environmental Science. New Central Book Agency.

Reference books:

1. D.W.Conell. Basic Concepts of Environmental Chemistry, CRC Press.
2. Peavy, H.S, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw - Hill International
3. G.M. Masters& Wendell Ela. 1991. Introduction to Environmental Engineering and Science, PHI Publishers.

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
Quiz (s) (1 & 2)	10+10
Teacher's assessment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid sem exam	✔	✔	✔		
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 onto Graduate Attributes

Course Outcome #											
	a	b	c	d	e	f	g	h	i	j	k
1	2	2	2	2	L	3	3	2	2	2	1
2	2	3	2	3	2	3	3	2	2	2	1
3	2	3	2	3	2	3	3	2	2	2	1
4	2	3	2	3	2	3	3	2	2	2	1
5	2	3	3	3	2	3	3	2	2	2	1

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**
CD 1	Lecture by use of boards/LCD projectors/OHP projectors		CO1	CD1, CD2
CD 2	Tutorials/Assignments		CO2	CD1, CD2
CD 3	Seminars		CO3	CD1, CD2
CD 4	Mini projects/Projects		CO4	CD1, CD2

COURSE INFORMATION SHEET

Course code: ME 201
Course title: Thermodynamics
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s):
Credits: 3 L:3, T:0, P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level: 03
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

A.	To present a comprehensive and rigorous treatment of classical thermodynamics while retaining an engineering perspective.
B.	To lay the groundwork for subsequent studies in such fields as heat transfer and energy conversion systems and to prepare the students to effectively use thermodynamics in the practice of engineering.
C.	To develop an intuitive understanding of thermodynamics by emphasizing the engineering and engineering arguments.
D.	To present a wealth of real world engineering examples to give students a feel for how thermodynamics is applied in engineering practice.

Course Outcomes

After the completion of this course, students will be:

1.	Outline the basic concepts of thermodynamics.
2.	Apply the first law of thermodynamics to analyze non-flow and steady flow systems.
3.	Apply the second law of thermodynamics to evaluate the performance of cyclic devices.
4.	Evaluate the entropy, availability, exergy and irreversibility in various thermodynamic processes.
5.	Analyze air standard cycles

Syllabus

Module: 1

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.

[10]

Module: 2

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: 3

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: 4

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: 5

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 of Thermodynamics, John Wiley and Sons.

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes(PO)**												PSO	
	a	b	c	d	e	f	g	h	i	j	k	l	1	2
1	3	3	3	2	1	1	1	1	1	1	1	1	2	2
2	3	3	3	3	1	1	1	1	1			1	2	2
3	3	3	3	3	1	1	1	1	1			1	2	2
4	3	3	3	3	1	1	1	1	1	1	1	1	2	2
5	3	3	3	3	1	1	1	1	1			1	2	2

COURSE INFORMATION SHEET

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

Course Objectives

This course enables the students:

A.	To present a comprehensive and rigorous treatment of classical fluid mechanics while retaining an engineering perspective.
B.	To lay the groundwork for subsequent studies in such fields as analysis of various fluid flow devicesand energy conversion systems and to prepare the students to effectively use Fluid mechanics theory in the practice of engineering.
C.	To develop an intuitive understanding of Fluid mechanics by emphasizing the engineering and engineeringarguments.
D.	To present a wealth of real world engineering examples to give students a feel for how Fluid mechanics is applied in engineering practice.

Course Outcomes

After the completion of this course, students will be:

CO1.	Outline the concepts of continuum, system of control volume, fluid and flow properties.
CO2.	Apply the appropriate fundamental laws of fluid statics, dynamics to various fluid devices.
CO3.	Analyse various fluid static, dynamics problems.
CO4.	Evaluate the performanceof various fluid static, dynamic devices, hydraulic machines.
CO5.	Create optimum design of simple, complex fluid flow devices using conventional methods and modern tools.

ME 203 FLUID MECHANICS AND HYDRAULIC MACHINES

Module: 1 Fluid statics: Concept of continuum and physical properties of fluids, specific gravity, viscosity surface Tension, vapour pressure. Buoyancy force and Metacentric height. Measurement of pressure- Piezometer, U-tube and differential tube manometers, Bourdon pressure gauge, electronic pressure sensors and transducers.Numerical examples. (7 Lectures)

Module: 2 Fluid kinematics : Eulerian and Lagrangian description of fluid flow, stream function and velocity potential function. 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, Reynolds transport theorem, 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.Buckingham's pi theorem and Rayleigh's method. Numerical examples. (9 Lectures)

Module: 3 Closed conduit flow: Reynold's experiment- Darcy Weisbach equation, Minor 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, Flow nozzle, Turbine flow meter. Concept of Boundary layer, separation of boundary layer and its control.Concept of fluid flow simulations.Numerical examples. (8 Lectures)

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, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies , hydraulic design, draft tube theory and functions and efficiency. Performance of hydraulic turbines, geometric similarity, unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. Hydraulic Turbine test standards.Numerical examples. (10 Lectures)

Module: V Hydraulic pumps : Classification, working, work done, manomertic head, losses and efficiencies, specific speed, pumps in series and parallel, performance characteristic curves, NPSH, Model studies, Reciprocating pumps, working, discharge, slip, indicator diagrams. Hydraulic Pump test standards.Numerical examples. (8 Lectures)

TEXT BOOKS :

T1. Hydraulics, fluid mechanics and Hydraulic machinery MODI and SETH.
T2. Hydraulic Machines by Jagdishlal
T3.Fluid Mechanics, Fundamentals and Applications (in SI Unit) by Yunus A. Cangel and John M. Cimbala, McGraw Hill.

REFERENCE BOOKS :

R1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, Kotaria& Sons.
R2. Fluid Mechanics with Engineering Application by J.B. Franzini and Finnemore, McGraw Hill.
R3. 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

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes(PO)**												PSO	
	a	b	c	d	e	f	g	h	i	j	k	l	1	2
1	3	3	3	3	1							2	2	2
2	3	3	3	2	2							2	2	2
3	3	3	3	2	2							2	2	2
4	3	3	3	2	2				2	1	1	2	2	2
5	3	2	2	2	2				2	1	1	2	2	2

COURSE INFORMATION SHEET

Course code: PE 213
Course title: MANUFACTURING PROCESSES
Pre-requisite(s): NIL
Co- requisite(s):
Credits: 03 L:3 T:0 P:0
Class schedule per week: 03
Class: B. Tech
Semester / Level:III/2
Branch: Mechanical Engineering
Name of Teacher:

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 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 1: Casting **[08]**

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,

Module 2: Theory of Metal Cutting **[08]**

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.

Module 3: Machine Tools **[08]**

Construction, operations and specifications of lathe and shaper. Construction, operations and specifications of milling & drilling machine. Introduction to grinding and types of grinding processes.

Module 4: Metal Deformation Processes [08]

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.

Module 5: Welding [08]

Principle, working and application of oxy- acetylene gas welding. Electric arc welding: MMAW/SMAW, SAW, GTAW and GMAW, Resistance welding. Soldering and Brazing

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

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
CO1	3	3	2	2	3		1			1		1		3
CO2	3	3	3	2	3		1			1		1		3
CO3	3	3	2	2	3		1			1		1		3
CO4	3	3	3	2	3		1			1		1	3	3
CO5	3	3	3	2	3		1			1		1		3

COURSE INFORMATION SHEET

Course code: ME 205
Course title: Strength of Materials
Pre-requisite(s): Basics Mechanical Engineering, Mathematics course with ordinary deferential equations
Co- requisite(s): NIL
Credits: 3 L: 3, T: 1, P:0
Class schedule per week: 04
Class: B. Tech
Semester / Level:03
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

A.	To understand the nature of stresses developed in structural members such as beams, shafts, curved bars, cylinders and spheres for various types of simple loads.
B.	To calculate the elastic deformation and deflection occurring in various simple geometries for different types of loading.

Course Outcomes

After the completion of this course, students will be:

1.	Understand the basic Strength of Materials theorems and to apply the concept in structural problems.
2.	Analyze different structural bodiesviz.beam, column, circular ring, cylinder and rotating disc.
3.	Evaluate the influence of various geometric and loading parameters of structural bodies.
4.	Compare the results obtained from bending theory of beam and strain energy method of structural problems.
5.	Create new ideas in the field of Solid Mechanics and Design.

Syllabus

Module: 1

Stress at a point on a plane, Stress transformation equation, Principal stresses, Mohr's circle of stresses, Strain transformation equation, principal strain, strain rosette. (10 Lectures)

Module: 2

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. (10 Lectures)

Module: 3

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 beamand thin circular ring. (10 Lectures)

Module: 4

Shear Centre: Theory of shear flow, shear flow diagrams and shear center for thinwalledsymmetrical sections.
Bending of curved beams: Beams of small and large initial curvature, evaluation ofcircumferential stresses. (10 Lectures)

Module: 5

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. (10 Lectures)

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

Gaps in the syllabus (to meet Industry/Profession requirements)
Analysis of torsion and combined stresses

POs met through Gaps in the Syllabus
PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design
Stress-strain behaviour of materials using tensorial approach

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

Mapping of Course Outcomes onto Program Outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO 2**
CO 1	3	2	1	1		1	1		1			2	2	2
CO 2	3	3	2	2		1	1		2			2	2	2
CO 3	3	3	2	3		1	1		2			2	2	2
CO 4	3	3	3	3		1	1		2	1		2	2	2
CO 5	3	2	3	3	2	1	1	1	2		1	2	2	2

COURSE INFORMATION SHEET

Course code: IT202
Course title: **Basic IT Workshop**
Pre-requisite(s):
Co- requisite(s):
Credits: L: 0 T: 0 P: 2
Class schedule per week: 2
Class: B. Tech
Semester / Level: IV/II
Branch: All

Course Objectives

This course enables the students:

1.	Understand and use the basic Matlab functions and understand its environment and variables
2.	Know about handling operations and advanced features like menus and toolbars
3.	Implement programs with the use of arrays, strings and graphical data representations
4.	Understand Python, Data Types, Operators, Arrays
5.	Implement Functions and loops, object oriented programming using Python

Course Outcomes

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

1.	Apply features of Matlab and algorithms to solve problems
2.	Develop application programs with the help of various tool boxes available in Matlab.
3.	Apply data analysis through graphical data representations
4.	Implement programs with the use of arrays, strings in Matlab
5.	Implement Functions and loops, using Python

Syllabus

Module I

Introduction to MATLAB and Basics Part I:

Introduction, Advantage, Disadvantage of MATLAB, MATLAB Environment, Variables and Array, Built-in Functions of MATLAB, Subarrays, Multidimensional Arrays, Data Files.

Module II

MATLAB Basic Part II:

Scalar and Array Operations, Hierarchy of Operations, Introduction to Plotting, Polar Plots, Subplots, MATLAB profiler. String Functions, Complex Data, Three-Dimensional Plot

Module III

MATLAB Advanced Features:

Sparse Arrays, Cell Arrays,Structure Arrays, I/O Functions, Object Handles, Position and Units, Graphical User Interface: Dialog Boxes, Menus, Toolbars.

Module IV

Introduction to Python Basics

Basics, I Python, Data Types, Operators, Arrays, Plotting

Module V

Python Programming Part 2:

Functions and loops, object oriented programming, Numerical Formalism

Sample list of Assignments:

Sample Assignments on Python

Data Types, Input- Outputs, Variables

1. Write a program in Python to swap two variables.

2. Write a program in Python to check the input character is an alphabet or not.

Loop

3. Write a program in python to shuffle a deck of card using the module random and draw 5 cards.

4. Write a program in python to find the factors of a number.

Array and Lists

5. Write a program in python to transpose a given matrix M = [[1, 2], [4, 5], [3, 6]].

6. Write a program in python to print the median of a set of numbers in a file.

Function

6. Write a function in Python to find the resolution of a JPEG image.

7. Write a program in python and use in-built functions to convert a decimal number to binary, octal and hexadecimal number.

8. Write a program in python to sort words in alphabetical order.

Plot

9. Use Matplotlib to draw histogram to represent average age of population given as Age [21, 54, 66, 44, 32,42, 54, 62, 93, 45, 32, 70]

10. Create a 3-D plot in Python for the function $\sqrt{y^2 - x^2}$ over the interval $-3 \leq x \leq 3$ and $-3 \leq x \leq 3$.

Sample Assignments on MATLAB

Assignment Statements:

1. Given two sides a= 3.2 and b=4.6 of a triangle and angle theta= 60^0 between these two sides. Find the length of the third side and the area of the triangle.

2. Write a MATLAB statement to calculate the sum of the series:

$$S= 1- x^2/2! + x^4/4! - x^6/6! + x^8/8! \quad \text{for } x= 1.5$$

Arrays

3. The array A is given below. Extend the 2-D array to 3-D array by including another 2-D array as second element in the third dimension.

$$A = 123; 543; 136;$$

4. Let a matrix A of size (3x4) is defined as, $= \ 12356791011 \quad 4812$. Reshape the matrix A into matrix B of the size (6x2).

5. Let a column vector z be given as z = [2; 3; 4; 5].

(i) Form a diagonal matrix A, using the elements of z as he main diagonal elements of A.

(ii) Form the matrix B, using the elements of vector z as elements of upper diagonal of B.

(iii) Form the matrix C, using the elements of vector z as elements of first lower diagonal of C.

Polynomials

6. Integrate the polynomial $y = 4x^3 + 12x^2 + 16x + 1$. Take the constant of integration as 3.

7. Find the polynomial of degree 2 to fit the following data:

x	0	1	2	4
y	1	6	20	100

Input-Output statement and files

8. Write a program in MATLAB to illustrate the use of 'pause' command.

9. Write a program in MATLAB to illustrate the use of fwrite function for writing binary data of different formats to a file named 'check.txt'.

Plots

10. Plot the curve given by the equation y = sin(x) where x varies from 0 to 2π. Also label the x-axis and y-axis and provide a suitable title for the plot

11. Plot a bar graph for the data given as x = [1 2 3 4 5 6] and y = [10 15 25 30 27 19]

12. Given $x = t^2$ and $y = 4t$ for $-4 < t < 4$. Using MATLAB obtain a 3-D plot showing the matrix in (x, y) space as a factors of time.

Control structures

13. Write a program in MATLAB to find the count of even values in the given n numbers.

Functions

14. Write a function in MATLAB to calculate the roots of the quadratic equation $ax^2 + bx + c = 0$, where a, b, c are constants.

Text Books:

1. MATLAB® Programming for Engineers:Stephen J. Chapman, Thomson Corporation, 4th Edition

2. Introduction to Python for Engineers and Scientists, Sandeep Nagar, Apress, 2018

Reference Books

1. Learn Python The Hard Way, Zed A. Shaw, Addison-Wesley, Third Edition

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

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design: through experiments involving design/modelling of device/circuits on advanced topics

POs met through Topics beyond syllabus/Advanced topics/Design: through experiments involving design/modelling of device/circuits on advanced topics

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 file Marks	12
Viva Marks	24
Day-to-day performance Marks	12
End SEM Evaluation	(40)
Lab quiz Marks	20
Lab performance Marks	20

Assessment Components	CO1	CO2	CO3	CO4
Progressive Evaluation	3	3	3	3
End SEM Evaluation	3	3	3	3

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

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD7

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

COURSE INFORMATION SHEET

Course code: MA 204
Course title: Numerical Methods Lab
Pre-requisite(s): NIL
Co- requisite(s): –-NIL
Credits: L: 0 T: 0 P: 2 C:1
Class schedule per week: 2 Sessionals
Class: BE
Semester / Level: III / UG
Branch: ALL
Name of Teacher:

Course Objectives

This course enables the students to understand

1.	derive appropriate numerical methods to solve algebraic, transcendental equations and linear system of equations
2.	approximate a function using various interpolation techniques, to find the numerical solution of initial value problems
3.	ncepts in probability theory, the properties of probability distributions
4.	estimation of mean, variance and proportion, the concepts of statistical hypothesis

Course Outcomes

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

1.	solve algebraic, transcendental equation and linear system of equations using an appropriate numerical method arising in various engineering problems
2.	evaluate derivative at a value using an appropriate numerical method in various research problems, solve differential equation numerically
3.	learn basic probability axioms, rules and the moments of discrete and continuous random variables as well as be familiar with common named discrete and continuous random variables.
4.	find the point and interval estimates, analyse data statistically and interpretation of the results

SYLLABUS

List of Assignments

1. 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. 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. Find a simple root of $f(x)=0$ using Newton Raphson method. Read any initial approximation x_0, maximum number of iterations n and error tolerance eps.
4. Solution of a system of $n\times n$ linear equations using Gauss elimination method with partial pivoting. The program is for 10×10 system or higher order system.
5. Matrix inversion and solution of $n\times n$ system of equations using Gauss-Jordan method. If the system of equations is larger than 15×15 change the dimensions of the float statement.
6. 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 x_0. If the system of equations is larger than 10×10 change the dimension in float.
7. 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. Program for Lagrange interpolation.
9. Program for Newton divided difference interpolation.
10. Program for Newton's forward and backward interpolation.
11. Program for Gauss's central difference interpolation (both backward and forward).
12. Program to evaluate the integral of $f(x)$ between the limits a to b 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. Program to evaluate the integral of $f(x)$ between the limits a to b using Simpson's rule of integration based on $2n$ subintervals or $2n+1$ nodal points. The values of a,b and n are to be read and the integrand is written as a function subprogram. The program is tested for $f(x)=1/(1+x)$.
14. Program to solve an IVP, $dy/dx=f(x),y(x_0)=y_0$ using Euler method. The initial value x_0,y_0 the final value x_f and the step size h are to be read. The program is tested for $f(x,y)=-2xy^2$.
15. Program to solve an IVP, $dy/dx=f(x),y(x_0)=y_0$ using the classical Runge-Kutta fourth order method with step size h, $h/2$ and also 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. S.S.Sastry-Introductory Methods of Numerical Analysis-PHI, Private Ltd., New Delhi.
2. N.Pal& S. Sarkar- Statistics: Concepts and Applications, PHI, New Delhi-2005.

Reference Books:

1 R.V.Hogg et.al- Probability and Statistical Inpane, 7th Edn, Pearson Education, New Delhi-2006.

2. R.L.Burden&J.D.Faires- Numerical Analysis, Thomson Learning-Brooks/Cole, Indian Reprint, 2005.

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

POs met through Gaps in the Syllabus: N/A

Topics beyond syllabus/Advanced topics/Design: through experiments involving design/modelling of device/circuits on advanced topics

POs met through Topics beyond syllabus/Advanced topics/Design: through experiments involving design/modelling of device/circuits on advanced topics

CD #	Course Delivery methods
CD1	Lecture by use of boards/LCD projectors/OHP projectors
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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 file Marks	12
Viva Marks	24
Day-to-day performance Marks	12
End SEM Evaluation	(40)
Lab quiz Marks	20
Lab performance Marks	20

Assessment Components	CO1	CO2	CO3	CO4
Progressive Evaluation	3	3	3	3
End SEM Evaluation	3	3	3	3

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	PO 2	PO3	PO4	PO 5	PO6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	2	2	1	1	3						1	
CO2	2	1	1	1	3			3			1	
CO3	1	2	3	3	3						1	1
CO4		1	1	3	2					1		
CO5	1	1	2	2				2		3	1	1

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

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD7

COURSE INFORMATION SHEET

Course code: ME 202
Course title: Fluid Mechanics and Hydraulic Machines lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5L:0, T:0, P:3
Class schedule per week: 03
Class: B. Tech
Semester / Level: Third
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

A.	To make student familiar with various fluid mechanics systems and machines
B	To make the student confident how to perform experiments related to fluid mechanics systems and machines
B.	To study performance of various fluid mechanics systems and machines

Course Outcomes

After the completion of this course, students will be:

1.	Able to apply the knowledge to perform the experiments on free surface flow
2.	Able to calibrate various flow measuring devices
3.	Able to experimentally find out forces experienced by various vane shapes Due to liquid jet impact on them
4.	Able to draw the characteristic curves of various hydro turbines
5.	Able to draw the characteristic curves of various pumps

List of experiments:

1. To verify Bernoullis equation experimentally and to plot the total energy line vs distance.
2. To determine the centre of pressure of a plane surface under partial and submerged conditions.
3. To determine the surface profile of liquid under free and forced vortex conditions.
4. To determine the friction factor f for the turbulent flow through the commercial pipes of various sizes.
5. To determine the coefficient of discharge and velocity of flow through an orifice.
6. To calibrate a Triangular notch.
7. To determine the coefficient of discharge through mouth pieces (convergent and divergent).
8. To determine the coefficient of discharge through venturimeter and orifice meter, and to calibrate rota meter.
9. To visualize the phenomena of cavitation in the flow and to find out cavitation number and critical cavitation number of the pump.
10. To study the effectof liquid jet impact on hemispherical and flat plate vanes.
11. To draw the characteristic curves of a Francis turbine.

12. To draw the characteristic curves of a Pelton turbine.
13. To draw the characteristic curves of a Modern Francis turbine (Mixed flow type).
14. To draw the characteristic curves of a multistage centrifugal pump.
15. To draw the characteristic curves of a reciprocating pump.
16. To draw the characteristic curves of a jet pump.

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes(PO)**												PSO	
	a	b	c	d	e	f	g	h	i	j	k	l	1	2
1	1	2		2	3				3	2	1	2	1	2
2	3	3	3	2	3				3	2	1	2	3	3
3	3	3	3	2	3				3	2	1	2	3	3
4	3	3	3	3	3				3	2	1	2	3	3
5	3	3	3	3	3				3	2	1	2	3	3

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: 03
Class: B. Tech
Semester / Level: 03
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students:

A.	To make student familiar with modern and conventional tools for material testing.
B.	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

Mapping of Course Outcomes onto Program Outcomes

Course Outcome #	**Program Outcomes(PO)**												PSO	
	a	b	c	d	e	f	g	h	i	j	k	l	1	2
1	1	1	1	3	3			3	3	3			2	2
2	1	3	2	3	3			3	3	3			2	2
3	3	3	3	3	3			3	3	3			2	2
4	3	3	3	3	3			3	3	3			2	2
5	3	3	3	3	1			3	3	3			2	2

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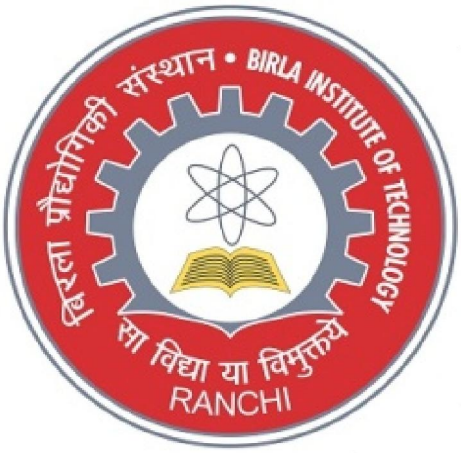


CHOICE BASED CREDIT SYSTEM (CBCS) CURRICULUM

(Effective from Academic Session: Monsoon 2018)

B. Tech.(4th Semester)

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE INFORMATION SHEET

Course code: IT201
Course title: **Basics of Intelligent Computing**
Pre-requisite(s):
Co- requisite(s):
Credits: L:3 T:0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: II/2
Branch: All

Course Objectives
This course enables the students:

A.	To know the basic functions of different AI branches.
B.	To understand the functionalities of IoT .
C.	To know the application of fuzzy logic.
D.	To understand the basic functionalities of a cloud based system.
E.	To find the basic functions of soft computing.

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

1.	Identify the difference between different branches of AI.
2.	Analyze a fuzzy based system.
3.	Design Neural Networks to solve problems.
4.	Analyze a problem in terms of ANN point of view.
5.	Identify the components of a cloud-based system.

SYLLABUS

Module I

Introduction

Definition of Computing, Conventional Computing vs. Intelligent Computing, Necessity of Intelligent Computing, Current trends in Intelligent Computing

AI Concepts

Introduction to AI, AI problems and Solution approaches, Fundamentals of problem solving using Search and Heuristics, Overview of Knowledge-base creation, and Intelligent Agents, Classification of AI.

(8 L)

Module II

Introduction to Soft Computing

Hard Computing vs. Soft Computing, Paradigms of Soft Computing, Real Life applications of Soft Computing

Fuzzy Logic

Classical Sets Vs Fuzzy Sets, Membership Functions, Fuzzy operations, Fuzzy Relations, Fuzzy Composition (Max-Min, Max-Product), Defuzzification, Fuzzy Inference System

Genetic Algorithm

Principle of Optimization, Traditional vs Evolutionary optimization, Genetic Algorithm: Working Cycle of GA, Encoding, Crossover, Mutation.(8 L)

Module III

Introduction to Artificial Neural Networks:

Biological Neuron to Artificial Neuron, Mc-Culloh Pitts Perceptron Model, Layer of Neurons, Activation Function, Artificial Learning, Types of Learning, Introduction to Back Propagation Networks, Applications of Neural Network. (8L)

Module IV

Introduction to Cloud computing

Conventional Computing, Historical developments, Defining a Cloud, Cloud Computing reference model, Overview of Virtualization: Introduction, Types of cloud, Cloud Platforms: Amazon Web Services, Microsoft Azure, Cloud Applications (8L)

ModuleV

Introduction to IOT

The IoT Paradigm, Concept of Things, IoT Hardware, IoT Protocols, IoT Architecture, enabling technologies of IoT, IoT Designing and its levels. (8L)

Text books:

1. Rich Elaine, Knight Kevin, Nair S. B. Artificial Intelligence, 3rd Edition, Tata Mc. Graw Hill.
2. Padhy N. P., Simon S. P. Soft Computing: With MATLAB Programming, Oxford University Press, 2015.
3. Buyya Raj Kumar, Vecchiola Christian &Selvi S.Thamarai , Mastering Cloud Computing, McGraw Hill Publication, New Delhi, 2013.
4. Madisetti Vijay and BahgaArshdeep, Internet of Things (A Hands-on-Approach), 1st Edition, VPT, 2014.

Reference Books:

Raj Pethuru and Raman AnupamaC.,The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press.
Konar Amit, Computational Intelligence: Principles, Techniques and Applications, Springer.
Shivanandam and Deepa, Principles of Soft Computing, 2nd Edition, John Wiley and Sons, 2011.

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

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	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**
Mid semester examination	25
End semester examination	50
Quiz (s)	10+10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4
Mid SEM Examination Marks	3	3	2	
End SEM Examination Marks	3	3	3	3
Assignment / Quiz (s)	3	3	3	2

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

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

MAPPING BETWEEN COURSE OUTCOMES AND COURSE DELIVERY METHOD

Course Outcomes	Course Delivery Method
CO1	CD1,CD6
CO2	CD1, CD6,CD7
CO3	CD1, CD2, CD3,CD6,CD7
CO4	CD1, CD3,CD6,CD7
CO5	CD1,CD2,CD3,CD4,CD5,CD7

COURSE INFORMATION SHEET

Course code: BE101
Course title: Biology 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: III-IV /First
Branch: All
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	Demonstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules involved in living system.
CO2	Interpret 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.

BE101 Biological Science for Engineers

Credit:2

Module-1:
Basic Cell Biology: Origin of life, Cell theory, Cell Structure and function, Biomolecules, Cell cycle and cell division, Biological Organization. **[5L]**

Module-2:
Bioenergetics and Metabolism:Gibbs free energy and thermodynamics, aerobic and anaerobic respiration, Glycolysis, Krebs cycle and electron transport chain, Beta oxidation, Photosynthesis. **[6L]**

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.
[5L]

Module-4:
Biological Signal Generation and Propagation: Nerve cell structure and signal propagation.Mechanism of vision and hearing, cell signaling, Circadian rhythm.
[6L]

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. **[6L]**

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
Teacher's Assesment	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: ME 207
Course Title: Kinematics and Dynamics of Machines
Pre-requisite(s): ME101 Basics of Mechanical Engineering
Co- requisite(s):
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 04/02
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1.	To understand basic principles of kinematic chains, Degree of freedom.
2.	To analyse 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

MODULE	(NO. OF LECTURE HOURS)
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 centre of zero velocity, Aronhold-Kennedy theorem of three centres.	**08**
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 diagram, fluctuation of energy and speed, flywheel, Principles of centrifugal governors: Porter, Proell and Hartnell governor.	**10**
Module – III Balancing: Balancing of rotating masses, Two plane balancing, Balancing of inline, V, twin, and radial engines, principles of balancing machines.	**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 cam, Displacement diagram, Velocity and acceleration of follower, Graphical determination of cam profiles.	**8**
Module – V Gyroscope and Vibrations: Euler's equation of motion, Euler's modified equation of motion, Steady state, Stability of spinning top, ship, two wheeled and four wheeled vehicle.	**8**

Text Books:

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. ShigleyTheory 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)
Detailed force analysis of gear and cam.

POs met through Gaps in the Syllabus
PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design
Balancing of locomotives

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

CDCode	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 209
Course Title: Energy Conversion Systems
Pre-requisite(s): ME 201 Thermodynamics
Co- requisite(s):
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 04/02
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1.	To provide basic knowledge of steam power cycle and different methods to improve the efficiency of the plant.
2.	To 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.	To develop an intuitive understanding of energy conversion devices by emphasizing the scientific and engineering arguments.
4.	To present a wealth of real world engineering examples to give students a feel for how energy conversion principle is applied in engineering practice.

Course Outcomes

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

CO1	Understand the basic working principle of vapour 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	(NO. OF LECTURE HOURS)
Module – I *Vapour Power Cycle:* Components of steam power system; Carnot vapour cycle and Rankine cycle; their comparison; 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.	**10**
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; its classification; Chimney height, maximum discharge and efficiency.	**10**
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.	**7**
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.	**10**
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.	**5**

Text Books:

1. Power Plant Engineering – P.K. Nag; Tata McGraw-Hill publication.
2. Elements of Heat Engine – Pandey&Saha
3. Steam and Gas Turbine and Power Plant Engineering – R. Yadav, Central Publishing House
4. Thermal Engineering – R. K. Rajput

Reference Books:

5. Power Plant Technology- M.M.Ei.-Wakil. McGraw Hill
6. Theory and Practice of Heat Engine – D. A. Rangham; Camb. Univ. Press.

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

Detailed analysis of combined power cycle, renewable energy conversion principles, major emissions and control, economics of energy conversion system.

POs met through Gaps in the Syllabus

PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design

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

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 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)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	2	2	3	2	1	2	1		1			2
CO2	3	2	3	3	2	3	2	2	1			3
CO3	2	2	3	2	2				2			2
CO4	3	3	2	3	2				1			2
CO5	3	2	3	3	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

CDCode	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): ME 201 Thermodynamics, ME 205 Strength of materials
Co- requisite(s):
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 04/02
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to 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.

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	Design various types of mechanical joints, power drives, bearings, and springs.
CO3	Evaluate stresses acting in various mechanical components.
CO4	Select appropriate types of power drives for designing mechanical systems.
CO5	Analyse the Design various types of mechanical systems.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I **Failure of materials:** Principles of Machine Design, standardization,Preferred numbers, 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.	**10**
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, Bolts for cylinder cover, Eccentrically loaded bolted joints in shear. Welded joints: Butt joints, Fillet joints, Strength of butt and fillet welds, Welded joints subjected to bending and torsion. Riveted joints: Types of rivet heads, types of rivet joints, rivet materials, Strength equations, Efficiency of joint, Caulking and fullering.	**9**
Module – III **Design of friction drives:**Design of belt, rope, and chain drives: Types of belts, Flat- and Round-Belt Drives, V-belts, Wire Rope, Chains, Brakes and clutches: Types of Brakes and Clutches, Clutch/Brake selection and specification, Clutch and Brake materials, Disc Clutches, Disk Brakes, Drum Brakes.	**9**
Module – IV **Design of bearing and springs:** Bearings, Comparison of Sliding and Rolling contact bearings, Types of sliding contact bearings, Bearing materials, Lubricating oils, Types of rolling contact bearings, Load carrying capacity, Equivalent bearing load, Load-life relationship, Selection of bearing life, Design of helical and leaf springs: Spring rate, Spring configuration, Spring materials, Design of helical compression springs, helical extension springs, helical torsion springs, and Belleville springs, Stresses in leaf springs, Nipping, Equalized stresses.	**9**
Module – V **Design of Gears:** Gear drives, 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 spur, helical, bevel, and worm gears, Lewis and Buckingham's equation, Effective load on spur gear tooth, Virtual number of teeth of helical and bevel gears, Effective load on gear teeth, Selection of materials.	**9**

Text Books:

1. Machine Design, An Integrated Approach,by, Robert L. Norton, Second Edition
2. Shigley's Mechanical Engineering Design, by Richard Budynas (Author), Keith Nisbett (Author)
3. Introduction to Machine Design by V. B. Bhandari

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

POs met through Gaps in the Syllabus
PO1 TO PO5

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

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

CDCode	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 251(**PROG ELECTIVE-1)**
Course Title: Thermo-Fluid Engineering
Pre-requisite(s): Engineering Mathematics, Fluid Mechanics, Engineering Thermodynamics
Co- requisite(s):
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 04/02
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.	Analyse the thermo-fluid aspects including the exergy of a system
3.	Evaluate and understand the rotational and irrotational flows
4.	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	Analyse both closed and open systems and be able to independently use the Reynolds transport theorem.
CO4	Analyse the exergy of both the open and closed systems
CO5	Applythe 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.	**9**
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.	**9**
Module – III Navier-Stokes equation and its applications; energy equation and its applications to various problems.	**9**
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.	**9**
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.	**9**

Text Books:

1. D.F. Young, B.R. Munsonand T.H. Okiishi, *A Brief Introduction to Fluid Mechanics*, 3rdEd., 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*, 4thEd., McGraw Hill, 2001.

Reference Books:
1. M.C. Potter and D.C. Wiggert, *Mechanics ofFluids*, 2ndEd., 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/

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

CDCode	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	CO1-5	CD8
CD9	Simulation		-

COURSE INFORMATION SHEET

Course Code: ME 253(**PROG ELECTIVE-1)**
Course Title: Composite Materials
Pre-requisite(s): Engineering Mathematics, Fluid Mechanics, Engineering Thermodynamics
Co- requisite(s): None
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 04/02
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to 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 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	(NO. OF LECTURE HOURS)
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.	**5**
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, 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 FiberPolymeric 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	**10**
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 **Nanocomposites:** Nano particle dispersion in polymer matrix, Polymer- nanoclay composites and polymer-carbon nanotubes composites; **Functionally graded and Hierarchical Composites**; Classification i.e. Natural and Man-made, Uniaxial and bi-axial property gradient, Application in various industrial sectors.	**7**
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	**10**

Text 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. K.K. Chawla, Ceramic Matrix Composites, Kluwer Academic Publishers, 2003.
4. N. Chawla, K.K. Chawla, Metal Matrix Composites, Springer-Verlag, 2006.
5. 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

Reference Books:

1. P.M. Ajayan, L. Schadler, P.V. Braun Nano Composite Science and Technology, Wiley VCH, 2003.
2. E. Fitzer, L.M. Manocha, Carbon Reinforcement and Carbon/Carbon Composites, SpringerVerlag, Heidelberg, New York, 1998.

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

Characterisation 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)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2	1									1
CO2	3	2	1			1	2					1
CO3	3	2	2			1		2	1	1		1
CO4	3	2	2			1		2	1	1		1
CO5	3	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

CDCode	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 255(**PROG ELECTIVE-1)**
Course Title: Renewable energy sources
Pre-requisite(s): Basic of Physics, Chemistry and Mathematics
Co- requisite(s):
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 04/02
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to 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

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	(NO. OF LECTURE HOURS)
Module – I ENERGY SOURCES: 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 SOLAR ENERGY : 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.	**9**
Module – III WIND ENERGY: 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	**9**
Module – IV BIOMASS ENERGY: 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.	**9**
Module – V **OTHER RENEWABLE ENERGY SOURCES** 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.	**10**

Text Books:

1. Rai. G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.
2. 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. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 1996.
3. Tiwari. G.N., Solar Energy – "Fundamentals Design, Modelling & Applications", Narosa Publishing House, New Delhi, 2002.
4. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
5. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 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
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)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	2	1	1	1	1	1	2	1			1
CO2	3	2	2	2	1	1	2	2	2	1		1
CO3	3	2	2	2	1	1	2	2	1	1		1
CO4	3	2	2	2	1	1	2	2	1	1		1
CO5	3	2	2	2	1	1	2	2	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

CDCode	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 257(**PROG ELECTIVE-1)**
Course Title: Non-Destructive Testing
Pre-requisite(s): NIL
Co- requisite(s): None
Credits: L: 3 T: 0 P: 0
Class schedule per week: 03
Class: B. Tech.
Semester / Level: 04/02
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course envisions to impart to students to:

1.	Understand various Non Destructive Evaluation and Testing methods, theory and their industrial applications.
2.	To develop comprehensive knowledge on various NDT techniques
3.	Analyse various NDT techniques and their employability for different materials
4.	Apply new inspection techniques for new materials

Course Outcomes

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

CO1	Comprehension:-Able to list & classify major Non-Destructive Testing methods available.
CO2	Analysis:-Able to find the defects in a given component/material without damaging it.
CO3	Analysis:-In a position to distinguish among various NDT techniques and their employability for different specimen under testing.
CO4	Analysis:-Having the knowledge and essential skills to specify strengths and weaknesses of materials used in fabrication.
CO5	Application:-To discover new inspection techniques for new materials.

SYLLABUS

MODULE	(NO. OF LECTURE HOURS)
Module – I Introduction and Classification of NDT, Visual Inspection Methods, Dye Penetrant Testing(DPT)- Basic Principle, Types of dye and method of application, DPT-Developer application and Inspection.	**9**
Module – II Thermography- Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications. Principle & Instrumentation for ECT, Techniques used in ECT, Advanced ECT methods, Applications & limitations of ECT.	**9**
Module – III Magnetic Particle Testing :Basic definition of Magnetism & Principle of MPT, Magnetizing Techniques, Procedure & Equipment used for MPT, Applications & limitations of MPT.	**9**
Module – IV 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.	**9**
Module – V Ultrasonic Testing:Basic Properties of Sound Beam, Ultrasonic Transducers, Inspection techniques, Flaw Characterisation Techniques and Detection Equipment, Applications, Advantages & Limitations of Ultrasonic Testing.	**9**

Text Books:

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

Topics beyond syllabus/Advanced topics/Design

Acoustic emission testing & advanced Ultrasonic testing

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)											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	2	1	1	1	1	3	3	2				
CO2	3	3	3	2	3	2					1	1

CO3	3	2	1	2	3	2	2	1		1	1	-
CO4	2	3	3	2	3	2	2	1		1	-	-
CO5	3	2	1	3	3	2	2	1		-	1	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

CDCode	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		-

Department of Electrical and Electronics Engineering
Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

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

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

Department Vision

To become an internationally recognized centre of excellence in academics, research and technological services in the area of Electrical and Electronics Engineering and related inter-disciplinary fields.

Department Mission

- Imparting strong fundamental concepts to students and motivate them to find innovative solutions to engineering problems independently
- Developing engineers with managerial attributes capable of applying latest technology with responsibility
- Creation of congenial atmosphere and excellent research facilities for undertaking quality research by faculty and students
- To strive for more internationally recognized publication of research papers, books and to obtain patent and copyrights
- To provide excellent technological services to industry

Program Educational Objectives (PEO)

1. To develop capability to understand the fundamentals of Science and Electrical & Electronics Engineering for analyzing the engineering problems with futuristic approach.
2. To foster a confident and competent graduate capable to solve real life practical engineering problems fulfilling the obligation towards society.
3. To inculcate an attitude for identifying and undertaking developmental work both in industry as well as in academic environment with emphasis on continuous learning enabling to excel in competitive participations at global level.
4. To nurture and nourish effective communication and interpersonal skill to work in a team with a sense of ethics and moral responsibility for achieving goal.

Program Outcomes (PO)

A graduate shall

a) Be competent in applying basic knowledge of science and engineering for the purpose of obtaining solution to a multi-disciplinary problem
b) Gain skillful knowledge of complex engineering problem analysis
c) Be able to design system components and processes meeting all applicable rules and regulations
d) Be proficient in arriving at innovative solution to a problem with due considerations to society and environment
e) Be capable of undertaking suitable experiments/research methods while solving an engineering problem and would arrive at valid conclusions based on appropriate interpretations of data and experimental results
f) Continually upgrade his/her understanding and become masterly at modern engineering and soft tools and apply them along with other appropriate techniques and resources
g) Exhibit understanding of societal and environmental issues (health, legal, safety, cultural etc) relevant to professional engineering practice and demonstrate through actions, the need for sustainable development
h) Be committed to professional ethics, responsibilities and economic, environmental, societal, and political norms.
i) Demonstrate appropriate inter-personal skills to function effectively as an individual, as a member or as a leader of a team and in a multi-disciplinary setting
j) Be able to comprehend and write effective reports and design documentations; give and receive clear instructions; make effective presentations and communicate effectively and convincingly on complex engineering issues with engineering community and with society at large.
k) Be conscious of financial aspects of all professional activities and shall be able to undertake projects with appropriate management control and control on cost and time.
l) Recognize the need for continuous learning and will prepare himself/ herself appropriately for his/her all-round development throughout the professional career.

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 modeling 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 Team Work**: 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.

COURSE INFORMATION SHEET

Course code: EE102
Course title: EE102 ELECTRICAL ENGINEERING LABORATORY
Pre-requisite(s): Physics, Fundamentals of Mathematics and Electrical Engineering.

Credits:	L	T	P
	0	0	3

Class schedule per week: 3

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 :

A.	To describe students practical knowledge of active and passive elements and operation of measuring instruments
B.	To demonstrate electrical circuit fundamentals and their equivalent circuit models for both 1-φ and 3- φ circuits and use circuit theorems
C.	To establish voltage & current relationships with the help of phasors and correlate them to experimental results
D.	1. To conclude performance of 1 – Φ AC series circuits by resonance phenomena 2. To evaluate different power measurement for both 1-φ and 3- φ circuits

Course Outcomes

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

1.	classify active and passive elements, explain working and use of electrical components, different types of measuring instruments;
2.	illustrate fundamentals of operation of DC circuits, 1-φ and 3- φ circuits and also correlate the principles of DC, AC 1-φ and 3- φ circuits to rotating machines like Induction motor and D.C machine.;
3.	measure voltage, current, power, for DC and AC circuits and also represent them in phasor notations;
4.	analyse response of a circuit and calculate unknown circuit parameters;
5.	recommend and justify power factor improvement method in order 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, Thevenin's and Reciprocity theorem**
   Aim : (i) To verify Superposition theorem for a given circuit
   (ii) To verify Thevenin'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/Profession requirements)

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

POs met through Gaps in the Syllabus : a, b, c, g

Topics beyond syllabus/Advanced topics/Design

1. Assignment : Simulation of electrical circuits with dependent/independent sources by various techniques (Mesh current/Node Voltage/Thevenin's theorem/Norton's theorem/Maximum power transfer theorem etc.) using MATLAB/PSIM/C++ softwares
2. Active/reactive power calculation for 3 – Φ circuits

POs met through Topics beyond syllabus/Advanced topics/Design: e, f, i, j, k

Mapping of lab experiment with Course Outcomes

Experiment	Course Outcomes				
	1	**2**	**3**	**4**	**5**
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	

3=High, 2=Medium, 1=Low

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 Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
(1) Progressive Evaluation (60)	
Day to Day performance & Lab files	30
Quiz (s)	10
Viva	20
(2) End Semester (40)	
Examination Experiment performance	30
Quiz	10
Grand Total	100

Assessment Compoents	CO1	CO2	CO3	CO4	CO5
Progressive Evaluation Marks					
End Semester Marks					

Indirect Assessment –

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

Mapping of Course Outcomes onto Course Objectives

Course Outcome #	Course Objectives			
	A	B	C	D
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											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	3	3	1	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 a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l
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 Machine Lab
Pre-requisite(s): ME207 Kinematics & Dynamics of Machines
Co- requisite(s):
Credits: 1.5 L: 0, T: 0, P: 3
Class schedule per week: 03
Class: B. Tech
Semester / Level: 04/02
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

1	Verify basic principles of vibration, its source and effect in different mechanical systems.
2	Verify the effect of critical speed in simple rotating systems
3	Verify and determine gyroscopic couple

Course Outcomes

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

CO1	Measure vibration parameters in single degree freedom systems
CO2	Understand the concept of whirling of shaft experimentally
CO3	Perform experiments on balancing of reciprocating masses
CO4	Apply the knowledge of dynamics in balancing of wheels.
CO5	Demonstrate the working principles of gyroscope, cam and governor

List of Experiments:

Experiment no. 1: Simple pendulum

Objective: To study the motion of simple pendulum.

Experiment no. 2: Compound pendulum

Objective: To verify the relation of a compound pendulum and determination of radius of gyration.

Experiment no. 3: Bifilar suspension

Objective:To determine the radius of gyration of a given bar using bifilar suspension.

Experiment no. 4: Torsional vibration I

Objective:To study the torsional vibration of a single rotor system.

Experiment no. 5: Torsional vibration II

Objective: To study the torsional vibration of two rotor system.

Experiment no. 6: Effect of damping

Objective:To find the frequency of beam at different damping

Experiment no. 7: Balancing

Objective:Balancing of reciprocating masses.

Experiment no. 8: Wheel balancer

Objective:To balance an unbalanced wheel on the Wheel balancer.

Experiment no. 9: Gyroscope

Objective: To study the gyroscopic couple due to simultaneous spin and precession of a disc.

Experiment no. 10: Whirling of a shaft

Objective: To study the effect of whirling of shaft for different boundary conditions.

Experiment no. 11: Hartnell Governer

Objective: To determine the position of sleeve against controlling force and speed of a Hartnell governer and to plot characteristic curve for radius of rotation.

Experiment no. 12: Cam follower mechanism

Objective: To construct displacement diagram for cam follower mechanism and to determine jump speed against different inertia of the follower.

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 to verify coriolis acceleration

POs met through Gaps in the Syllabus
PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design
Second and third critical speed of a whirling shaft

POs met through Topics beyond syllabus/Advanced topics/Design
PO1 TO PO5
Mapping Between COs and Course Delivery (CD) methods

CDCode	Course Delivery Methods	Course Outcome	Course Delivery Method Used
CD1	Lecture by use of Boards/LCD Projectors	CO1-5	CD1
CD2	Tutorials/Assignments		
CD3	Seminars	-	-
CD4	Mini Projects/Projects	-	-
CD5	Laboratory Experiments/Teaching Aids	CO1-5	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 Outcome (CO) Attainment Assessment Tools & Evaluation Procedure

Direct Assessment
Direct Assessment

Assessment Tool	% Contribution during CO Assessment
(1) Progressive Evaluation (60)	
Day to Day performance & Lab files	30
Quiz (s)	10
Viva	20
(2) End Semester (40)	
Examination Experiment performance	30
Quiz	10
Grand Total	100

Indirect Assessment

1. Students' Feedback on Course Outcome.

Mapping of Course Outcomes onto Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
	a	b	c	d	e	f	g	h	i	j	k	l
CO1	3	2	1	1		1			1			1
CO2	3	2	2	2		1			2			2
CO3	3	3	2	2		1			2			2
CO4	3	3	3	3	2	3	1	1	2	1	1	2
CO5	3	3	3	3	2	3	1	1	2	1	1	2

COURSE INFORMATION SHEET

Course code: PE 205
Course title: MANUFACTURING PROCESSES -I LAB
Pre-requisite(s): Nil
Co- requisite(s): PE204MANUFACTURING PROCESSES - I
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: IV/Second
Branch: Production 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 and drawing inference from it.
3	Get hands on experience of arc welding and selecting best technique in engineering practices.
4	Develop skills on ultrasonic welding and spot welding.
5	Know different techniques used in polymer processing.

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

CO1	Distinguish and develop the patterns used in sand casting.
CO2	Judge the composition of molding sand for sand casting.
CO3	Compare arc welding processes and identify their respective applications.
CO4	Classify welding process and identify their respective applications.
CO5	Discriminate between the processes used in polymer processing.

SYLLABUS

LIST OF EXPERIMENT:

1. **FOUNDRY SHOP**
   EXPERIMENT – I:Pattern Study
   Objective: To study different types of pattern used in sand casting.

2. **CARPENTARY SHOP**
   EXPERIMENT-I:Pattern Making
   Objective: To prepare a single piece wooden pattern according to given dimension for Al casting.

3. **FOUNDRY SHOP**
   EXPERIMENT-II:Permeability Test
   Objective: To determine the permeability number for given molding sand sample.

4. **FOUNDRY SHOP**
   EXPERIMENT-III: Moisture Test
   Objective: To determine the amount of moisture for given molding sand sample.

5. **FOUNDRY SHOP**
   EXPERIMENT-IV:Clay Content Test
   Objective: To determine the amount of clay for given molding sand sample.

6. **FOUNDRY SHOP**
   EXPERIMENT-V:Grain Fineness Number
   Objective: To determine the Grain fineness number for given molding sand sample.

7. **WELDING SHOP**
   EXPERIMENT-I:Shielded Metal Arc Welding
   Objective: To study the effect of AC and DC arc in manual/shielded metal arc welding.

8. **WELDING SHOP**
   EXPERIMENT-II: Gas Metal Arc Welding
   Objective: To determine metal deposition rate in GMAW.

9. **WELDING SHOP**
   EXPERIMENT-III:Submerged Arc Welding
   Objective: To study Submerged arc welding equipment and perform SAW welding.

10. **WELDING SHOP**
    EXPERIMENT-IV:Spot Welding
    Objective: To study resistance welding equipment and perform spot welding on thin sheet.

11. **POLYMER**
    EXPERIMENT-I:Ultrasonic Welding
    Objective: To study ultrasonic welding setup and perform plastic welding using the same.

12. **POLYMER**
    EXPERIMENT-II:Blow Molding
    Objective: To study blow molding equipment and perform molding operation.

13. **POLYMER**
    EXPERIMENT-III: Injection Molding
    Objective: To study injection molding machine and perform molding operation.

Books recommended:

TEXT BOOK

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)**

EFERENCE BOOK

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	

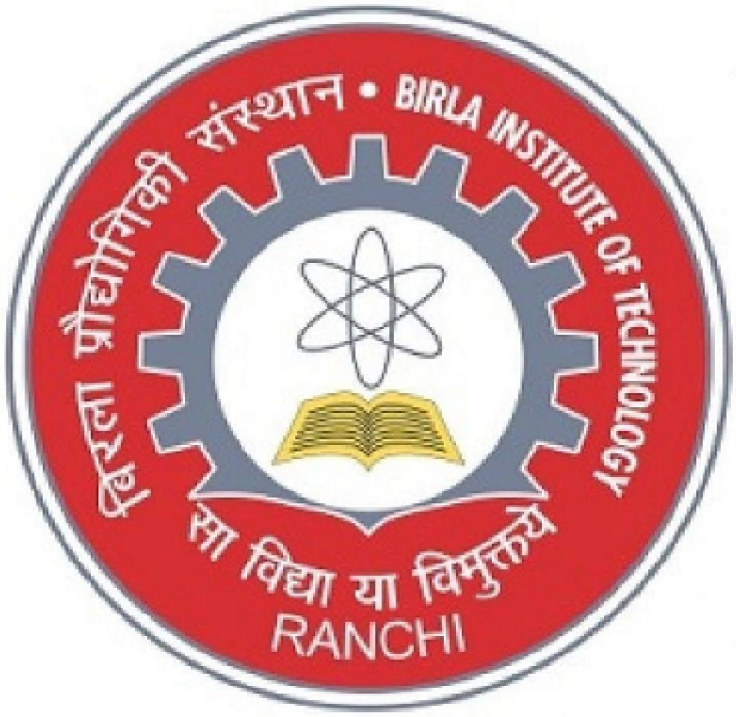
Course Evaluation:

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
Quiz1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30

BIRLA INSTITUTE OF TECHNOLOGY



CHOICE BASED CREDIT SYSTEM(CBCS) CURRICULUM

(Effective from Academic Session: Monsoon 2018)

B. Tech. (5 th SEMESTER)

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE INFORMATION SHEET

Course code: MT123
Course title: Business Communication
Credits: 3 (L:2, T:0, P:2)
Class schedule per week: 4
Class: B. Tech
Semester / Level: 5
Branch: Mechanical Engineering

Syllabus

Module	Hours
Module: 1 Introduction to Business Communication: Importance and Objectives of Business communication, Process of communication, Barriers to effective communication, Techniques of effective communication. Forms of communication (Written, Oral, audio-visual communication).	6
Module –II Managing Business Communication: Formal and Informal communication, Non- verbal communication (Body language, Gestures, Postures, Facial expressions). The cross-cultural dimensions of business communication. Techniques to effective listening, methods and styles of reading.	6
Module – III Other Aspects of Communication: Vocabulary: Single word substitution, Idioms and phrases, Precis writing, Comprehension. Group Discussions, Extempore, Principles of effective speech and presentations, Role playing.	6
Module - IV Introduction to Managerial Writing: Business letters: Inquiries, Circulars, Quotations, Orders, Acknowledgement, Claims & adjustments, Collection letters, Sales letters, Drafting of different resumes, Covering letters Applying for a job, Social correspondence, Invitation to speak. Official Correspondence: Memorandum, Notice, Agenda, Minutes, Circular letters.	6
Module –V Report writing: Business reports, Types, Characteristics, Importance, Elements of structure, Process of writing, Order of writing, the final draft, check lists for reports.	6

Recommended books:

1. Communication Skills, Sanjay Kumar &PushpLata, Oxford University Press .
2. Business Correspondence and Report Writing,R.C.Sharma, Krishna Mohan.Mcgraw Hill
3. Communication for Business,Shirley Taylor, V.Chandra, Pearson.
4. Business Communication- HorySankar Mukherjee, Oxford University Press.
5. Basic Business Communication-. Lesikar I Flatley, McGraw Hill.
6. Business Communication Today, Bovee, Thill and Chaterjee, Pearson.

COURSE INFORMATION SHEET

Course code: ME 301
Course title: IC Engines and Gas Turbines
Credits: 3 (L:3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 5
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To make student familiar with operating characteristics of internal combustion engines and hybrid vehicles.
B.	To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emissions
C.	To apply analytical techniques to the engineering problems and performance analysis of internal combustion engines.
D.	To introduce students to future internal combustion engine and hybrid and electric vehicles technology.

Course Outcomes

After the completion of this course, students will be:

1.	Understand working principle of IC Engines, hybrid and electric vehicles.
2.	Understand combustion and fuel injection phenomena in SI and CI engines and factors influencing combustion phenomena.
3.	Analyze cooling systems and latest developmentin hybrid vehicles.
4.	Apply different methods for measuring engine performance and pollutants.
5.	Analysegas turbine and jet propulsioncycles.

Syllabus

Module	Hours
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.	8
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 factors, detonation and affecting factors, control and comparison with knocking of S.I. engines.	8
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. EngineCooling: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

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.

Text books:

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.

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 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 Assessment	5
End Semester Examination	50

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	2	1	1	2	1	1	1	1	1
2	3	3	3	3	1	1	1		1			1
3	3	3	3	3	2	2	2	1	1			2
4	3	3	3	3	2	1	2	1	1	1	1	2
5	3	3	3	3	1	1	1	1	1			1

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 303
Course title: Mechanical Vibration
Credits: 3 **(**L: 3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 5
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To be able to obtain the model of vibratory systems of single, multi degrees of freedom system as well as continuous systems.
B.	To perform modal analysis of different systems.
C.	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	Analyse multi degrees of freedom systems.
CO3	Solve the natural frequencies and mode shapes of a vibrating system.
CO4	Analyse the vibration of continuous systems.
CO5	Apply the knowledge of vibration in practical problems.

Syllabus

Module	Hours
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

Text Books:

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

2. Introductory Course on Theory and practice of Mechanical Vibrations by J.S.RaoandK.Gupta, Wiley Eastern Ltd.

Reference Book

1. Mechanical vibrations by ThammaiahGowda, 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 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 Assessment	5
End Semester Examination	50

Assessment Compoents	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 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: ME 315
Course title: Heat and Mass Transfer
Credits: 3 (L: 3, T: 0, P: 0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 5
Branch: Mechanical Engineering

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	Hours
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 Colburnsanalogies.	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

Text books:

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 Ghoshdustidar, 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 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	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

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 347 (Program Elective-2)
Course title: Advance Thermodynamics
Credits:3 **(**L: 3, T:1, P: 0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 5
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To present animportance of combustion in an engineering perspective.
B.	To develop an intuitive understanding of physics of combustion by emphasizing the engineering and engineeringarguments.

Course Outcomes

After the completion of this course, students will be:

1.	Understand the basic concepts of combustion with its thermodynamic approach.
2.	Analyse the kinetics of combustion.
3.	Analyze the concept of Flames.
4.	Analyze the concept of ignition
5.	Analyze the Combustion Generated Pollution & its Control.

Syllabus

Module	Hours
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.	8
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 RankineHugoniot 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 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;	8

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 NOxformation and control in combustors Fuel NOxand 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).

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

Analysis of combustion in various thermal systems.

POs met through Gaps in the Syllabus

PO1-5

Topics beyond syllabus/Advanced topics/Design

Numerical analysis of combustion.

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
Teacher's Assessment	5
End Semester Examination	50

Assessment Components	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 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	3	1	-	-	-	1
2	3	3	3	3	1	1	3	1	-	-	-	1
3	3	3	3	3	1	1	3	1	-	-	-	1
4	3	3	3	3	1	1	3	1	-	-	-	1
5	3	3	3	3	1	1	3	1	-	-	-	1

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 349(Program Elective -2)
Course title: Turbo Machinery
Credits: 3 **(**L:3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 5
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To present a comprehensive and rigorous treatment of classical turbo machinery while retaining an engineering perspective.
B.	To lay the groundwork for subsequent studies in such fields as analysis of various turbo machinesand energy conversion systems and to prepare the students to effectively use Fluid mechanics and thermodynamics theory in the practice of turbo machinery in engineering.
C.	To develop an intuitive understanding of turbo machinery by emphasizing the engineering and engineeringarguments.
D.	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,thermodynamicsconcepts, system of control volume, to turbomachines
CO2.	Apply the appropriate fundamental laws of fluid dynamics, thermodynamics to various turbomachines.
CO3.	Analyse various turbomachines for energy transfer
CO4.	Evaluate the performance of various turbomachinery components
CO5.	Create optimum aerodynamicdesign/geometrical dimension of simple, complex turbomachinerycomponents using conventional methods and modern tools.

Syllabus

Module	Hours
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 aerofoil 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

Text Books:

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

Reference Books:

1. Fluid Mechanics and Thermodynamics of Turbomachinery, S. L. Dixon.
2. Fundamentals of Turbomachinery, William W Perg, John Wiley & Sons, Inc.
3. 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 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

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

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 onto Program Outcomes

Course Outcome	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
CO1	3	3	3	3	1							2
CO2	3	3	3	2	2							2
CO3	3	3	3	2	2							2
CO4	3	3	3	2	2				2	1	1	2
CO5	3	2	2	2	2				2	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	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 351
Course title: Finite Element Methods(Program Elective -2)
Credits: 3 **(**L:3, T:0, P: 0)
Class schedule per week: 3
Class: B.Tech
Semester / Level: 5
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To present a comprehensive treatment on finite element methods.
B.	To lay the groundwork for subsequent studies in the fields of stress, strain, including the design aspects.
C.	To develop an intuitive understanding of various mathematical techniques to solve the problems.
D.	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:

1.	To understand the fundamentals of Finite Element Methods.
2.	To develop an intuitive understanding of finite element techniques by emphasizing the engineering arguments.
3.	To apply the finite element methods for solving differential equations arising in solid and fluid mechanics.
4.	To evaluate the stresses, strains in real-world examples related to mechanical engineering
5.	To analyse the strength of the mechanical members.

Syllabus

Module	Hours
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 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 – 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

TEXT BOOKS:

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

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

3. 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:

1. 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

	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

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

AssessmentComponents	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 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	-	-	1	2	-	1	1	-	-	2
CO2	3	3	2	-	3	2	1	1	2	2	-	2
CO3	3	3	3	2	3	3	1	1	2	2	2	2
CO4	3	3	2	3	3	3	1	1	2	-	-	2
CO5	3	3	3	3	3	3	1	2	3	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-2)
Course title: Computational Fluid Dynamics
Credits: 3 **(**L: 3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 5
Branch: Mechanical Engineering

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	Hours
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 upto 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

Text Books:

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 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 Assessment	5
End Semester Examination	50

Assessment Compoents	CO1	CO2	CO3	CO4	
Mid Sem Examination Marks					
End Sem Examination Marks					
Assignment					

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		1	1	2	1	2					
CO2	3	3	1	1	1	1	2					
CO3	3	3	1	2	1	1	1		1			1
CO4	2	2	2	2	2	2	2		2	1		1
CO5	3	3	3	2	2	2	3	1	2	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		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-2)
Course title: Advanced solid Mechanics
Credits: 3 **(**L: 3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 5
Branch: Mechanical Engineering

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:

1.	Outline the basic concepts of three –dimensional stress and strain as well as three-dimensional Mohr's circle.
2.	Analyse beam-column structure and column with energy methods
3.	Analyse the stresses resulting from asymmetrical bending of straight beam and curved beams
4.	Evaluate the torsion problems of non- circular bars.
5.	Apply the concept of thermal elastic stress strain relation

Syllabus

Module	Hours
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.	8
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.	8

Text Books:

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

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 Assessment	5
End Semester Examination	50

Assessment Compoents	CO1	CO2	CO3	CO4	
Mid Sem Examination Marks					
End Sem Examination Marks					
Assignment					

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	3	2	1	2	1	1		1	1		2
CO2	3	3	2	3	2	1	1	1	2			2
CO3	3	3	2	3	2	1	1	1	2			2
CO4	3	3	3	3	2	1	1	1	2			2
CO5	3	3	3	3	2	1	1	1	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/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 357(Program Elective-2)
Course title: Measurement and Instrumentations
Credits: 3 **(**L:3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 5
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To present a comprehensive knowledge of different measurement and instrumentation technologies available and in practice in modern day industry.
B.	To lay the foundation to understand the basic principles of operation of various sensors and transducers.
C.	To develop the knowledge needed to justify and select any specific type of instrumentation needed for any industrial/domestic application.
D.	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.	Evaluatethe 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	Hours
Module -I Measurements 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

TEXT BOOKS:

1. A. K. Sawhney and PuneetSawney, Mechanical Measurements and Instrumentation and Control, DhanpatRai and Co., 2016
2. R. K. Rajput, Mechanical Measurements and Instrumentation, S.K. Kataria& Sons, 2013
3. Helfrickand Cooper, Modern Electronic Instrumentation & Measurement Techniques, PHI, 2011.

REFERENCE BOOKS:

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

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

N.A

POs met through Gaps in the Syllabus

N.A

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
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

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

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 onto Program Outcomes

Course Outcome	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
CO1	3	2	2	2	2	-	-	-	-	-	-	-
CO2	3	3	2	3	3							
CO3	3	3	3	3	3							
CO4	3	3	3	2	3							
CO5	3	3	3	3	3							

COURSE INFORMATION SHEET

Course code: ME 291 (OPEN ELECTIVE- I)
Course title: Renewable energy Systems
Credits: 3 L:3, T:0, P:0
Class schedule per week: 3
Class: B. Tech
Semester / Level: Level-2
Branch:

Course Objectives

This course enables the students:

A.	To present a comprehensive and rigorous treatment of renewable and non renewable energy system.
B.	To lay the groundwork for subsequent studies in the fields of renewable energy systems.
C.	To develop an intuitive understanding of the applications of renewable energy **Systems and Solar Photovoltaic Systems**
D.	To understand the working principles of different renewable energy systems.

Course Outcome

After the completion of this course, students will be:

1.	Outline the various renewable energy systems.
2.	Discuss the traditional energy system.
3.	Examine thesolar thermal systems
4.	Analyze the **Solar Photovoltaic Systems**
5.	Demonstrate the working principles of different biomass system.

Syllabus

Module	Hours
Module: 1 Introduction: Fossil fuel-based systems. Impact of fossil fuel-based systems, Non-conventional energy, Seasonal variations and availability. Renewable energy – sources and features. Hybrid energy systems Distributed energy systems and dispersed generation (DG).	8
Module: II Traditional Energy Systems: Sources. Features and characteristics. Applications: Transport – bullock cart, horse carriage, camels; Agriculture – ox plough, water lifting devices; Human power – bicycle, cycle rickshaw etc.; House hold – cooking (bio mass), lighting etc.	8

Module – III Solar Thermal Systems: Solar radiation spectrum. Radiation measurement. Technologies. Applications: Heating, Cooling, Drying, Distillation, Power generation.	8
Module - IV Solar Photovoltaic Systems: Operating principles. Photovoltaic cell concepts. Cell, module, array. Series and parallel connections. Maximum power point tracking. Applications: Battery charging, Pumping, Lighting, and Peltier cooling.	8
Module –V Biomass: Operating principles. Combustion and fermentation. Anaerobic digester. Wood gasifier. Pyrolysis. Applications: Biogas, Wood stoves, Bio diesel, Combustion engine.	8

TEXT BOOKS:

1. Renewable Energy Systems /Henrik Lund, 2014, Elsevier, Academic Press.
2. Renewable Energy Resources – Twidell & Wier, CRC Press, 2010(Taylor & Francis)

REFERENCEBOOKS:

1. Solar Engineering of Thermal process, 2nd Edition of John A. Duffie & William A. Beckman-2014.
2. Renewable Energy: Technology, Economics and Environment, Martin Kaltschmitt, Wolfgang Streicher, Andreas Wiese-2007
3. Renewable Energy, Fourth Edition: Physics, Economics and planning by Bent Sorensen-2010.

. Renewable Energy, Fourth Edition: Physics, Economics and planning by Bent Sorensen-2010.

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 Assessment	5
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks					
End Sem Examination Marks					
Assignment					
Quiz 1					
Quiz 2					

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	2	1	1	1	1	1	1	1			1
2	3	2	1	1	1	1	1	1	1			1
3	3	2	1	1	1	1	1	1	1			1
4	3	2	1	1	1	1	1	1	1			1
5	3	2	1	1	1	1	1	1	1			1

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 292 (OPEN ELECTIVE- I)
Course title: : Smart and New Materials
Credits: 3 L:3, T:0, P:0
Class schedule per week: 3
Class: B. Tech
Semester / Level: level 2
Branch:

Course Objectives

This course enables the students:

A.	To present a comprehensive exposure to various new engineering materials
B.	To lay the groundwork for various smart materials and their applications
C.	To develop an intuitive understanding of Electro-Rheological (Fluids) Smart Materials, Piezoelectric Smart Materials, Shape – Memory (Alloys) Smart Materials etc.
D.	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:

1.	Correlate requirement of smart and new materials.
2.	Understand applicability of smart materials under various conditions.
3.	Characterize necessity of development of new materials with better properties and cost effective processes.
4.	Apply various techniques for selection of suitable material
5.	Evaluate the performance of new materials for engineering applications.

Syllabus

Module	Hours
Module: 1 1Introduction 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 – Biomimetics – Wolff's law– Technological applications of Intelligent materials.	8
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 smar tstructures – Smart skins – Aero elastic tailoring of airfoils – Synthesis of future smart systems.	8
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.	8
Module - IV Piezoelectric Smart Materials Background – Electrostriction – Pyroelectricity – 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..	8
Module –V 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, chiralmaterials – Applications of SMA – Continuum applications of SMA fastners – SMA fibers – reaction vessels, nuclear reactors, chemical plants, etc. – Micro robotactuated by SMA – SMA memorisation process (Satellite antenna applications) SMAblood clot filter – Impediments to applications of SMA – SMA plastics – primarymolding – secondary molding – Potential applications of SMA plastics.	8

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 of Shape 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
Teacher's Assessment	5
End Semester Examination	50

Assessment Components	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 onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	I	j	k	l
1	3	3	3	2	1	1	1	1	1	1	1	1
2	3	3	3	3	1	1	1	1	1			1
3	3	3	3	3	1	1	1	1	1			1
4	3	3	3	3	1	1	1	1	1	1	1	1
5	3	3	3	3	1	1	1	1	1			1

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 302
Course title:	Heat Transfer Lab
Credits: 1.5	**(**L:0, T:0, P:3)
Class schedule per week:	3
Class:	B. Tech
Semester / Level:	5
Branch:	Mechanical Engineering

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 INFORMATION SHEET

Course code: ME 304
Course title: Internal Combustion Engine lab
Credits: 1.5 **(**L:0, T: 0, P:3)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 5
Branch: Mechanical Engineering

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./ Carburettor 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 INFORMATION SHEET

Course code: ME 306
Course title: Mechanical Engineering Lab II
Credits: 1 (L: 0, T: 0, P: 2)
Class schedule per week: 2
Class: B. Tech
Semester / Level: 5
Branch: Mechanical Engineering
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 Meniscus 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.

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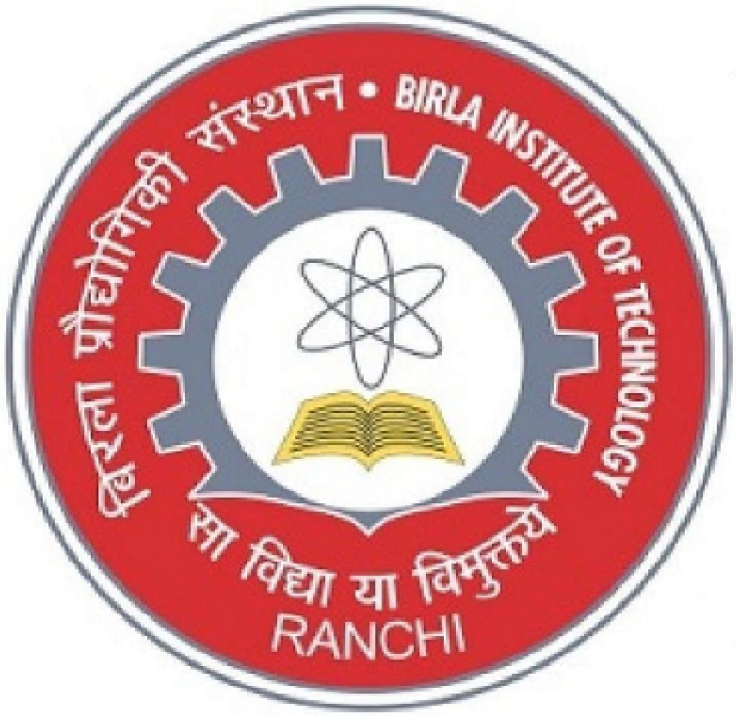

CHOICE BASED CREDIT SYSTEM(CBCS) CURRICULUM

(Effective from Academic Session: Monsoon 2018)

B. Tech. (6 th SEMESTER)

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE INFORMATION SHEET

Course code: ME 305
Course title: Automobile Engineering
Credits: 3 **(**L: 3, T:0, P: 0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To know the basics of automobile in general
B.	To understand the working of different automotive systems and subsystems
C.	To update the latest developments in automobiles

Course Outcomes

After the completion of this course, students will be:

CO1.	Practically identify different automotive system and subsystem.
CO2.	Understand the principles of electrical, transmission, suspension, steering and braking system of an automobile
CO3.	Develop a strong base for understanding the current and future developments in the automobile industry

Syllabus

Module	Hours
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:

1. Automotive Mechanic by W.H. Course.
2. Automotive Mechanics by Heitner.
3. Electric and Hybrid Vehicles: Design and Fundamental by Iqbal Hussein
4. Modern Electrical Equipment of Automobiles by Judge A.W

REFERENCE BOOKS :

1. The Motor Vehicles by D.S. Newton and Steeds.
2. Fundamental of motor vehicle technology by Hillier and Peter Coobes.
3. Propulsion System for Hybrid Vehicle by John M. Miller.
4. Automotive Electrical Equipments by Kohli P L

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
CO1	3	1	1	1	2	2	1	1			1	3
CO2	3	3	2	2	3	2	2	2			1	2
CO3	3	3	2	3	3	2	2	2	1		1	2

Gaps in the syllabus (to meet Industry/Profession requirements)
Performance and testing of vehicles

POs met through Gaps in the Syllabus
PO1 TO PO9& PO12

Topics beyond syllabus/Advanced topics/Design
Application of CFD in automobiles

POs met through Topics beyond syllabus/Advanced topics/Design
PO1 TO PO9 &PO12

	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**
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

AssessmentCompoents	**CO1**	**CO2**	**CO3**
Mid Sem Examination Marks			
End Sem Examination Marks			
Assignment			

Indirect Assessment –

1. Student Feedback on Faculty
2. Student 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	CO-1-3	CD8
CD9	Simulation	CO -2-3	CD9

COURSE INFORMATION SHEET

Course code: ME 307
Course title: Robotics Engineering
Credits: 3 **(**L: 3, T: 0, P: 0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To present a comprehensive and rigorous treatment of different robot types.
B.	To lay the mathematical backgroundwhich is required to understand the mechanical design of different industrial robots used in modern industry.
C.	To develop an intuitive understanding of the limitations of various robots and its safe handling.
D.	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.	Evaluateinverse 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	Hours
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.	8
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.	8
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:

1. Subir Kumar Saha, Introduction to Robotics, TMH, New Delhi, 2014.
2. John J. Craig, Introduction to Robotics, Pearson Education, 2011.
3. J. P. Marlett, Parallel Robots, Springer, 2006.

REFERENCE BOOKS:

1. Dilip K. Pratihar, Fundamentals of Robotics, Narosa Publishing House, 2016.
2. KS Fu, C. S. G Lee, R. Gonzalez, Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill Education, 1987.
3. Bruno Siciliano and OussamaKhatib, Handbook of Robotics, Springer, 2016.
4. Saeed B. Niku, An Introduction to Robotics Analysis, Systems, Applications, Prentice-Hall, 2001.

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

N/A

POs met through Gaps in the Syllabus

N/A

Topics beyond syllabus/Advanced topics/Design

Compliant structures, Force control, System Identification.

POs met through Topics beyond syllabus/Advanced topics/Design

	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

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

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 onto Program Outcomes

Course Outcome	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
CO1	2	2	2	2	2	-	-	-	-	-	-	-
CO2	3	2	3	2	2							
CO3	3	2	3	2	2							
CO4	3	2	3	2	2							
CO5	3	2	3	3	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	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		

COURSE INFORMATION SHEET

Course code: ME359 (Program Elective-3)
Course title: Power Plant Engineering
Credits: 3 **(**L:3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To have clear understanding of different power plant technologies.
B.	To be able to select an appropriate type of plant for given requirement under different situations.
C.	To be able to select the suitable components/equipment/accessories for proper functioning of power plant
D.	To understand the operational requirements and do the economic analysis of power plant.

Course Outcomes

After the completion of this course, students will be:

1.	Classify the different power plants with their applications and future trends.
2.	Understand the different components of Thermal power plant and evaluate the heat balance.
3.	Distinguish between Diesel, Gas Turbine and Hydraulic power plant
4.	Illustrate the working of nuclear power plants and Nonconventional power plants.
5.	Analyze the power plant economics and determine the best possible combinations of power plant, depending on requirement.

Syllabus

Module	Hours
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.	8

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.

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

Practical analysis and data collection

POs met through Gaps in the Syllabus

PO1-5

Topics beyond syllabus/Advanced topics/Design

Supercritical boiler.

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
Teacher's Assessment	5
End Semester Examination	50

Assessment Compoents	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 onto Program Outcomes

Course Outcome #	**Program Outcomes**											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	2	1	1	2	1	1	1	1	1
2	3	3	3	3	1	1	2	1	1	1	1	1
3	3	3	3	3	1	1	2	1	1	1	1	1
4	3	3	3	3	1	1	2	1	1	1	1	1
5	3	3	3	3	1	1	2	1	1	1	1	1

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 361(Program Elective-3)
Course title: Combustion
Credits: 3 **(**L:3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To present animportance of combustion in an engineering perspective.
B.	To develop an intuitive understanding of physics of combustion by emphasizing the engineering and engineeringarguments.

Course Outcomes

After the completion of this course, students will be:

1.	Understand the basic concepts of combustion with its thermodynamic approach.
2.	Analyse the kinetics of combustion.
3.	Analyze the concept of Flames.
4.	Analyze the concept of ignition
5.	Analyze the Combustion Generated Pollution & its Control.

Syllabus

Module	Hours
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.	8
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 RankineHugoniot 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 flame speeds, flame speed measurements. Stability limits of laminar flames; flammability limits and quenching distance; bumer design. Mechanisms of	8

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 NOxformation and control in combustors Fuel NOxand 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).

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

Analysis of combustion in various thermal systems.

POs met through Gaps in the Syllabus

PO1-5

Topics beyond syllabus/Advanced topics/Design

Numerical analysis of combustion.

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
Teacher's Assessment	5
End Semester Examination	50

Assessment Compoents	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 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	3	1	-	-	-	1
2	3	3	3	3	1	1	3	1	-	-	-	1
3	3	3	3	3	1	1	3	1	-	-	-	1
4	3	3	3	3	1	1	3	1	-	-	-	1
5	3	3	3	3	1	1	3	1	-	-	-	1

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 363(Program Elective-3)
Course title: Vehicle Dynamics
Credits: 3 **(**L:3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To understand longitudinal, lateral and vertical dynamics of vehicle
B.	To construct mathematical models for the analysis of vehicle motion
C.	To analyse kinematics and dynamics of tyres
D.	To design vehicle with less noise and vibration
E.	To evaluate handling of vehicles

Course Outcomes

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

1.	Demonstrate various principles related to motion of the vehicle
2.	Design tyres and other vehicle components
3.	Evaluate handling of vehicle
4.	Construct mathematical models for different motions of vehicle
5.	Evaluate forces, moments and kinematic quantities involved in the motion of vehicle

Syllabus

Module	Hours
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.	8
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.	8
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.	8

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,

Gaps in the syllabus (to meet Industry/Profession requirements)
Detailed modelling of tyres.

POs met through Gaps in the Syllabus
PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design
Non-Steady-State Out-of-Plane String-Based Tyre Models

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 Assessment	5
End Semester Examination	50

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 onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	3	3	1		1	1	1		1
2	3	3	3	2	3		1	1	1	2	1	1
3	2	3	2	1	2			1				1
4	3	3	3	3	3				2	2		1
5	3	3	3	3	3				1			1

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 365 (Program Elective-3)
Course title: Design of Mechanisms
Credits: 3 **(**L:3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To understand kinematic and dynamics of links and joints in a mechanism
B.	To construct mathematical models for the analysis of link motion
D.	To design mechanisms for practical purposes
E.	To evaluate forces and moments in the links

Course Outcomes

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

1.	Demonstrate various principles related to motion of the links and joints
2.	Design mechanisms for practical purposes
3.	Construct mathematical models for motions of rigid links
4.	Evaluate forces, moments and kinematic quantities involved in the motion of links

Syllabus

Module	Hours
Module -I Introduction to Mechanisms and number synthesis: Mechanisms, Kinematic pairs, Plane and space mechanisms, Kinematic chains, Kinematic diagram, Kinematic Inversions, Equivalent linkage, Mobility and range of movement, Four and six link mechanisms.	8
Module –II Kinematic Synthesis 1: (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, (Analytical Methods) Complex number modelling in kinematic synthesis, The Dyad, Motion path and function generation with three prescribed points, Three precession point synthesis for multiloop mechanisms, Freudenstein's equation for three point function generation, Loop-closer equation technique.	8
Module – III Kinematic Synthesis 2 and Curvature Theory: Motion generation with four prescribed points, Special cases of four position synthesis, Five position motion generation, Extensions of Burmester point theory for path and function generation, Geared linkages. Curvature theory: Fixed and moving centroide, Velocity and Acceleration, Inflection points and inflection circles, The Euler-Savary Equation, Bobillier's construction, Hartmann's construction, Cusp points.	8

Module - IV Dynamics of Mechanisms: Review kinetostatics using matrix method, Lagrange equation of motion, Force and moment balancing of linkages, Shaking moment balancing, Effect of moment balance on input torque, Analysis of high speed elastic mechanism.	8
Module –V Synthesis of Spatial Linkages: Matrix method for translation and rotation, Modelling and kinematic analysis of spatial mechanisms, Kinematic analysis of industrial robot.	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. K. Mallik, A. Ghosh and G. Dittrich, Kinematic Analysis and Synthesis of Mechanisms, CRC 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)
N.A.
POs met through Gaps in the Syllabus
PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design

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 Assessment	5
End Semester Examination	50

Assessment Compoents	CO1	CO2	CO3	CO4
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 onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	3	3	1		1	1	1		1
2	3	3	3	2	3		1	1	1	2	1	1
4	3	3	3	3	3				2	2		1
5	3	3	3	3	3				1			1

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		CO1-4	CD1
CD2	Tutorials/Assignments		CO1-4	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: ME367 (Program Elective -3)
Course title: Industrial Tribology
Credits: 3 **(**L:3,T:0,P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

This course enables the students to:

A.	Understand of basic principles of tribology and its role in engineering.
B.	Applyconcepts of wear, friction and lubrication for industrial significance and economic aspects.
C.	Understand in detail necessity oftribology and lubrication in real world.

Course Outcomes

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

1.	Understand role of tribology in engineering.
2.	Analysis of contact surfaces phenomenon and friction.
3.	Identification of wear type and quantification.
4.	Description and understanding of lubrication mechanisms.
5.	Implementation of industrial applications of tribology and lubrication.

Syllabus

Module	Hours
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.	8
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, lubricants 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

Text Book

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 Book

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

Gaps in the syllabus (to meet Industry/Profession requirements): New subject incorporated.
POs met through Gaps in the Syllabus:PO1-6
Topics beyond syllabus/Advanced topics/Design: Applications
POs met through Topics beyond syllabus/Advanced topics/Design:PO1-6

Course Delivery methods
Lecture by use of boards/LCD 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
Modelling and Simulation

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 Assessment	5
End Semester Examination	50

Assessment Components	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 CO and PO

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	2	2	2	2	3						1
2	3	3	2	2	2	3						1
3	3	3	3	2	2	2						1
4	3	2	3	2	2	2						1
5	3	2	3	2	3	2						1

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 373 (Program Elective-4)
Course title: Design, Modelling and Application of Solar Energy
Credits: 3 **(**L:3, T: 0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To develop capability in the students to design solar thermal energy storage systemsand solar photovoltaic system
B.	To familiarize the students with modeling methods of solar thermal energy storage systems and photovoltaic systems
C.	To familiarize the students with the various applications of solar thermal energy storage systems and photovoltaic systems

Course Outcomes

After the completion of this course, students will be:

1.	Understand the design concepts of solar systems.
2.	Analyze the mathematical modeling methods
3.	Analyze the computational modeling methods
4.	Analyze the performance of solar energy systems.
5.	Design and modelling of photovoltaic system.

Syllabus

Module	Hours
Module -I **Design concepts of solar systems**: System conceptual design, design of major components, overall system, design of physical principles to the solar system based on application. The process includes idea generation, concepts election and estimation, design of major components, and overall system design, solar radiation data.	8
Module –II **Mathematical Modeling**: overview of modelling – Types, stages, selection of modeling, Renewable Energy Devices and Systems equations, levels of analysis, steps in model development, solving and testing of models.	8
Module – III **Computational Modeling**: Computational modeling overview – Types, stages, selection of the modeling equations, levels of analysis, and steps in model development, solving and testing of models.	8

Module - IV **Solar thermal energy storage**: Design aspects of solar thermal energy storage systems. Selection criteria of storage materials for heating and cooling applications, selection of heat transfer fluid for heating and cooling applications. Case study of design and modelling of solar thermal energy storage-based system.	8
Module –V **Solar photovoltaic system**: Design of photovoltaic off-grid and grid- connected power systems. Design of system components - PV modules, batteries, charge controllers, inverters, auxiliaries. Case study of design and modelling of solar photovoltaic system.	8

Text Book

1. Solar Energy: Fundamentals and Applications by Garg&Prakash, H. P. Garg TMH Publication 2000.
2. Modelling and optimization of renewable energy systems. ArzuSencan. 2012. Intech publication ISBN : 978-953-51-0600-5

Reference Books:

1. Da Rosa. A.V, "Fundamentals of Renewable Energy Processes", 2nd ed., Academic Press, 2009.
2. Bender. E.A, "Introduction to Mathematical Modeling", Dover Publ., 2000
3. Fluid dynamics computational modeling and applications. Edited by L. Hector Juarez February 24th 2012 ISBN: 978-953-51-0052-2

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

Various solar thermal application

POs met through Gaps in the Syllabus

PO1-5

Topics beyond syllabus/Advanced topics/Design

High temperature solar power with thermal energy storage

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
Teacher's Assessment	5
End Semester Examination	50

AssessmentComponents	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 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	1	1			1
2	3	3	3	3	1	1	1	1	1			1
3	3	3	3	3	1	1	1	1	1			1
4	3	3	3	3	1	1	1	1	1			1
5	3	3	3	3	1	1	1	1	1			1

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 375(Program Elective-4)
Course title: Power Gear Train
Credits: 3 **(**L:3, T: 0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To identify the speed ratios for a given automobile gearbox.
B.	To determine the epicyclic gear trains with number of gears on Sun, ring and planetary gears in each gear train.
C.	To choose gear materials with respect to the service conditions and design by taking into account tooth load, contact stress and surface durability.
D.	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	Hours
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	8
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.	8
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.	8
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.	8
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.	8

TEXT BOOK :
1. Machine Design by U. C. Jindal.

REFERENCE BOOK :
1. Julian Happian-Smith, Introduction to Modern Vehicle Design, Butterworth Heinemann..

Gaps in the syllabus (to meet Industry/Profession requirements)
Detailed analysis of different gear drives used in industries.Outline of various parameters used in industries for designing the gear drive through finite element approach.

POs met through Gaps in the Syllabus
PO2, PO5, PO6& PO12

Topics beyond syllabus/Advanced topics/Design
Design of gear box of autonomous electric overhead crane.

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

	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

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

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 onto Program Outcomes

Course Outcome	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
CO1	3	3	3	2	2	2	3	2	2	2	1	1
CO2	3	2	2	1	1	1	2					1
CO3	3	2	2	2	1	1	1					1
CO4	3	2		3	2	2	2		1		1	1
CO5	3	2	1	3	3	3	3	1	1	1	2	1

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 377(Program Elective-4)
Course title: Mechatronics
Credits: 3 **(**L:3, T:0, P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

This course enables the students:

To present a comprehensive treatment on Mechatroncs and Real time interfacing.
To lay the groundwork for subsequent studies in the fields of sensors, actuators and digital technologies
To develop an intuitive understanding of various microcontrollers and automated systems for system design
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:

1.	Understand the importance of mechatronics and its application in real world.
2.	To know for the latest design considerations and concepts in new products
3.	Analyse different systems and take challenges to design newer technology
4.	Able to understand the different components like drives and sensors
5.	Outline the concepts changes done and what are the needs and advantages of implementing Mechatronics.

Syllabus

Module	Hours
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, sytem components and graphic representations	8
Module –V CNC Technology and Robotics : CNC Machines and Part programming, Real time Systems, Industrial Robotics, Case Studies	8

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

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

POs met through Gaps in the Syllabus
PO1 TO PO5

Topics beyond syllabus/Advanced topics/Design
PID, ROBOTICS

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 Assessment	5
End Semester Examination	50

Assessment Compoents	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 onto Program Outcomes and PSOs

CO's	Program Outcomes(POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	-	-	1	2	-	1	1	-	-	2			
CO2	3	3	2	-	3	2	1	1	2	2	-	2			
CO3	3	3	3	2	3	3	1	1	2	2	2	2			
CO4	3	3	2	3	3	3	1	1	2	-	-	2			
CO5	3	3	3	3	3	3	1	2	3	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/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: ME 381 (Program Elective-4)
Course title: Design of Brake System
Credits: 3 **(**L: 3, T:0, P: 0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

The primary objective of the course is to introduce the student to Design of Brake systems in automobiles. It would cover issues like locking of brakes and stability of the vehicle during braking, and optimizing brake performance by utilization of adhesion optimally.

Course Outcomes

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

1.	Understand the design of brake systems used in automobiles.
2.	Apply the concept of combination of trailer in vehicle to prevent brake overrun.
3.	Analyse the brake and shoe factors in different types of brakes including thermal effects.
4.	Implement electronic devices in braking systems for controlling and maintaining stability of the vehicle.
5.	Analysis of brake noise and create new ideas in the field of design of braking systems.

Syllabus

Module	Hours
Module -I Types of brakes, Friction materials in brakes and their characteristics, Design of Brakes in Passenger cars / Vans: Weight transfer, effect of tire / road adhesion, wheel lock, brake efficiency / adhesion utilization.	8
Module –II Design of Brakes in Vehicle – trailer combinations: in light trailers, overrun brakes, centre axle trailer, chassis trailer.	8
Module – III Brake design Analysis: Brake and shoe Factors in different types of brakes, estimation by analytical methods, Thermal Effects in Friction Brakes (Thermal analysis and Heat Dissipation).	8
Module - IV Electronic brake systems: Features of Anti-lock brake system (ABS), Traction Control System, Electronic Stability Control, Adaptive Cruise Control, trailer Sway Control, Electronic Brake force Distribution (EBD).	8
Module –V Brake Noise: Sources, its analysis (using analytical approaches) and control, system response, modal analysis and variability in brake noise.	8

Text Books

1. Day A, Braking of Road Vehicles, Butterworth Heinmann (Elsevier).
2. Julian Happian-Smith, Introduction to Modern Vehicle Design, Butterworth Heinemann.

Reference Books

1. UweDausend, Bert J. Breuer, Advanced Brake Technology, SAE International.
2. Ronald W. Walker, High-Performance Brake Systems, Car Tech Incoporated.

Gaps in the syllabus (to meet Industry/Profession requirements)
Finite Element approach to design brake systems

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

Topics beyond syllabus/Advanced topics/Design
Regenerative and Autonomous Emergency Braking (AEB)

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

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 Assessment	5
End Semester Examination	50

Assessment Compoents	CO1	CO2	CO3	CO4	
Mid Sem Examination Marks					
End Sem Examination Marks					
Assignment					

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

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	CD8
CD9	Simulation			

COURSE INFORMATION SHEET

Course code: ME 383(Program Elective-4)
Course title: Automation in Manufacturing
Credits: 3 **(**L: 3,T:0,P:0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To learn how to apply the principles of mechatronics and automation for the development of productive and efficient manufacturing systems
B.	To recognize the meaning of Machine tool automation, and To develop skill in part programming
C.	Acquire knowledge about controllers and Sensor
D.	To acquire knowledge about Machining Lines Automation, Assembly automation
E.	Apply concepts for the planning, design, analysis and implementation of flexible manufacturing systems ,CM and CIM

Course Outcomes

After the completion of this course, students will be:

1.	Know the various aspects of automation in manufacturing.
2.	Recognize the fundamentals of Machine Tool Automation and part programming
3.	Knowledge about various control systems andProduct Automation
4.	Machining Lines Automation and Assembly automation
5.	Implement FMS, CM and CIM concept in a manufacturing environment and product development through automation.

Syllabus

Module	Hours
Module -I Manufacturing automation, components and types of automation, CAD,CAM, Computer Control of Manufacturing Systems. Mechatronics in Manufacturing Systems. Modeling of Mechanical Systems for Mechatronics Applications, Automation Strategies in manufacturing industries.	8
Module –II Basic Principle, classification and structure of NC systems, NC-coordinate system, Constructional features and feedback devices for CNC machine tools, part programming (Fanuc), DNC and adaptive control.	8
Module – III Sensors, Actuators,Control System in manufacturing: Mechanical & Electric mechanical system, Pneumatics and hydraulics and servo control in CNC machine tools, Illustrative examples and case studies.	8
Module - IV Assembly Automation: Automatic Assembly Transfer Systems, Transfer mechanism, buffer storage and control functions for transfer devices, feeding mechanism definition and concept, AGV, AS/RS.	8
Module –V Flexible automation: Flexible manufacturing systems: concept, need, structure & operation, objectives and benefits. Quantitative Analysis of Flexible Manufacturing Systems, Quantitative Analysis in Cellular Manufacturing,CIM.	8

Text Books:

1. Automation, Production System, and CIM,M.P. Groover
2. CNCMachines,P. Radhakrishnan
3. System approach to Computer Integrated Design and Manufacturing: Nanua Singh

References Books:

1. Numerical Control of Machine Tools, Y. Koren
2. Manufacturing Technology II, P.N. Rao
3. Performance Modeling of Automated Manufacturing System : N. Viswannadham& Y Narhari

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

DESIGN AND ANALYSIS OF CNC SYSTEMS

POs met through Gaps in the Syllabus

Topics beyond syllabus/Advanced topics/Design

Key Technologies for Future Intelligent Machine Tool

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
First Quiz	10
Mid Semester Examination	25
Second Quiz	10
Teacher's Assessment	5
End Semester Examination	50

Assessment Compoents	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

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

COURSE INFORMATION SHEET

Course code: ME 385 (Program Elective-4)
Course title: Theory of Elasticity
Credits: 3 **(**L: 3, T:0, P: 0)
Class schedule per week: 3
Class: B.Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A.	To present the fundamentals of the theory of elasticity.
B.	To lay the groundwork for subsequent studies in the fields of stress, strain, and various mathematical methods.
C.	To develop an intuitive understanding of various mathematical techniques to solve the problems.
D.	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:

1.	To understand the fundamentals of Stresses, Strains, and Energy Equations.
2.	To develop an intuitive understanding of the theory of elasticity.
3.	To apply the conceptswith suitable assumptions on mechanical members using boundary conditions.
4.	To evaluate the stresses, strains in real-world examples related to mechanical engineering
5.	To analyse the simple mechanical elements.

Syllabus

Module	Hours
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.	8

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.

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

	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

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

AssessmentComponents	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 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	-	-	1	2	-	1	1	-	-	-
CO2	3	3	2	-	3	2	1	1	2	1	-	-
CO3	3	3	3	2	3	2	1	1	2	1	1	-
CO4	3	3	2	3	3	3	1	1	2	-	-	1
CO5	3	3	3	3	3	3	1	2	2	2	1	1

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: ME387(Program Elective-4)
Course title: Advanced Heat Transfer
Credits: 3 **(**L: 3, T:0, P: 0)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

Course Objectives

This course enables the students:

A	Provide a fundamental understanding of analytic and numerical methods used to solve heat transfer problems
B	Understand the usage of tables and charts to determine properties for problem solutions
C	To develop the skill to develop models of real processes and systems and draw conclusions
D	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:

1	Apply the concepts to solve complex conduction problems
2	Analyze the different fin shapes.
3	Compare the correlations for different Convection flow problems.
4	Examine the boiling and condensation parameters.
5	Analyze the mass transfer equations.

Syllabus

Module	Hours
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	8
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.	8
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.	8

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
Teacher's Assessment	5
End Semester Examination	50

Assessment Compoents	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 onto Program Outcomes

Course Outcome #	Program Outcomes											
	a	b	c	d	e	f	g	h	i	j	k	l
1	3	3	3	3	2	1	1		2			3
2	3	3	3	3	2	1	1		2			3
3	3	3	3	3	2	1	1		2			3
4	3	3	3	3	2	1	1		2			3
5	3	3	3	3	2	1	1		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:	ME 391(OPEN ELECTIVE - II)
Course Title:	Elements of Nuclear and Diesel Power plants
Credits: 03	L: 3,T: 0,P: 0
Class schedule per week:	3
Class:	B. Tech**.**
Semester / Level:	Level 2
Branch:	Mechanical Engineering

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:

1. Understand the applications of nuclear energy and manufacturing of nuclear fuel.
2. Develop an understanding of power generation through nuclear energy.
3. Select the safety features in the nuclear power plants by analyzing past nuclear accidents.
4. Develop an understanding of power generation through diesel engine power plants.
5. Analyze various performance parameters of diesel engine power plants.

Syllabus

Module	Hours
Module: 1 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, DhanpatraiPublication (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 Assessment	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 306
Course title:	Robotics and Automation Lab.
Credits: 1.5	**(**L:0, T:0, P:3)
Class schedule per week:	3
Class:	B. Tech
Semester / Level:	6
Branch:	Mechanical Engineering

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 RoboAnalyzer.
3. End-effector 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/SimMechanics for perform mechanical simulation.
12. Create and simulate a 2R robot in MATLAB/SimMechanics and control its position.

COURSE INFORMATION SHEET

Course code: ME 310
Course title: Automobile Engineering Lab
Credits: 1.5 **(**L: 0, T:0, P:3)
Class schedule per week: 3
Class: B. Tech
Semester / Level: 6
Branch: Mechanical Engineering

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.