Department of Mechanical Engineering

SCHEME & SYLLABUS

B.Tech. Mechanical Engineering

2025-26

Shri G S Institute of Technology & Science Indore

[Govt. Aided Autonomous Institute Estd. In 1952]

Vision and Mission of Institute

Vision:

A front-line institute in science and technology making significant contributions to Human resource development envisaging dynamic needs of the society.

Mission:

To generate experts in science and technology akin to society for its accelerated Socio-economic growth in professional and challenging environment imparting Human values.

Vision and Mission of Department

Vision:

To be recognized globally for outstanding education and research leading to develop well qualified engineers who are innovative, entrepreneurial and successful in advanced fields of Mechanical engineering and research.

Mission:

M1- To provide state of the art education to students of Mechanical Engineering.

M2- To enable the students to cater the needs of society and industries.

M3- To excel in research and development activities in Mechanical Engineering.

Program Educational Objective (PEOs)

PEO1: To develops students for applying Mechanical Engineering knowledge and problem solving skill in their professional careers.

PEO2: To create interest in lifelong learning by pursuing higher education in specific field.

PEO3: The mechanical Engineering graduates shall have high moral values/ ethics to build an efficient team with appropriate soft skill capabilities.

Department of Mechanical Engineering (2025-26)

Program Outcomes

Graduates Engineers will be able to

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

(ii) Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

(iii) 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.

(iv) 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 for complex problems.

(v) 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.

(vi) 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.

(vii) 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.

(viii) Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

(ix) Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

(x) 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.

(xi) 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.

(xii) Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes

Graduates Engineers will be able to

PSO1:Apply mechanical design engineering, thermal engineering and interdisciplinary knowledge for analyzing, designing, and manufacturing products to address the need of society.

PSO2: Implement state of the art knowledge and technology in order to fulfill current industrial requirement.

I B.TECH. (4YDC) MECHANICAL ENGINEERING

Semester :A (1st Year – Common to all Branches)

Semester : I

Sr. No.	Subject Code	Subject Category	Subject	Credits			Hours/Week			Theory		Practical		Total Credits
				L	T	P	L	T	P	Th.	CW	Pr.	SW	
1	MA10021	BSC	Mathematics for Engineers	2	1	0	2	1	0	70	30	0	0	3
2	HU10181	HSMC	Understanding Bharat	0	2	1	0	2	2	-	-	60	40	3
3	CO10007	ESC	Fundamentals of Information Technology & Artificial Intelligence	2	1	2	2	1	4	70	30	60	40	5
4	ME10008	ESC	Overview of Mechanical Engineering and Graphics	2	0	2	2	0	4	70	30	60	40	4
5	PH10009	BSC	Applied Physics	2	0	1	2	0	2	70	30	60	40	3
6	CH10010	BSC	Chemistry for Engineers	1	0	1	1	0	2	70	30	60	40	2
			Total	**9**	**4**	**7**	**9**	**4**	**14**	**350**	**150**	**300**	**200**	**20**

Semester : B (1st Year – Common to all Branches)

Semester : II

Sr. No.	Subject Code	Subject Category	Subject	Credits			Hours/Week			Theory		Practical		Total Credits
				L	T	P	L	T	P	Th.	CW	Pr.	SW	
1	MA10509	BSC	Mathematics for Data Science	2	1	0	2	1	0	70	30	-	-	3
2	EE10510	ESC	Fundamentals of Electrical & Electronics Engineering	2	1	1	2	1	2	70	30	60	40	4
3	HU10512	HSMC	Language for Engineers	1	1	1	1	1	2	70	30	60	40	3
4	CE10513	ESC	Fundamentals of Civil Engineering and Applied Mechanics	2	1	1	2	1	2	70	30	60	40	4
5	PY10514	BSC	Biology for Engineers	2	0	1	2	0	2	70	30	60	40	3
6	IP10584	ESC	Design Thinking and Manufacturing Practices	0	1	2	0	1	4	-	-	60	40	3
			Total-	**9**	**5**	**6**	**9**	**5**	**12**	**350**	**150**	**300**	**200**	**20**

II B.TECH. (4YDC) MECHANICAL ENGINEERING

Semester: III

Sr. No.	Subject Category	Subject Code	Subject	Hours per Week			Credit		Maximum Marks				Total
				L	T	P	Th	Pr	Th.	CW	SW	Pr.	
1	PCC	ME26021	Fluid Mechanics	3	-	-	3	-	70	30	-	-	**100**
2	PCC	ME26012	Strength of Materials	3	-	-	3	-	70	30	-	-	**100**
3	BSC	MA26014	Mathematics -III	3	-	-	4	-	70	30	-	-	**100**
4	PCC	ME26018	Material Science	3	-	-	3	-	70	30	-	-	**100**
5	PCC	ME26015	Engineering Thermodynamics	3	-	-	3	-	70	30	-	-	**100**
6	LC	ME26401	Fluid Mechanics Lab	-	-	2	-	1	-	-	40	60	**100**
7	LC	ME26402	Strength of Material Lab	-	-	2	-	1	-	-	40	60	**100**
8	LC	ME26403	Material Science Lab	-	-	2	-	1	-	-	40	60	**100**
9	LC	ME26404	Engineering Thermodynamics Lab	-	-	2	-	1	-	-	40	60	**100**
10	HSMC	HU26481	Values, Humanity and Professional Ethics	-	2	-	2	-	-	100	-	-	**100**
11	PCC	ME26405	Skill Lab-1, Modelling/ Simulation Software	-	-	2	-	1	-	-	40	60	**100**
12	MC	ME26482	Design Thinking	-	1	-	1	-	-	30	-	-	**30**
13	MC	MEM2002	Environmental Science *	2	-	-	-	-	-	50	-	-	**50**
*** Non Credit Mandatory Subject.**			**Total**	**17**	**3**	**10**	**18**	**5**	**350**	**330**	**200**	**300**	**1080**

Semester: IV

Sr. No.	Subject Category	Subject Code	Subject	Hours per Week			Credit		Maximum Marks				Total
				L	T	P	Th	Pr	Th.	CW	SW	Pr.	
1	PCC	ME26501	Machine Design – I	3	-	-	3	-	70	30	-	-	**100**
2	PCC	ME26512	Kinematics & Dynamics of Machine	3	1	-	4	-	70	30	-	-	**100**
3	PCC	ME26504	Measurement & Control Systems	3	-	-	3	-	70	30	-	-	**100**
4	PCC	IP26513	Manufacturing Processes	3	-	-	3	-	70	30	-	-	**100**
5	HSMC	HU26507	Economics for Engineers	3	-	-	3	-	70	30	-	-	**100**
6	LC	ME26802	Machine Design - I lab	-	-	2	-	1	-	-	40	60	**100**
7	LC	ME26803	Kinematics & Dynamics of Machine Lab	-	-	2	-	1	-	-	40	60	**100**
8	LC	ME26804	Measurement & Control System Lab	-	-	2	-	1	-	-	40	60	**100**
9	LC	ME26805	Manufacturing Processes Lab	-	-	2	-	1	-	-	40	60	**100**
10	PCC	ME26807	Skill Lab-2 Idea Lab	-	-	2	-	1	-	-	40	60	**100**
11	MC	HUM2052	Essence of Indian Knowledge Tradition*	2	-	-	-	-	-	50	-	-	**50**
*** Non Credit Mandatory Subject.**			**Total**	**17**	**1**	**10**	**16**	**5**	**350**	**180**	**200**	**300**	**1050**

Internship of 4-6 weeks between semester IV & semester V

III B.TECH. (4YDC) MECHANICAL ENGINEERING

Semester: V

Sr. No.	Subject Category	Subject Code	Subject	Hours per Week			Credit		Maximum Marks				Total
				L	T	P	Th	Pr	Th.	CW	SW	Pr.	
1	PCC	ME36009	Computer Aided Design	3	-	-	3	-	70	30	-	-	**100**
2	PCC	ME36010	Mechatronics & Automation	3	-	-	3	-	70	30	-	-	**100**
3	PCC	ME36012	Heat Transfer	3	-	-	3	-	70	30	-	-	**100**
4	PCC	ME36007	Steam and Gas Power System	3	-	-	3	-	70	30	-	-	**100**
5	PCC	IP36052	Manufacturing Processes-II	3	-	-	3	-	70	30	-	-	**100**
6	LC	ME36401	Computer Aided Design Lab	-	-	2	-	1			40	60	**100**
7	LC	ME36402	Mechatronics & Automation lab	-	-	2	-	1			40	60	**100**
8	LC	ME36403	Heat Transfer lab	-	-	2	-	1			40	60	**100**
9	LC	ME36404	Manufacturing Processes-II lab	-	-	2	-	1			40	60	**100**
10	PROJ	ME36481	Evaluation of Industrial Training/ Internship	-	-	4	-	2	-	-	100	-	**100**
11	MC	MEM3002	Environmental Science*	2	-	-	-	-	-	50	-	-	**50**
*** Non Credit Mandatory Subject.**			**Total**	**17**	**-**	**12**	**15**	**6**	**350**	**200**	**260**	**240**	**1050**

Semester: VI

Sr. No.	Subject Category	Subject Code	Subject	Hours per Week			Credit		Maximum Marks				Total
				L	T	P	Th	Pr	Th.	CW	SW	Pr.	
1	PCC	ME36511	Refrigeration and Air conditioning	3	–	-	3	-	70	30	-	-	**100**
2	PCC	ME36513	Machine Design – II	3	-	-	3	-	70	30	-	-	**100**
3	PCC	ME36516	Fluid Machinery	3	-	-	3	-	70	30	-	-	**100**
4	PEC	ME36519	Internal Combustion Engines	3	-	-	3	-	70	30	-	-	**100**
5	HSMC	IP36504	Industrial Engineering and Production Management	3	-	-	3	-	70	30	-	-	**100**
6	LC	MExxxx	Refrigeration and Air conditioning Lab	-	-	2	-	1	-	-	40	60	**100**
7	LC	MExxxx	Machine Design – II Lab	-	-	4	-	2	-	-	40	60	**100**
8	LC	MExxxx	Fluid Machinery Lab	-	-	2	-	1	-	-	40	60	**100**
9	LC	MExxxx	Internal Combustion Engines Lab	-	-	2	-	1	-	-	40	60	**100**
10	PROJ	ME36581	Minor Project	-	-	4	-	2	-	-	100	-	**100**
*** Non Credit Mandatory Subject.**			**Total**	**15**	**0**	**14**	**15**	**7**	**350**	**150**	**260**	**240**	**1000**

Internship of 4-6weeks between semester VI & semester VII.

IV B.TECH. (4YDC) MECHANICAL ENGINEERING

Semester: VII													
Sr. No.	Subject Category	Subject Code	Subject	Hours per Week			Credit		Maximum Marks				Total
				L	T	P	Th	Pr	Th.	CW	SW	Pr.	
1	PEC	ME46018	Automobile Engineering	3	-	2	3	1	70	30	40	60	**200**
2	PEC	ME46051	Vibration and Noise Control	3	-	2	3	1	70	30	40	60	**200**
3	PEC	ME46020	Computer Aided Design	3	-	2	3	1	70	30	40	60	**200**
4	PEC		Elective-I	3	-	-	3	-	70	30	-	-	**100**
5	PEC		Elective-II	3	-	-	3	-	70	30	-	-	**100**
6	PROJ	ME46481	Industrial Training	-	-	-	-	2	-	-	100	-	**100**
7	PROJ	ME46498	Major Project Phase-I (AB Group)	-	-	6	-	3	-	-	40	60	**100**
8	PROJ	ME46998	Major Project Phase-II (BA Group)	-	-	8	-	4	-	-	60	90	**150**
Total			**For AB Group**	**15**	**0**	**12**	**15**	**8**	**350**	**150**	**260**	**240**	**1000**
			For BA Group	**15**	**0**	**14**	**15**	**9**	**350**	**150**	**280**	**270**	**1050**

Elective-I			SEMESTER - VII
S.No	Subject Category	Subject Code	Subject
1		ME46218	Mechatronics & Automation
2		ME46219	Advanced Machine Design
3		ME46220	Industrial Tribology and Maintenance
4		ME	Design of Air Conditioning Equipment

Elective-II			SEMESTER - VII
S.No	Subject Category	Subject Code	Subject
1		IP46316	Operational Research
2		ME46315	Hydraulic, Pneumatic & Fluid Control
3			Bio- Mechanics
4		ME463**	Manufacturing Automation & CAM
5		ME46327	Data Science and Machine Learning
6		ME46314	Power Plant and Energy Management

IV B.TECH. (4YDC) MECHANICAL ENGINEERING

Semester: VIII														
Sr. No.	Subject Category	Subject Code	Subject	Hours per Week			Credit		Maximum Marks				Total
				L	T	P	Th	Pr	Th.	CW	SW	Pr.	
1	PEC		Elective III	3	-	-	3	-	70	30	-	-	**100**
2	PEC		Elective IV	3	-	-	3	-	70	30	-	-	**100**
3	PROJ	ME46882	Industrial Training/Internship	-	-	-	-	4	-	-	100	-	**100**
4	PROJ	ME46998	Major Project Phase- II **(AB Group)**	-	-	8	-	4	-	-	60	90	**150**
5	PROJ	ME46498	Major Project Phase-I **(BA Group)**	-	-	6	-	3	-	-	40	60	**100**
Total			**For AB Group**	**6**	**0**	**8**	**6**	**8**	**140**	**60**	**160**	**90**	**450**
			For BA Group	**6**	**0**	**6**	**6**	**7**	**140**	**60**	**140**	**60**	**400**

Elective-III			SEMESTER - VIII
S.No	Subject Category	Subject Code	Subject
1		ME46667	Composite Materials
2		ME46668	Renewable Energy Sources
3		IP46669	Industrial Inspections & Quality Control
4		ME46670	Finite Element Methods
5		ME46672	Robotics
6		ME46673	Rotor Dynamics
7		ME46671	Artificial Inteligence

Elective-IV			SEMESTER - VIII
S.No	Subject Category	Subject Code	Subject
1		ME46708	Gas Dynamics & Fluid Control
2		ME46705	Engineering Optimization
3		ME46704	Design of Thermal Systems
4		ME46707	Computational Fluid Dynamics
5		ME46706	3D Printing and Design

B. Tech. 1st Year (Common to all Branches of Engineering and Technology)

ME10008: Overview of Mechanical Engineering and Graphics

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
ME10008	Overview of Mechanical Engineering and Graphics	L	T	P	T	P	Total	Th.	CW	Pr.	SW	200
		2	-	4	2	2	4	70	30	60	40	

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

CO 1 Explain the types of materials and their properties for engineering applications.

CO 2 Analyze the fundamentals of links and pair for different mechanism of machines.

CO 3 Enhancement of fundamental knowledge of a variety of practical fluid flow.

CO 4 Analyze the efficiency of I.C. Engine and working of automobile components

CO 5 Distinguish standard drawing conventions, apply the concept of orthographic projection of line, plane, solid and section of solid.

ARTICULATION MATRIX

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

COURSE CONTENTS

Unit 1 **Engineering Materials and Properties:** Introduction, properties, normal tensile shear and thermal stress, stress-strain diagrams for ductile and brittle materials, elastic constants and relationship between elastic constant.

Unit 2 **Mechanism and Machines:** Types of motion, links, kinematic pair, types of joints, degree of freedom, classification of kinematic pairs, kinematic chain, linkage, mechanism and structure, inversions of basic mechanisms (four- bar chain, single slider and double slider crank mechanisms) and their applications. Hook's joint, Types of gears and gear trains.

Unit 3 **Fluid Kinematics:** Basic concepts and properties of fluids, manometry, and fluid statics. Fluid kinematics: Lagrangian & Eulerian approach, types of fluid flow, local and connective acceleration, continuity equation, Bernoulli's equation and applications.

Unit 4 **Introduction of IC Engines and Automobile:** Classification of IC engines, terminology used in I C engine;

Otto & Diesel Cycle; their air standard efficiencies. Principal parts of IC engine, their functions and working. Introduction of electrical vehicle, components of automobile and their function like brakes, clutch, gear etc.

Unit 5 **Engineering Graphics:** Principles of Engineering Graphics and their significance, usage of Drawing instruments, lines, lettering and dimensioning, Introduction of Projection of Line, Plane, Solid and Section of Solid, overview of orthographic and isometric projection.

ASSESSMENT

The following methods shall be adopted for the assessment of this course;

1. Theory Examination (70 marks) on the basis of end term theory paper examination (from Units 1 to 5)

2. Class Work (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

3. Sessional Work (40 marks) on the basis of assignments, internal viva and attendance. Student are require to submit at least five imperial drawing sheets/ computer aided drawing print.

4. Practical examination (60 marks) on the basis of evaluating practical knowledge, Quiz and viva voce.

List of Experiments:-

Sheet 1:- Orthographic Projection

Sheet 2:- Scales and Projection of Line

Sheet 3:- Projection of Planes

Sheet 4:- Projection and section of Solids

Sheet 5:- Isometric Projection

TEXT BOOKS

1. N.D. Bhatt and V.M. Panchal, Engineering Drawing Plane and Solid Geometry, Charotar Publishing House
2. Agrawal Basant and Agrawal C.M. (2018), Engineering Drawing, McGraw Hill Publishing.

B. Tech. 2nd Year (Semester - 3)

ME26021: Fluid Mechanics

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME26021	Fluid Mechanics	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: **Mathematics – I, Physics, Mathematics – II**

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

CO 1 Determine the fluid pressure and use various devices for measuring fluid pressure. Calculate hydrostatic force and use of law of conservation mass to fluid flow

CO 2 Apply fluid flow patterns and describe continuity equation

CO 3 To analyze a variety of practical fluid flow and measuring devices and utilize Fluid Mechanics principles in design. Apply Bernoulli's equation to fluid flow problems and boundary layer theory to determine lift and drag forces on a submerged body

CO 4 Apply appropriate equations and principles to analyze pipe flow problems

CO 5 Apply boundary layer concepts

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

COURSE CONTENTS

Unit 1 **Introduction**: Fluids and the continuum, Fluid properties, Surface tension, Bulk modulus and thermodynamic properties, Newton's law of viscosity and its coefficients. Newtonian & non- newtonian Fluids.

Hydrostatics and Buoyancy: Pascal's law, Hydrostatics law, Force on immersed plane and curved surfaces, center of pressure, laws of buoyancy, Meta center and Metacentric height, Stability of floating bodies.

Unit 2 **Fluid Kinematics** : Langragian & Eulerian Method, Description of Fluid Flow, Stream Line, Path line and Streak Line, Types of Flow and Types of motion, local and connective acceleration, continuity equation., Circulation, Velocity potential, Stream function, Laplace equation, Flow nets.

Compressible Flow: Introduction, Mach Number, Isentropic Flow, Stagnation Properties.

Unit 3 **Fluid Dynamics**: System and control volume, Reynold transport theorem, Euler's equation, Bernoulli's equation, Momentum and Moment of Momentum Equation. Their application,

Forces on Immersed Bodies: Lift and Drag, Stream Lined and Bluff bodies, Flow around Circular Cylinders and Aerofoils.

Unit 4 **Viscous Flow**: Preliminary Concepts, governing equations, Viscous flow through parallel plates and pipes

Flow Through Pipes: Reynold Number, Laminar and Turbulent flow, Navier Stoke's equation, Pressure gradient, Head loss in Turbulent Flow (Darcey's Equation), Friction factor, Minor losses, Hydraulic and Energy gradient, Pipe networks.

Unit 5 **Boundary Layer Theory**. Von Karman Momentum Equation, Laminar Boundary Layer, Turbulent Boundary Layer, Boundary Layer Separation.

Introduction to Open Channel Flow

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Shames, Fluid Mechanics, Tata McGraw-Hill, 1962

2 Massey, B.S., Mechanics of Fluids, Routledge Publication, 2006

3 Kumar D.S., Fluid Mechanics, S K Kataria Publication, 2003

B. Tech. 2nd Year (Semester - 3)

ME 26012 -Strength of Materials

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME26012	Strength of Materials	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Fundamentals of Civil Engineering & Applied Mechanics,

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

CO 1 Distinguish elastic constants, types of stresses and mechanical properties of materials

CO 2 Apply shear force and bending moment diagrams to analyze the resistance offered by the beam and able to solve practical problems in real world scenario

CO 3 Evaluate principal stresses and strains analytically and graphically

CO 4 Determine the deflection and curvature in beams with different supports and buckling of column.

CO 5 Analyze and design thin cylinders and energy stored due to deformation

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	–	–	–	–	–	2	2	2	–	1	3	1
CO2	3	3	–	–	–	–	–	2	2	2	–	1	3	1
CO3	3	3	–	–	–	–	–	2	2	2	–	1	3	1
CO4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CO5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Average	**3**	**3**	–	–	–	–	–	**2**	**2**	**2**	–	**1**	**3**	**1**

COURSE CONTENTS

Unit 1 **Stress and Strain:** Tension, compression and shear, Complementary shear stresses. Elastic constants and their relationship. Thermal stresses. Statically indeterminate system, Shear stress in a circular member due to Torsion. Mechanical Testing of materials: Tensile, Compression, Shear, Torsion, Fatigue, Impact, Hardness Tests

Unit 2 **Bending Moment and Shear Forces:** Diagrams of Shear Forces and Bending Moment for determinate beams. Relation between loads, shearing forces and bending moments.

Bending Stress: Theory of bending, bending and shear stresses in beams and their distributions, modulus of section and modulus of rupture, beams of varying cross section, beam of uniform strength. Introduction to composite beams

Unit 3 Stress on oblique section of a bar subjected to axial stress, compound stress. Principal stress and strain, plane stress and plane strain and their Mohr's Circle. Combined direct and bending stress.

Unit 4 **Deflection:** Uniform curvature, Relation between curvature and deflection, cantilevers and simply supported beams of varying cross section. Macaulay's method, Moment area method, deflection due to shear. Propped

beam. Parts subjected to column action with and without lateral loading.

Unit 5 **Elastic strain energy :** Resilience, Proof Resilience, Material under tension, Static, Sudden and Falling loads, Strain Energy due to direct shear, bending and torsion, Castigliano's theorem.

Thin walled pressure vessels- stresses, strain and deformation due to internal fluid pressure.

ASSESSMENT

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1. Ramamrutham S., Strength of Materials, Dhanpat Rai, 2003
2. Ryder, G.H., Strength of Materials, Macmillan India, 2002

REFERENCE BOOKS

1. Popov, E.P., Mechanics of Solids, Prentice-Hall (India), 2001
2. Beer &Johnston, Mechanics of Material. Tata McGraw-Hill, 2004
3. Ratan, S.S., Strength of Materials, Tata McGraw-Hill, 2011

B. Tech. 2nd Year (Semester - 3)

MA26014 - Mathematics-III

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
MA26014	Mathematics-III	3	1	-	4	-	4	70	30	-	-	100

PRE-REQUISITES: Nil

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

CO 1 To identify real phenomena as models of partial derivative equations. Solve real problems by identifying them appropriately from the perspective of partial derivative equations

CO 2 To demonstrate their understanding of the Dirichlet conditions by using them to evaluate infinite series. Calculate the Fourier transform of elementary functions from the definition.

CO 3 To select and combine the necessary Laplace transform techniques to solve second-order ordinary differential equations involving the Dirac delta (or unit impulse).

CO 4 Apply the concept of approximation methods to solve differentiation and integration problems.

CO 5 To define principal concepts about sampling. Explains the advantages of sampling. Lists the stages of sampling process. Categorizes and defines the sampling methods.

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

COURSE CONTENTS

Unit 1 **Partial Differential Equations:** Formation of partial differential equations, partial differential equations of first order and first degree i.e., Pp + Qq = R, Linear homogeneous partial differential equation of nth order with constant coefficient, separation of variables, Application to simple problems of heat, Wave and Laplace equations.

Unit 2 **Fourier Series and Fourier Transformation :** Expansion of functions in a Fourier series, Half range series, Sine and Cosine series and change of interval. Fourier Integral. Fourier transforms: sine and cosine transforms and their application to solution of linear Partial Differential Equations.

Unit 3 **Laplace Transform :** Definition of Laplace Transform, Laplace Transform of elementary and periodic functions, properties of Laplace Transform including Laplace Transform of derivatives, Inverse Laplace Transform

and its properties, Convolution Theorem, Application of Laplace Transform to ordinary differential equations with constant and variable coefficients.

Unit 4 **Calculus of Finite Differences :** Difference table, Operators E and Δ, Newton's forward and backward interpolation formula for equal intervals, Lagrange's interpolation formula and divided difference method for unequal intervals, Numerical Differentiation and Integration (Trapezoidal rule, Simpson's 1/3 rule ,Simpson's 3/8 rule and Weddle's rule).

Unit 5 Statistics: Brief idea of Sampling, t, F and $\chi 2$ distributions and their applications, ANOVA, Statistical Quality Control (SQC), Control Charts, Sampling inspection, Acceptance sampling, Producer's and Consumer's risk, O. C. curve, Taguchi method.

ASSESSMENT

1 Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc. (30%)

2 Theory Examination (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS RECOMMENDED

1 Ramana B V, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2006.

2 Das H. K, Higher Engineering Mathematics, S. Chand New Delhi, 2011.

REFERENCE BOOKS

1 Kreyszig Erwin, Advanced Engineering Mathematics, 8th edition, John Willy and sons Publications, 1999.

2 Jain, R.K. and Iyengar S.K, Advanced Engineering Mathematics, Narosa Publishing House, New-Delhi, 2006.

3 Vedamurthy V.N. & Iyengar S.N., Numerical Methods, Vikas Publishing, 2008.

B. Tech. 2nd Year (Semester - 3)

ME26018 Materials Science

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME26018	Materials Science	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Physics , Chemistry & Mathematics

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

CO 1 Description of various types of crystal structures and their relation with material properties

CO 2 Mechanical properties of materials and role of individual material in varying the properties.

CO 3 Various phases of materials, phase diagrams role of phases on properties of materials through iron carbon equilibrium diagram and Time Temp Transformation (TTT) diagram and effect of heat treatment.

CO 4 Various ferrous and non ferrous materials used and powder metallurgy technique.

CO 5 Testing of materials through non destructive means. Knowing fundamental of composite materials including their types, applications and constituents.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	3	2	-	-	3	1	2	-	2	1	1
CO2	3	3	2	3	-	-	-	3	2	2	-	2	3	2
CO3	3	3	3	3	2	3	-	3	2	2	-	2	2	3
CO4	3	3	2	3	-	1	-	1	1	1	-	2	1	1
CO5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Average	3	3	2	3	2	2	–	2.5	1.5	1.75	–	2	1.75	1.75

COURSE CONTENTS

Unit 1 Description of crystal structure, seven crystal systems. Bravais lattice. Symmetry and properties of simple crystal structure. Miller Indices. Direction and Plane Indices.

Schottky and Frenkel defects. Dislocation, Edge dislocation, Screw Dislocations, Slip Planes. Stress Fields of Dislocations. Grain Boundaries, Dislocation densities, Diffusion in solid, Fick's Law,

Unit 2 Mechanical Properties and Mechanical Working of Metals: Various mechanical properties like Strength, Stiffness, elasticity, plasticity, ductility, hardness, impact strength, malleability, brittleness, toughness, resilience, Creep and stress rupture.

Alloying: characteristics of alloying elements C,Mn,Cr,Ni, Ph, S, Mo, Pb,Si, etc. The effects of alloying elements on mechanical behavior of steel Cu, Al etc.

Unit 3 **Equilibrium Diagram:** Allotropy structure of alloys, Lever rule, phase rule, various types of phase diagrams. Cooling curves, Iron carbide equilibrium diagram. Strengthening mechanisms, TTT diagram, Heat treatment procedure for steel, Hardening, Hardenability, Defects in heat treated Parts.

Unit 4 **Ferrous and Non-ferrous metals and alloys:** Properties and application of various steels and cast irons. Effect of impurities in ferrous metal. High speed steels, Stainless steel, Other steels. Properties and application of aluminium and its principle alloys, Copper and its principle alloys.

Powder Metallurgy: Manufacturing of metal powders. Sintering and secondary operations. Projects of finished parts. Design considerations and applications.

Unit 5 **Non-destructive Testing:** Dye penetration, Ultrasonic, Magnetic, Eddy Current, Radiography NDT tests. A brief discussion of the properties and applications of the rare metals like Titanium, Uranium, Beryllium and Zirconium.

Composite material: properties, applications, types and their's characteristics.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Abdul Mubeen, Material Science, Galgotia Publications, 2003

2 Raghvan V., Material Science and Engineering, PHI Learning Pvt. Lt, 2006

REFERENCE BOOKS

3 Cedric W. Richards, Engineering Material Science, Literary Licensing, LLC, 2012

4 Chalmers, Physical Metallurgy, Chapman & Hall, London, 1969

5 John Walff, Structure and Properties of Material, J Wiley Eastern University Ed., 1986

B. Tech. 2nd Year (Semester - 3)

ME26015 Engineering Thermodynamics

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME26015	Engineering Thermodynamics	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Physics , Mathematics.

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

CO 1 Apply first and second laws on thermodynamics systems and explain their applications.

CO 2 Evaluate entropy changes in a wide range of processes and determine the available and unavailable energy. Analysis for the performance of different air standard cycles.

CO 3 Evaluate properties of pure substances and gas mixtures. Demonstrate various types of high pressure boilers and their relative merits and demerits.

CO 4 Performance evaluation of boilers. Apply the fundamentals of thermodynamics for analysis of boiler Performance. Procedure to draw Heat Balance Sheet.

CO 5 Classify the concept of draught. Evaluate draught created by chimney. Demonstrate reactive system of combustion process for different fuels. Analyze dry flue gases.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	–	–	1	2	–		2	–	–	2	–
CO2	3	3	2	3	–	2	2	–	3	2	–	–	2	1
CO3	3	3	3	2	–		1	–	2	2	–	–	2	1
CO4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CO5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Average	**3**	**3**	**3**	**2.5**	**–**	**1.5**	**2**	**–**	**2.5**	**2**	**–**	**–**	**2**	**1**

COURSE CONTENTS

Unit 1 **First Law of thermodynamics:** Work and Heat Transfer, First Law of thermodynamics applied to a closed system, applied to Steady and variable Flow Processes.

Second Law of Thermodynamics: Limitations of First law of thermodynamics, Heat Engine and Heat Pump, Kelvin Plank and Clausius statements and their equivalence, Reversibility and Irreversibility, Causes of irreversibility, Carnot's Theorem.

Unit 2 **Entropy & Availability:** Clausius theorem, Clausius inequality, entropy principle, calculation of entropy, changes for various processes, principle of increase of entropy, Available and unavailable energy, Maximum Work in a Reversible Cycle.

Air Standard Cycles: Otto, Diesel, Dual and Brayton Cycles; Air Standard Efficiencies; Mean Effective

Pressure. Condition for maximum work output from these cycles. Comparison between Otto, Diesel and Dual cycles for different conditions.

Unit 3 **Properties of Steam:** P-v diagram, p-T diagram, p-v-T surface, T-s diagram, Mollier diagram, Types of steam, dryness fraction, calculation of Enthalpy, specific volume, internal Energy and entropy of steam, Heating cooling and expansion of steam.

High Pressure Boilers: Fire tube and water tube boilers, Advantages of high pressure boilers, Construction and working of Lamont Boiler, Benson Boiler, Loeffler Boiler, Schmidt-Hartmann Boiler and Velox boilers, their Relative Merits and Demerits.

Unit 4 **Boiler Performance:** Evaporation, Equivalent Evaporation, factor of Evaporation. Boiler efficiency. Factors affecting Performance of Boilers. Boiler Trials. Heat Balance Sheet.

Unit 5 **Draught:** Types of draught. Natural Draught and artificial Draught viz. Mechanical draught (Forced, Induced and Balanced) and Steam Jet Draught. Height of the chimney required for Natural Draught. Condition for maximum discharge through chimney, efficiency of chimney.

Combustion: Principle of combustion, Stoichiometric Combustion, Analysis of flue gases by Orsat Apparatus. Requirement of Theoretical Amount of Air, Calculation of Constituents of Flue Gas with Excess Air, Optimizing Excess Air and Combustion.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Kumar, D.S., Thermodynamics, Kataria & Sons Publication, 2003

2 Nag P.K., Engineering Thermodynamics, Tata McGraw-Hill, 1988

3 R Yadav, Fundamentals of Thermodynamics, Central Publishing House, 1999

REFERENCE BOOKS

4 Van Wylen, Thermodynamics, Wiley, 1994

5 Mathur & Mehta, Thermal Engineering, Jain Brothers Publication, 1987

6 Cengel Y A, Thermodynamics, Tata McGraw-Hill, 2008

B. Tech. 2nd Year (Semester - 3)

HU26481: Values, Humanities and Professional Ethics

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
HU26481	Values, Humanities and Professional Ethics	-	2	-	2	-	2	100	-	-	-	100

PRE-REQUISITES: Nil

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

CO 1 Explain and elaborate the social institutions and Constitution of India through which the society and nation is governed.

CO 2 Describe the kinds of values and ethics and their importance

CO 3 Contextualize the professional attitude and approaches as per needs of society and values.

CO 4 Explain and illustrate the process of Social, Political and Technological changes in context to global changes

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	–	1	–	–	–	2	1	2	–	1	–	1	1	1
CO2	1	1	–	–	–	2	–	3	1	2	–	2	1	–
CO3	1	–	–	1	–	2	–	3	1	1	–	1	1	1
CO4	1	1	2	1	–	3	2	3	1	1	–	3	2	1
CO5	1	1	2	–	1	2	3	2	2	1	–	2	1	1
Average	1.0	1.0	2.0	1.0	1.0	2.2	2.0	2.6	1.3	1.2	0.0	1.8	1.2	1.0

COURSE CONTENTS

Unit 1 Role of Humanities in Engineering education, Morals, Values and Ethics, social institutions and association, social stratification in India, social change, Universal and Situational values, coexistence of self and body and their needs and activities.

Unit 2 **Constitution of India** - Preamble, Rights and Duties. Directive Principles, Parliamentary and presidential democracy, The Problem of hierarchy of values and their choice, the views of Mahatma Gandhi on concept Indian nation and democracy.

Unit 3 Ethical and decision making capability and its development: Meaning of Ethical dilemma, Concept of personal and group Ethics: Balance between -rights and duties, The Problem of Sustenance of value in the process of Social, Political and Technological changes.

Unit 4 **Engineering Ethics:** engineers as responsible experimenters - codes of ethics - a balanced outlook on law - the challenger variety of moral issued - types of inquiry - moral dilemmas – moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy Models of Professional Roles.

Unit 5 **Global Issues:** Multinational corporations - Environmental ethics - computer ethics - weapons development – engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership.

ASSESSMENT

1 Only **Sessional Work** (100 marks) on the basis of internal viva (30), Attendance (20), Quizes /Tests (30) and Presentations (20) will be awarded against the assessment done throughout the session.

REFERENCE BOOKS

1 Little, William: An Introduction of Ethics (Allied Publisher, Indian Reprint1955)

2 William, K Frankena : Ethics (Prentice Hall of India,1988)

3 Gaur R. R., Sangal R. and Bagaria G. P., Haman Values and Professional Ethics, Excel Books, New Delhi, 2010

4 Mike Martin and Roland Schinzinger, Ethics in Engineering, McGraw-Hill, New York 1996.

5 Govindarajan M, Natarajan S, Senthil Kumar V. S, Engineering Ethics, Prentice Hall of India, New Delhi, 2004.

6 Introduction to the Constitution of India, D.D. Basu

B. Tech. 2nd Year (Semester - 3)

MEM2002: Environmental Science *

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
MEM2002	Environmental Science*	2	-	-	-	-		-	50	-	-	50

PRE-REQUISITES: Knowledge of basics of science studied in Class XI and XII.

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

CO 1 Analyze the causes of pollution in our environment.

CO 2 Explain the effects of air pollution on environment and suggest ways to reduce them.

CO 3 Develop in depth knowledge about water Quality parameters and its estimation.

CO 4 Develop knowledge on soil and noise pollution & related parameters.

CO 5 Understand the Ethics and Evaluate policies of climate change mitigation Strategies and Create a knowledge base for global and national Action.

COURSE CONTENTS

Unit 1 Environment: General Studies:

a) Introduction, segments of environment, Energy flow in environment, Composition and structure of atmosphere. Chemical Species and particulates in atmosphere. Reaction and Phenomena occurring in atmosphere.

b) Man and Environment

Unit 2 AIR Pollution

a) Air pollution: Sources and effects, particulate control, control of gaseous pollutants (SOx, NOx, oxides of carbon, hydrocarbon pollutants), Air Quality standards and Management.

b) Case studies

Unit 3 Water Pollution

a) Water Pollution: Types of water pollution, sources, water pollution control. Waste water treatment technologies and Recycle.

b) Case studies.

Unit 4 Soil and Noise Pollution

a) Soil Pollution: Introduction, sources/causes, effects and control.

b) Noise Pollution: Introduction, sources/causes, effects and control, noise measuring instruments and noise pollution control technology.

Unit 5 Environment, Society and Ethics

a) Society and Environment, Solid waste-types, impact on society, solid waste management, specific applications to

solid waste management.

b) Environmental Ethics: Need and Types, Regulations: ISO 14000, 9000, pollution Acts and Regulations. Environmental Auditing

ASSESSMENT

1 S.C. Bhatia, "Environmental Pollution and control in chemical process industries", Khanna Publishers, 1st edition, 2001.

2 C.S.Rao, "Environmental Pollution Control Engineering", Wiley Eastern, 1992.

REFERENCE BOOKS

1 S.P.Mahajan, Pollution control in Process Industries, Tata McGraw Hill, 1990.

2 F. P. Lees, Loss prevention in process industries, 2nd edition., Butter worth Heinemann, 1996.

3 Martin Crawford, Pollution Control Theory, McGraw Hill, 1976.

4 Marell, "Solid Wastes", John Wiley, 1975.

B. Tech. 2nd Year (Semester – 4)

ME26501 : Machine Design I

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME26501	Machine Design I	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Engineering Mechanics , Strength of Material

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

CO 1 Distinguish machine component behavior under different types of loads, select factor of safety and identify the failure criteria.

CO 2 Analyze the principles and applications of keys, cotters, couplings, joints, and levers to design mechanical components effectively.

CO 3 valuate design considerations for pressure vessels and pipe joints to create reliable and efficient mechanical structures

CO 4 Apply engineering concepts to bolted joint design, contact stress analysis, and bearing selection for mechanical efficiency.

CO 5 Design of riveted and welded joints

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	1	-	-	-	-	-	1	-	3	3	3
CO3	3	3	3	1	-	-	-	-	-	1	-	3	3	3
CO4	3	3	3	1	-	-	-	-	-	1	-	3	3	3
CO5	3	3	3	1	-	-	-	-	-	1	-	3	3	3
Average	**3**	**3**	**2.6**	**1**	-	-	-	-	-	**1.00**	-	**3**	**3**	**3**

Unit no.	COURSE CONTENTS
Unit 1	Engineering design, Phases of design, design consideration, Ergonomics consideration, Factor of safety, Material selection, manufacturing consideration, Standardization, Preferred sizes. Modes of failure, Types of loads, statistical nature of loading, change in stresses due to type of loading, preliminary stress calculations. Theories of failure and application to the design problems: Principal stress theory, maximum shear stress theory, principal strain theory, maximum strain energy theory, maximum distortion energy theory, etc.
Unit 2	**Design of shaft, keys and coupling:** Types of keys and their design, design for transmission by shaft through rigid and flexible coupling, stress distribution and angle of twist. Design of different types of lever.
Unit 3	**Pressure vessels and cover plates:** Analysis of thick pressure vessels, compound cylinders, design

considerations for pressure vessels

Pipe and pipe joints: design of different types of pipe joints for high pressure Design of cotter joint and knuckle joint.

Unit 4 **Threaded fasteners:** Classification, standard specifications, effect of initial tension, Effect of static and dynamic load, eccentric loading, types of nut - bolt - washers, design of threaded fasteners, turnbuckle

Contact stress and deformation: Contact surfaces - their geometries and deformations, contact stress distributions. Antifriction bearing: types of bearings, life and load criteria of bearings, different applications and selection procedure of bearings.

Unit 5 **Design of Riveted Joints:** Types of rivet joints, rivet heads, terminology, caulking and fullering, analysis of riveted joint, efficiency of a riveted joint, design of boiler joints and structural joints, direct and eccentric loading.

Design of Welded Joints: Welding process, merits and demerits of welded joint, analysis of heat affected zone, Types of welded joints, Strength of a welded joint, welded joint subject to bending moment, torsional moment, direct and eccentric loading

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Sharma and Aggarwal, Machine Design, S K Kataria and Sons, 2001

2 V. Bhandari, Design of Machine Elements, Tata McGraw-Hill, 20014

REFERENCE BOOKS

3 R. C. Juvinall and K. M. Marshek, Fundamentals of Machine Component Design, John Wiley, 1991

4 Shigley and Mischke, Mechanical Engineering Design, Tata McGraw-Hill, 2001

B. Tech. 2nd Year (Semester – 4)

ME26512 : Kinematics & Dynamics of Machine

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME26512	Kinematics & Dynamics of Machine	3	1	2	4	1	5	70	30	40	60	200

PRE-REQUISITES: Engineering Mechanics , Physics

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

CO 1 Construct the motion of planar four-link mechanisms and draw their velocity and acceleration diagrams.
CO 2 Determine the parameters of gears and the velocity ratio of gear trains
CO 3 Construct different types of cam profiles, and determine gyroscopic couple and its effects
CO 4 Determine power transmitted/lost/absorbed in different friction devices like thrust bearings, clutches, belt drives and dynamometers.
CO 5 Analyze dynamics of simple mechanisms, flywheel, and balance rotating and reciprocating masses

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	–	–	–	–	–	–	–	–	3	3	1
CO2	3	3	2	–	–	–	–	–	–	–	–	3	3	1
CO3	3	2	2	–	–	–	–	–	–	–	–	3	3	1
CO4	3	2	2	–	–	–	–	–	–	–	–	3	3	1
CO5	3	2	2	–	–	–	–	–	–	–	–	3	3	1
Average	**3**	**2.2**	**2**	–	–	–	–	–	–	–	–	**3**	**3**	**1**

Unit no.	COURSE CONTENTS

Unit 1 **Basic Mechanisms and their Motion Analysis**

Kinematic link, Kinematic pairs, Kinematic chain, classification, Degree of freedom of chain and mechanism, Grubler's and Kutchbach Criterion. Inversions of four bar chain, single slider crank chain, and double slider crank chain. Number synthesis with number of links less than or equal to eight. Various Mechanisms with lower pairs.

Velocity and acceleration analysis, Relative velocity and relative acceleration approach, Problems with Coriolis component of acceleration.

Instantaneous centre method, Keneddy's theorem and its applications.

Unit 2 **Gears, Gear Trains**

Toothed Gearing: Types of gears, Terminology, Condition for correct gearing. Tooth profiles- cycloidal and involute gears, Tooth proportions,

Interference and its prevention.

Gear trains, Tabular and algebraic approach of solution. Differential gear box

Unit 3 CAMs-followers and Gyroscope

Types of CAMS, Terminology, Generation of CAM profile for specified follower motions.

Gyroscopic couple and its effects

Unit 4 Friction devices:

Pivot and Collar Bearing, Belt, Rope and Chain drives.

Clutches, Brakes and Dynamometer: Plate Clutch, Cone Clutch, block brake, band brake, the band and block brake, Types of dynamometers, Prony brake dynamometer, Rope brake dynamometer, hydraulic absorption dynamometer

Unit 5 Dynamic force analysis and balancing

Dynamic Force analysis of Simple Mechanisms, Equations of motion for four-bar and slider-crank mechanisms. Piston Efforts and Crank Effort Diagrams, Fluctuation of energy and speed. The Flywheel.

Balancing of rotating masses, Primary balancing of reciprocating masses, secondary balancing of reciprocating masses. Condition of balance in V-Engine, radial engine and multi cylinder inline engine

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Bevan T., Theory of Machines, C B S Publishers, 1993

2 Ambekar A. G., Mechanism & Machine Theory, Prentice-hall of India, 2007

3 Ratan S.S., Theory of Machines, Tata Mcgraw Hill, 2009

REFERENCE BOOKS

1 Shigley J. E., Theory of Machines (Kinematics), Tata Mcgraw Hill, 1981

B. Tech. 3rd Year (Semester – 4)

ME26504 : Measurement and Control System

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME26504	Measurement and Control System	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Physics, Basic Electrical & Electronics

Course Objectives

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

CO 1 Discuss engineering skills required for measurement & control systems

CO 2 Enhancement of analytical skills for modeling & analyses of measurement& control system

CO 3 Explain problem solving domain of measurement & control

CO 4 Exposure to application oriented problem solving and building capabilities to formulate and solve such Problems

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	–	–	–	–	–	–	–	–	–	–	1	1	1
CO2	3	3	3	–	–	–	–	–	–	–	–	1	1	1
CO3	3	2	3	1	–	–	–	–	–	–	–	1	1	1
CO4	3	3	3	–	–	–	–	–	–	–	–	1	2	1
CO5	3	2	2	1	–	–	–	–	–	–	–	–	–	–
Average	3	2.5	2.75	1	–	–	–	–	–	–	–	1	1.25	1

COURSE CONTENTS

Unit 1 **Basic Concepts of Measurement**: General measurement system, Noise and interference, Calibration, Static Performance Characteristics of measuring instrument and measurement system, Sequential and random tests. Measurement errors; error sources: calibration, data acquisition, data reduction; Design stage uncertainty analysis; combining elemental errors; Bias & Precision errors; Error propagation, Higher order uncertainty analysis.

Unit 2 **Temperature Measurements**: Temperature standards, Temperature scales; Thermometry based on thermal expansion: Liquid in glass thermometers, Bimetallic Thermometers; Electrical resistance thermometry: Resistance Temperature Detectors, Thermistors; Thermoelectric Temperature Measurement: Temperature measurement with thermocouples, thermocouple standards.

Pressure and Velocity Measurements: Relative pressure scales, pressure reference instruments, barometer, manometer, deadweight tester, pressure gauges and transducers, total and static pressure measurement in moving fluids

Flow measurements: Pressure differential meters: Orifice meter, Venturi meter; rota-meter.

Unit 3 **Strain Measurements:** Stress and strain, resistance strain gauges, gauge factor, strain gauge electrical circuits, multiple gauge bridge, bridge constant, apparent strain and temperature compensation, bending compensation

Motion, Force and Torque Measurements: Displacement measurement: Potentiometers, Linear variable differential transformers, rotary variable differential transformer; Velocity measurement: moving coil transducers; angular velocity measurement: electromagnetic techniques, stroboscopic measurement; Force measurement: load cells, piezoelectric load cells; Torque measurement: measurement of torque on rotating shafts, Power estimation from rotational speed and torque.

Unit 4 **Introduction to control systems:** Examples of control systems. Open loop and closed loop control. **Mathematical modeling of dynamic systems:** Transfer function, impulse response function, block diagram of closed loop system, block diagram reduction, modeling of mechanical systems, modeling of electrical systems, signal flow graphs, modeling of fluid systems, liquid level systems, hydraulic systems, modeling of thermal systems.

Unit 5 **Transient and steady state response analyses:** First order systems, unit step and unit impulse response of first order systems, second order systems, unit step and unit impulse response of second order systems, transient response specifications. Routh Hurwitz stability criteria, Introduction to Bode plot and root locus method. System modelling using MATLAB.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Nakra B.C., Chaudhary K.K., Instrumentation, Measurement and Analysis, Tata McGraw Hill, New Delhi, 2004

2 Nakra B.C., Chaudhary K.K., Control Systems, Tata McGraw Hill, New Delhi, 1985

3 Modern Control Engineering, 4e, Katsuhiko Ogata, Pearson Education, New Delhi, 2004

REFERENCE BOOKS

1 Richard S. Figiola & Donal E. Beasley, Theory and Design for Mechanical Measurements, 5e, John Wiley, 2005

2 Gopal M., Control Systems Principles and Design, 2e, Tata McGraw Hill, New Delhi, 2006

3 Beckwith and Buck, Mechanical Measurements, Addison-Wesley Pub. Co., 1982

B. Tech. 2nd Year (Semester - 3)

IP26513: Manufacturing Process

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
IP26513	Manufacturing Process	L	T	P	T	P	Total	Th.	CW	Pr.	SW	200
		3	-	2	3	1	4	70	30	60	40	

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

CO1 Explain various casting, forming, and joining processes along with associated defects and remedies.

CO2 Analyze the mechanics of metal cutting and apply Merchant's theory to cutting force calculations.

CO3 Demonstrate operations on conventional machine tools like lathe, milling, shaper, and drilling machines.

CO4 Describe grinding, broaching, and unconventional machining processes with their working principles.

CO5 Apply measurement techniques and interpret limits, fits, tolerances, and gauge design in metrology.

ARTICULATION MATRIX

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

COURSE CONTENTS

Unit 01 **Casting, Forming and Joining Processes: Foundry:** Different types of castings, casting defects & remedies. Solidification and cooling; riser and gating design. **Forming Processes:** Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, and drawing) and sheet (shearing, deep drawing, and bending) metal forming processes. **Joining Processes:** Types of Welding processes, power sources, characteristic curves, Principles of welding, brazing, soldering, Welding Defects, and remedies.

Unit 02 **Mechanics of Metal Cutting:** Metal cutting analysis, orthogonal and oblique cutting, Mechanics of cutting, shear angle relationship, Merchant circle and Force analysis for orthogonal cutting. Cutting tool, materials and their properties.

Unit 03 **Machine Tool Operations I:** Geometry of single point and multipoint cutting tools like drill, milling cutter etc. Classification of lathe, lathe accessories. Operations of shaper, planner, slotter, drilling machines. Classification of Milling machines, principal parts, milling cutter and various operation performed and indexing

Unit 04 **Machine Tool Operations II:** Broaching operation & types of broaching machines and geometry of broaching tools. **Theory of grinding:** Various types and constructional features of grinding machines, Selection of wheels & marking system, Balancing, dressing & truing of wheels. **Unconventional machining processes**: principles and applications of unconventional machining processes like AJM, ECM. EDM and USM.

Unit 05 **Linear & angular measurement**: Comparator, Slip gauges, angle gauges, sine bar, auto-collimator, measurement of straightness, flatness & square-ness. **Limits, fits and tolerances**: Interchangeability, types of fits, allowances, hole & shaft basis system, standard limit system, tolerance & fundamental deviation, gauges & gauge design.

ASSESSMENT

The following methods shall be adopted for the assessment of this course;

1. Theory Examination (70 marks) on the basis of end term theory paper examination (from Units 1 to 5)

2. Class Work (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

3. Sessional Work (40 marks) on the basis of assignments, internal viva and attendance.

4. Practical examination (60 marks) on the basis of evaluating practical knowledge, Quiz and viva voce.

LIST OF PRACTICAL:

1. To prepare a corner joint by manual metal arc welding (MMAW) process.
2. To prepare MS hexagonal chisel by hot forging technique from m. S. rod.
3. Measurement of drawing force on wire drawing setup for mild steel wire.
4. To make a split pattern to prepare a green sand mould.
5. To prepare a mould by shell moulding process.
6. To prepare a mould using CO2 moulding process.
7. To manufacturing job on the lathe machine as per drawing.
8. To manufacturing of gear on milling machine as per drawing.
9. To manufacture a v-block as per drawing on shaper machine.
10. Study and analysis the wire drawing process.

TEXT BOOKS

1. Kalpakjian, S., & Schmid, S. R., *Manufacturing Engineering and Technology*, 7th Edition, Pearson Education, 2014.
2. Ghosh, A., & Malik, A. K., *Manufacturing Science*, 2nd Edition, East-West Press Pvt. Ltd.,2010 (Reprint).
3. Sharma, P. C., *A Textbook of Production Technology: Manufacturing Processes*, 8th Edition, S. Chand Publishing, 2014.
4. Begeman, M. L., & Amstead, B. H., *Manufacturing Processes*, 9th Edition, John Wiley & Sons, 1987.
5. Jain, R. K., *Engineering Metrology and Measurements*, Reprint Edition, Khanna Publishers

B. Tech. 2nd Year (Semester – 4)

HU26507: Economics For Engineers

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
HU26507	Economics For Engineers	3	-	-	3	-		70	30	-	-	100

PRE-REQUISITES: Nil

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

CO 1 Explain economic cyclic flow and Estimate the demand and demand elasticity for a product.

CO 2 Plan the production; choose appropriate production technology (combination of production factors); and estimate feasible range of production

CO 3 Analyze the production-cost-profit relation and select the suitable project for investment

CO 4 Estimate price and the equilibrium for a firm/organization in different competitive market situations.

CO 5 Review, summarize and compare the financial statements of an accounting entity and able to apply financial ratiotechnique for financial analysis.

ARTICULATION MATRIX

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

COURSE CONTENTS

Unit 1 Nature and scope of economics, Economic cyclic flow, Central Economic problems, macro and micro economics, concept, determinants and law of demand and supply, Elasticity of demand, Equilibrium price, consumer surplus and equilibrium.

Unit 2 Production, cost and Revenue: Production function, laws of return to variable proportion, Laws of return to scale, cost concepts, cost functions and their inter relation, Revenue Concepts and functions, break-even analysis, Time value of money and Investment analysis- NPV, IRR, ARR and payback period method.

Unit 3 Pricing and Market: Price determination and firm's equilibrium under perfect competition and monopoly, price- output determination under monopolistic competition, kinked demand curve, collusive and non-collusive oligopoly.

Unit 4 Entrepreneur, entrepreneurship and start-up, characteristics of an entrepreneur, forms of business organization, phases of startup, small medium and large scale enterprise, problems, opportunities, Design Thinking

and Ideation. Business model.

Unit 5 **Accountancy:** Accountancy and bookkeeping, GAAP, Assets, Liabilities and Capital, types of accounts, Journal, Ledger, Trial Balance and Financial Statements, Financial Ratio Analysis.

ASSESSMENT

1 Through End-Sem. Theory Exam, Theory Sessionals, Mid-Sem Tests, and Assignments

REFERENCE BOOKS

1 Jhingal M.L., Economics of development and Planning, Vrinda Publication (40th Ed./latest).

2 Ahuja H. L., Advance economic theory, S Chand Publication, (21st Ed./Latest)

3 Riggs, Bedworth and Randhawa, Engineering Economics, Tata McGraw-Hill, (4th Ed./latest)

4 Principles of accountancy, Nirmal Jain,

5 Entrepreneurship by Rajeev Roy, 2nd edition

B. Tech. 2nd Year (Semester – 4)

HUM2052: Essence of Indian Knowledge Tradition*

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
HUM2052	Essence of Indian Knowledge Tradition*	2	-	-	-	-			50	-	-	50

PRE-REQUISITES: Nil

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

CO 1 Elucidate the legacy and essence of Indian knowledge tradition.

CO 2 Comprehend the importance of tracing of text, archeological, and inscriptional evidences in cultural history and civilization.

CO 3 Classify the philosophical literature of different Indian philosophies – Vedic and non-Vedic.

CO 4 Evaluate contribution of ancient Indian scholars in various disciplines – arts, sciences, mathematics, and engineering & Technology.

CO 5 Imbibe the essence of karma theory and yogic practices to sustain mental and physical wellbeing.

COURSE CONTENTS

Unit 1 Introduction to Indian knowledge tradition (IKT): nature and scope of IKT, Vedic and non- Vedic philosophies, nature and cause of the universe, nature and role of God, concepts of panch-bhutas, substances/matters/elements (dravya, jada, tattva) and Samsara, joy & sorrow, rebirth, state of liberation and its path.

Unit 2 Cultural history and civilization in India: texts, inscriptions and archeological ways of historical comprehension of culture and civilization, some inscriptions and archeological evidences – e.g. Nalanda, Takshshila, Ajanta-Elora, Udaygiri caves, Mohan-Jodaro, chronology of Vedas and other religious/philosophical texts.

Unit 3 Structural classification of ancient Indian knowledge Texts: Ashtadash-Vidya, four Anuyogas, three volumes of Tripitika, some selected religious text literature and their subject matter – Ramayana, Gita, Shatkhandagam, Jatak Kathayen, Harivansh purana etc.

Unit 4 Mathematics, Science and technology: Astrology, metallurgy, town planning, rock arts, vastukala, sthapatya, health care, ancient Indian Scientists and mathematicians – Aryabhatta, Shridharacharya, Bhaskaracharya, Mahaviracharya, Brahmagupta, Yativrishabh acharya, sushrut, charak etc.

Unit 5 Language, Knowledge, Yoga and Meditation: Ancient Indian languages, means of knowledge and communication, Sensory Knowledge, direct knowledge, inferential knowledge, testimony (Shabd/Agam), Karma theories – Karma as action or matter, states and types of karma, yoga and mental wellbeing, Ashtang yoga, Maharshi Patanjali,

ASSESSMENT : Class Work(50 marks):

1 Attendance - 10 Marks

2 Quizes/Assignments/Class activities : 25 Marks

3 Presentation and Viva : 15 Marks

REFERENCE BOOKS

1 B. Mahadevan, Nagendra Pavana, Vinayak Rajat Bhat, Indian Knowledge System: Concepts and Applications, PHI, 2022

2 Dr. Umashankar Rishi, Hindi commentary on madhavacharya's "Sarva darshan sangrah", Chokhamba Vidyabhavan, Varanasi, 221001

3 Chatterjee, Satishchandra. Introducation toIndian Philosophy. Rupa & Co, 2012.

4 Radhakrishnan, Sarvepalli. Indian Philosophy. Oxford Univ. Press, 2009.

5 Shastri, Foolchand, Hindi translation of "Sarvarth Siddhi" – A Sanskrit commentary by Achrya Pujyapad on 'Tattavarth Sutra' of Umaswami, 7th Ed. 2013, Bhartiya Gyanpith, New Delhi 110003

6 Upā dhyā ya Baldev. Bhā ratiȳ adarśana; BHĀRATAVARSA Kī Vividh adarśanika vicāradhā raom KĀ PRĀMĀNIKAVIVECANA. ŚārdāMandira,1957.

7 V. Sivaramkrishnan(Ed.), Cultural Heritage Of India course material, Bharitya Vidya Bhavan, Mumbai. 5thEdition. 2014

8 Pritchett, Frances. The Buddha and His DHAMMA, by Dr. B. R. Ambedkar, www.columbia.edu/itc/mealac/pritchett/00ambedkar/ambedkar_buddha/.

9 Shastri,Dr. Nemichand,"TirthankarMahaveer aur unki Acharya PARAMPARA Part-1: Read Jain Books Online at Jainebooks.org." Jainebooks.org, Pandit Todarmal Smarak Trust,

www.jainebooks.org/books/4129/tirthankar-mahaveer-aur-unki-acharya-parampara-part-1 .

B. Tech. 3rd Year (Semester –5)

ME36009: Computer Aided Design

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME36009	Computer Aided Design	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Engineering Graphics, Mathematics & Basic computer.

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

CO 1 Distinguish the application of CAD Hardware and Software.

CO 2 Explain the Mathematical modeling of curves representation for geometric modeling and geometric models transformation

CO 3 Design and application of parametric representation of curves for surface modeling.

CO 4 Apply solid modeling tools and understanding about reverse engineering

CO 5 Apply numerical methods for analysis of the various types of models

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	3	-	1	1	3	1	1	3	3	2
CO2	3	2	3	1	3	-	-	-	2	1	1	3	1	2
CO3	3	3	3	3	3	1	-	1	3	1	1	3	2	3
CO4	2	2	2	2	3	-	1	-	3	3	1	3	2	3
Average	2.8	2.4	2.6	2.2	3	1	1	1	2.8	1.8	1.2	3	2	2.6

COURSE CONTENTS

Unit 1 **CAD Hardware:** Types of systems, Systems evaluating criteria, Input devices, output devices. Hardware Integration, Networking.

CAD Software: Graphics standards, Modes of graphics operation, modelling and viewing, CAD data Exchange, overview of different solid modelling software.

Unit 2 **Geometric Modelling:** Types of Mathematical representation of curves, parametric representation of Analytic and synthetic curves, wire frame modelling.

Introduction of transformation of geometric models, visual realism.

Unit 3 **Surface Modelling:** Parametric representation of analytic and synthetic curves, surface manipulation, Design and engineering applications.

Unit 4 **Solid Modelling:** Boundary representation, constructive solid geometry, boundary representation, Sweep representation, Analytical solid modelling, brief overview of reverse engineering and rapid prototyping. Design and Engineering applications, prototyping

Unit 5 **Numerical Methods:** Solution of algebraic linear equation, Eigen Value problem, Differential equations, Convergence errors. Introduction to FEM and its application to simple 1-D problem

ASSESSMENT

1. **Class Work:** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work:** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination:** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination:** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1. V Ramammurthy, Computer-Aided Mechanical Design and Analysis, McGraw-Hill, 1998
2. Besant and Lui, CAD, East-west Press Pvt Ltd, 1986
3. Ibrahim Zeid, CAD/CAM: Theory & Practical, Tata Mc-Graw Hill, 2012
4. Faut & Pratt, Computational Solid Geometry, Villy storm Ltd, 2002
5. E. Mortenson, Geometric Modelling, Villy storm Ltd, 2002

REFERENCE BOOKS

1. Donald Hearn & M. Pauline Balear, Computer Graphics, Prentice Hall, 1997
2. Dean and Taylor, Computer-Aided Design, Addison Wesley, 1992
3. Herrington, S., Computer Graphics, McGraw Hill, 1987
4. K C Jain, Vikas Gohil, CAD/CAM/CIM, Khanna Publishers, 2014

B. Tech. 3rd Year (Semester – 5)

ME36010: Mechatronics and Automation

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME3610	Mechatronics and Automation	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Basic Mechanical Engineering , Basic Electrical & Electronics Engineering

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

CO 1 Distinguish various control actions and apply the concepts of transfer functions for mathematical modeling mechanical and electrical system
CO 2 Explain system stability criteria, method and application of PID controller
CO 3 Discuss various types of solenoids, relays and electromechanical actuators and Demonstrate various hydraulic and pneumatic systems and their applications
CO 4 Apply different motion control techniques in various engineering applications.
CO 5 Explain signal conditioning and data acquisition process.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	-	2	-	-	-	-	-	-	2	2	2
CO2	2	3	3	2	2	-	-	-	-	-	-	1	3	2
CO3	2	1	-	-	-	-	-	-	-	-	-	1	3	-
CO4	2	2	2	-	-	-	-	-	-	-	-	2	2	-
CO5	2	-	-	-	-	-	-	-	-	-	-	1	2	-
Average	2	2	2.333	2	2	-	-	-	-	-	-	1.4	2.4	2

COURSE CONTENTS

Unit 1 **Control system and types:** Open loop and closed loop control systems. Block Diagrams representation of control system. Laplace Transform and Transfer Function. Mathematical modeling of mechanical and electrical system. Poles and zeros. Zero order, first order and second order systems and their dynamic response.

Unit 2 Routh Hurwitz stability criteria, Introduction to bode plot and root locus method. Basic control actions. Proportional, integral and derivative control. Op Amp based PID controller, PID control using MATLAB. Combinatorial and sequential logic. Simple logic networks.

Unit 3 **Electro-Mechanical Actuators:** Electro-mechanical actuators, solenoids and relays, types of electric motors and their characteristics, electrical drives and control of electric motor.

Hydraulic &Pneumatic Systems: Hydraulic & Pneumatic cylinders and Actuators, Pressure and Flow Control Valves, Direction Control Valves, Basic circuit, Reference circuit, Meter-in, Meter-out and Bleed off circuit, Accumulator circuit, Circuit Diagram representation,

Unit 4 **Motion Control:** Trajectory planning, motion controllers, point to point motion, co-ordinated multi-axis motion, electronic gearing,

Feedback devices: linear and rotary encoders, resolvers, tachometers and tacho-generators.

Unit 5 **Signal Conditioning & Data Acquisition:** Amplification. Filters. Operational amplifier and its applications. Analog to digital conversion. Data acquisition. Introduction of microcontrollers interfacing with micro-controller and micro-processor.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 K. Ogata, Modern Control Theory, PHI, 2004

2 Nakra & Choudhary, Instrumentation, Measurement and Analysis, TMH, 2004

3 Bolton, Mechatronics, Pearson Education India, 2004

4 Norman S. Nice, Control System engineering, John Wiley & Sons, Inc.

B. Tech. 3rd Year (Semester – 5)

ME36011: Heat Transfer

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME36011	Heat Transfer	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Thermodynamics, Fluid Mechanics , Mathematics

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

CO 1 Explain basic modes of heat transfer. Application of Fourier's law in plane, composite walls, cylinder and sphere.

CO 2 Analyze finned surfaces and assess how fins can enhance heat transfer and unsteady state heat conduction.

CO 3 Describe various convection modes and their application to solve heat transfer problems for tubes, flat plates For laminar and turbulent flow.

CO 4 Design heat exchangers using LMTD and NTU methods and explain heat transfer with change of phase.

CO 5 Apply the principles of radiation heat transfer and basics of mass transfer to real world problems.

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	2	–	–	–	–	–	3	3
CO2	3	3	3	3	2	–	–	–	–	–	–	–	3	3
CO3	3	3	3	3	3	–	–	–	–	–	–	–	3	3
CO4	3	3	3	3	3	–	1	–	–	–	–	–	3	3
CO5	3	3	3	3	–	–	–	–	–	–	–	–	3	3
Average	3	3	3	3	2.75	1	1.5	–	–	–	–	–	3	3

COURSE CONTENTS

Unit 1 **Introduction:** Various modes of Heat Transfer. Fourier's low, Thermal conductivity, Newton's law, film coefficient, combined conduction and convection: overall heat transfer coefficient, Stephan Boltzman's law.

Conduction: General heat condition equation in Cartesian coordinate, one dimensional study state, conduction through plane wall, cylinder and spheres. Composite wall cylinders and spheres. Critical thickness of insulation. Effects of variable thermal conductivity on temperature distribution and heat flux.

Unit 2 **Fins:** Heat transfer from fins of uniform cross section for different boundary condition. Fins effectiveness and fins efficiency.

Brief introduction to Unsteady State Heat Conduction: Lumped parameters, Heisler chart.

Unit 3 **Boundary Layer:** Fundamentals, Equations of energy in the boundary layer. Thermal boundary layer. The Nusselt number.

Convection Heat Transfer: Mechanism of convection, free and forced Dimensionless numbers used in convections. Empirical relations for convective heat transfer through tubes and flat plate, Heat transfer in turbulent flow. Reynold's Analogy.

Unit 4 **Heat exchangers:** Basic types of heat exchangers. The overall heat transfer coefficient and fouling factor. Log – Mean temperature difference. Effectiveness – NTU approach.

Recent Development in the heat transfer: Elementary idea about heat pipe, transpiration and ablation cooling, heat transfer in high speed flow etc.

Heat transfer with change of phase: Fundamentals of boiling heat transfer. Boiling curve and various boiling regions. Condensation heat transfer phenomena.

Unit 5 **Radiation:** Thermal Radiation. Monochromatic and total emissive power, absorptivity, reflectivity and transmissivity, Kirchoff's law, Black and Gray bodies, Plank's distribution law, Stefan Boltzman's law, Heat transfer by radiation between Black surfaces. Electrical analogy for solving Radiation problems.

ASSESSMENT

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1. Holman J. P., Heat Transfer, Tata McGraw Hill, 1968
2. Kumar, D.S., Heat &Mass transfer, S K Kataria & Sons, 2009
3. Cengel Y. A., Heat Transfer, Tata McGraw Hill, 2005

REFERENCE BOOKS

1. Eckert & Drake, Heat &Mass Transfer, Tata McGraw Hill, 1979
2. Ozisic, Basic Heat Transfer, Tata McGraw Hill, 1975
3. Incropera & DeWitt, Fundamentals of Heat and Mass Transfer, Wiley, 1996

B. Tech. 3rd Year (Semester – 5)

ME 36007: Steam and Gas Power Systems

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 36007	Steam and Gas Power Systems	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Thermodynamics , Heat transfer , Fluid Mechanics

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

CO 1 Analyze simple power plant cycles including reheat, regenerative and binary cycles.

CO 2 Evaluate performance of nozzle and its efficiency. Explain and differentiate between impulse and reaction turbines. Analyze various energy losses in turbines

CO 3 Explain the working principle of gas turbines and calculate its efficiency for various modifications in cycles.

CO 4 Describe elements and principle of operation for Jet propulsion systems and calculate thrust, power and efficiency.

CO 5 Analyze Combined cycle steam and gas power system. Purpose of condenser in steam power system

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

COURSE CONTENTS

Unit 1 Thermodynamic Cycle of Steam Plant. Analysis and calculation of reheat. Regenerative & Binary Cycles.

Unit 2 Nozzle flow analysis conditions for maximum flow.. Theory of steam injectors.

Basic types of Steam turbines. Governing and lubrication of steam turbines. losses in turbine

Unit 3 Thermodynamic Cycle of Gas turbine Plant. Analysis and calculation of Reheating, regenerative and multistage compression cycle.

Unit 4 Jet propulsion systems: Air Breathing and Rocket propulsion. Principle of operation, calculation of thrust and efficiency.

Unit 5 Combined cycles of steam and gas turbine Power plant.

Steam condensers. Principle and working. Types of condensers. Cooling water calculations.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Yadav, R., Steam & Gas Turbine, Standard Publishers, 2007

2 Cohen, Rogers, & Saravanamuttoo, Gas Turbine Theory, Prentice Hall, 2001

REFERENCE BOOKS

1 Noeb Hussain, Steam turbine theory and Design, Tata McGraw-Hill, 1984

2 Yahaya S.M., Turbine Compressors & Fans, Tata McGraw Hill, 2005

3 Khajuria & Dubey, Gras Turbine & Propulsive System, Dhanpat Rai and Sons, 1984

B. Tech. 3rd Year (Semester – 5)

IP36052: Manufacturing Processes-II

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
IP36062	Manufacturing Processes-II	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Material Science

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

CO 1 To apply fundamental knowledge about basic mechanism of metal cutting, conventional machine tools and estimation and relationship between performance measures and machining parameters

CO 2 To explain Shaping, Milling and Broaching operation and their importance.

CO 3 To illustrate Grinding functions and processes on grinding machines.

CO 4 To demonstrate Gear elements and gear manufacturing and finishing processes.

CO 5 To infer the surface finishing, super finishing and polishing processes and their importance.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	–	2	–	2	2	2	–	–	–	–	2	–	2
CO2	3	2	2	2	2	2	–	2	–	–	–	2	3	3
CO3	3	2	2	2	2	2	–	–	2	–	2	2	3	3
CO4	3	2	3	2	2	2	–	–	–	2	–	2	3	3
CO5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Average	2.75	2	2.25	2	2	2	2	2	2	2	2	2	3	2.75

Unit no.	COURSE CONTENTS
Unit 1	Principle of generation of surfaces, classification of machining processes, Geometry of single point and multipoint cutting tools like drill, milling cutter etc. Classification of lathe, lathe accessories. work holding & supporting devices, types of hand _drill, different methods of taper Turing, thread cutting & calculation of gear ratios. Concepts of feed speed & depth of cut, Capstan, turret, automates and copying machines.
Unit 2	Constructional features and operations of shaper, planner, slotter, drilling & poring machines. Classification of Milling machines, principal parts, milling cutter and various operation performed, gear cutting and indexing, Broaching operation & types of broaching machines and geometry of broaching tools.
Unit 3	Theory of grinding: Various types and constructional features of grinding machines, Surface, cyiindricaỉ and center-less grinding. Types of abrasives, grinding wheels, bonding materials, Selection O f wheels & marking system, Balancing, dressing & truing of wheels, Introduction to lapping, honing, super-finishing, polishing and buffing. Classification of unconventional machining processes, principles and applications of processes like AJM, ECM. EDM and USM.
Unit 4	Mechanics of Metal Culting: Metal cutting analysis, orthogonal and oblique cutting, Mechanics of cutting, shear angle relationsinip, Merchant circle and Force analysis for orthogonal cutting, dynamometry. Cutting

tool, materials and their properies. Machinability an Economics of Machining: Tool Wear, tool life and methods of improving tool life, friction and heat in metal cutting, distribution of heat, Machinability and selection of economic speed & feed, Cutting fluids.

Unit 5 Metal Working Analysis: Plastic deformation of metals, force analysis for wire drawing, forging, rolling and extrusion processes. Press Working: Power presses, load calculation in shearing, blanking, drawing, bending and forming operation Elements of dies and punches, clearance, center of pressure, blank-layout. Progressive, combination and compound dies.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Chapman, Workshop Technology Part-II aud III.

2 Pandey and Singh, Production Engineering.

3 Lindberg, Manufacturing Processes

REFERENCE BOOKS

4 Khere and Vajpayee, Dimensional Metrology

5 Juneja B.L.. Manufacturing Processes.

B. Tech. 3rd Year (Semester - 5)

MEM3002: Environmental Science *

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
MEM3002	Environmental Science*	2	-	-	-	-		-	50	-	-	50

PRE-REQUISITES: Knowledge of basics of science studied in Class XI and XII.

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

CO 1 Analyze the causes of pollution in our environment.
CO 2 Explain the effects of air pollution on environment and suggest ways to reduce them.
CO 3 Develop in depth knowledge about water Quality parameters and its estimation.
CO 4 Develop knowledge on soil and noise pollution & related parameters.
CO 5 Understand the Ethics and Evaluate policies of climate change mitigation Strategies and Create a knowledge base for global and national Action.

COURSE CONTENTS

Unit 1 Environment: General Studies:

a) Introduction, segments of environment, Energy flow in environment, Composition and structure of atmosphere. Chemical Species and particulates in atmosphere. Reaction and Phenomena occurring in atmosphere.

b) Man and Environment

Unit 2 AIR Pollution

a) Air pollution: Sources and effects, particulate control, control of gaseous pollutants (SOx, NOx, oxides of carbon, hydrocarbon pollutants), Air Quality standards and Management.

b) Case studies

Unit 3 Water Pollution

a) Water Pollution: Types of water pollution, sources, water pollution control. Waste water treatment technologies and Recycle.

b) Case studies.

Unit 4 Soil and Noise Pollution

a) Soil Pollution: Introduction, sources/causes, effects and control.

b) Noise Pollution: Introduction, sources/causes, effects and control, noise measuring instruments and noise pollution control technology.

Unit 5 Environment, Society and Ethics

a) Society and Environment, Solid waste-types, impact on society, solid waste management, specific applications to

solid waste management.

b) Environmental Ethics: Need and Types, Regulations: ISO 14000, 9000, pollution Acts and Regulations. Environmental Auditing

ASSESSMENT

1 S.C. Bhatia, "Environmental Pollution and control in chemical process industries", Khanna Publishers, 1st edition, 2001.

2 C.S.Rao, "Environmental Pollution Control Engineering", Wiley Eastern, 1992.

REFERENCE BOOKS

1 S.P.Mahajan, Pollution control in Process Industries, Tata McGraw Hill, 1990.

2 F. P. Lees, Loss prevention in process industries, 2nd edition., Butter worth Heinemann, 1996.

3 Martin Crawford, Pollution Control Theory, McGraw Hill, 1976.

4 Marell, "Solid Wastes", John Wiley, 1975.

B. Tech. 3rd Year (Semester – 6)

ME36511: Refrigeration & Air Conditioning

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME36511	Refrigeration & Air Conditioning	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Thermodynamics , Physics

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

CO 1 Describe the basic concepts of refrigeration system and explain various types of refrigerants and their properties
CO 2 Explain and analyze vapour compression systems
CO 3 Analyze vapour absorption systems, low temperature and unconventional refrigeration systems
CO 4 Analyze air-conditioning processes using the principles of psychometry
CO 5 Explain air-conditioning systems and their applications in real world scenario.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-		-	-	-	-	-	2	3	1
CO2	3	3	2	3	-		1	-	-	-	-	2	3	1
CO3	3	2	2	2	-		-	-	-	-	-	2	3	1
CO4	3	3	2	2	-		-	-	-	-	-	2	3	1
CO5	3	3	2	2	-		-	-	-	-	-	2	3	1
Average	3	2.8	2	2.2	-	-	1	-	-	-	-	2	3	1

Unit no.	COURSE CONTENTS

Unit 1 **Principles of refrigeration :** Review of revised Carnot cycle. Coefficient of Performance, Ton of Refrigeration, Various types of Refrigeration systems.

Air Refrigeration System : Bell Coleman Cycle, air cycle systems for aircraft. Boot Strap Type and simple evaporative system.

Refrigerants : Classification, Nomenclature, Desirable properties, important refrigerants, secondary refrigerants

Unit 2 **Vapour Compression Systems :** The Simple cycle. The Analysis of the simple cycle, effects of suction superheat and under cooling representation of cycle on T-S and P-H diagrams.

Unit 3 **Vapour Absorption System:** The simple Absorption cycle, use of heat exchanger, analysis and rectifier, the electrolux system Lithium – Bromide Water Absorption system.

Low Temperature Refrigeration: Limitations of vapour compression systems for production of low temperature. Cascade System of Refrigeration. Multistage systems. Use of Flash Intercooler Dry ice, its

manufacture and uses. Joule-Thomson Effect and liquification of gases. Application of low temperatures.

Unconventional Refrigeration System: Steam jet and thermo-electric refrigeration systems, their principle of working and application.

Unit 4 **Psychrometric Process:** Different psychrometric chart. By-pass factor.

Comfort Air Conditioning: Factors affecting human comfort. Flienyer's Equation. Effective temperature, comfort chart and comfort zone.

Air conditioning load calculation: Sensible and latent loads, principles for calculation of building heat transmission, solar heat gain, infiltration and occupancy loads, load due to electric motors and electric driven machineries, other sources of heat gain.

Unit 5 **Air conditioning Systems:** Unitary and central air conditioning systems, evaporative cooling system, heat pump. Air conditioning equipment: Direct expansion and chilled water coils, air washers, apparatus dew point temperature, cooling towers, simple heat factor. Requirement of air for heating and cooling system. Fans and Blowers for air conditioning, their classification and characteristics, grills and registers.

Ducts and Piping: Principles of layout and design of duct system, refrigerants and water pipings pressure losses through ducts and pipings.

Application of Refrigeration and Air conditioning: Food preservation, industrial air conditioning, survey of applications, manufacturing of ice.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Arora C. P., Refrigeration and Air Conditioning,, Tata McGraw-Hill Education, 2000

2 Ananthanarayanan, Basic Refrigeration and Air Conditioning, Tata McGraw-Hill Education, 2005

3 Prasad Manohar, Refrigeration and Air Conditioning, New Age International, 2003

REFERENCE BOOKS

4 Dossat, R.J., Principles of Refrigeration, Pearson Education India, 1996

5 Whitman, Johnson & Tomczyk, Refrigeration and Air Conditioning Technology. Cengage Learning, 2009

6 Hundy, & TtoTT,hcleW Refrigeration and Air Conditioning, Butterworth-Heinemann, 2008

B. Tech. 3rd Year (Semester – 6)

ME36513: Machine Design – II

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME36513	Machine Design – II	3	-	4	3	2	5	70	30	40	60	200

PRE-REQUISITES: Engineering Mechanics , Strength of Material

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

CO 1 Apply the theory of dynamics loading, fatigue, endurance limits, creep and stress concentration to solve engineering problems.

CO 2 Design and evaluate spur, bevel, helical, and worm gears by selecting appropriate materials, considering kinematic requirements, and analyzing gear failure case studies.

CO 3 Analyze and design various types of springs such as helical, leaf, and spiral under axial, torsional, and combined loading conditions for practical mechanical applications.

CO 4 Design and evaluate power screws, journal bearings, and drives by considering load, stress, and material selection for effective power transmission.

CO 5 Design analysis of various I.C. engine components

ARTICULATION MATRIX														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3			2					2	3	1
CO2	3	3	3	3	1							2	3	1
CO3	3	3	3	3	1							2	3	1
CO4	3	3	3	3	1							2	3	1
CO5	3	3	3	3	2							2	3	1
Average	**3**	**3**	**3**	**3**	**1.25**		**2**					**2**	**3**	**1**

COURSE CONTENTS

Unit 1 Dynamic loading, fatigue and endurance limits, creep: Effect of abrupt changes in the geometries in stresses, stress concentration, stress concentration factors and methods of reduction, notch sensitivity. Types of dynamic loading, S - N curves, fatigue life, fatigue strength, Bauschinger effects, low-high cycle fatigue, effect of various factors, Different criteria for design of parts subjected to fatigue.

Tribological consideration in design of machine components such as clutches and brakes

Unit 2 **Gears:** Material selection for different types of gears, reviews of kinematic considerations, design of spur, bevel, worm, helical gears, different case studies of failures.

Unit 3 **Springs:** Design of different types of springs subjected to axial, torsion, bending, and different combinations of loads and stresses. Different applications and case studies of design, Helical, leaf, spiral etc. types of springs.

Power screw: Parts of power screw, thread profiles of power screws, stress distribution, analysis and design of power screws for various applications.

Unit 4 **Design of journal bearings:** Specifying bearing modulus, minimum oil film thickness, flow of oil and bearing dimensions.

Belts, Rope and chain Drive: Types of belts and their selection criteria, types of ropes and chains and design criteria for their selections for various applications, matched sets of belts, calculations of different tensions, lengths, sections, materials, etc.

Unit 5 **Design of engine components:** such as– cylinder, piston, connecting rod, crank and crank shaft, etc.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Bhandari V.B., Design of Machine Elements, Tata McGraw Publication, 2014

2 Sharma and Agrawal, Machine Design, S.K. Kataria and Sons, 2012

REFERENCE BOOKS

1 Shigley and Mischke, Mechanical Engineering Design, Tata McGraw Publication, 2001

2 Robert C. Juvinall and Kurt M. Marshek, Fundamentals of Machine Component Design, John Wiley, 2006

3 Black V, Machine Design, Tata McGraw Publication, 1988

B. Tech. 3rd Year (Semester – 6)

ME36516: Fluid Machinery

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME36516	Fluid Machinery	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Fluid Mechanics

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

CO 1 Explain fundamentals of working of hydraulic turbines, reciprocating pumps, centrifugal pumps.

CO 2 Distinguish steady and unsteady flow characteristics in hydraulic machinery and conduit systems connected to the machinery

CO 3 Develop an ability to apply knowledge of mathematics, science and engineering, to understand effect of hydrodynamic force on various types of vanes

CO 4 Analyze design a system, component or process to meet desired needs with in realistic constraints

CO 5 Apply problem solving in particular domain such as hydraulic turbines, reciprocating pumps & centrifugal pumps

ARTICULATION MATRIX														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	3	1	-	-	-	2	-	-	2	3	2
CO2	3	2	2	3	1	-	-	-	2	-	-	2	3	2
CO3	3	2	2	3	3	-	-	-	2	-	-	2	3	1
CO4	3	2	2	2	1	-	-	-	-	-	-	2	3	1
CO5	3	3	3	2	-	-	-	-	-	-	-	2	3	2
Average	**3**	**2.2**	**2.2**	**2.6**	**1.5**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**3**	**1.6**

COURSE CONTENTS

Unit 1 **Theory of Fluid Machinery**: Impact of jet, velocity triangles, Euler's Equation for work done, efficiencies. Impulse flow turbines and their constructional details, characteristics of turbines, unit quantities, specific speed, governing of turbines, Phenomenon of water hammer, type of surge tank.

Unit 2 **Reaction Turbines**: Francis, Propeller, Kaplan, Bulb Turbine, their constructional details, characteristics of turbines, unit quantities, specific speed, governing of turbines. , types of cavitation, cavitation effects, Thoma cavitation factor, apparatus for cavitation tests, effects of cavitation in pumps and turbine, prevention of cavitation.

Unit 3 **Rotodynamics Pump:** Classifications of Rotodynamics pumps and their constructional details, Vector diagram, Work done by impellor, Efficiencies, Specific speed, Performance characteristics, NPSH, Cavitation Specific Speed, Multi-staging.

Unit 4 **Positive Displacement and other Pumps**: Reciprocating pump theory, Slip, Indicator diagram, Effect of acceleration, air vessels and separation, Comparison of centrifugal and reciprocating pumps, Performance

characteristics. Hydraulic ram, Jet pumps, Air lift pumps.

Unit 5 **Dimensional Analysis**: Dimensional homogeneity, Buckingham Theorem and its Applications, parameters, similitudes modelling criteria and distorted models.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Yahya, S.M., Turbines, Compressor & Fans, Tata McGraw Hill.

2 JagdishLal, Hydraulic Machine, Metropolitan book co.

3 Kumar, D.S., Fluid mechanics and Hydraulic Machines, S K Kataria & Sons Publication.

REFERENCE BOOKS

1 Govindarao, N.S., Fluid Flow Machines, Tata McGraw Hill.

B. Tech. 3rd Year (Semester – 6)

ME36519: Internal Combustion Engines

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME36519	Internal Combustion Engines	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Thermodynamics

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

CO 1 Analyze various air standard and actual cycles. Classify internal combustion engines based on different parameters.

CO 2 Describe various qualities of engine fuels, carburetor fundamentals and its function for automobiles.

CO 3 Analyze the phenomenon of combustion and describe the functioning of fuel injection system in SI engine and analyze the combustion phenomenon in CI engine.

CO 4 Discuss pollutant formation and their control. Explain modern trends in IC engines

CO 5 Describe various mechanisms of lubrication and cooling systems. Evaluate the performance of engines.

ARTICULATION MATRIX														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3			2					2	3	1
CO2	3	3	3	3	1							2	3	1
CO3	3	3	3	3	1							2	3	1
CO4	3	3	3	3	1							2	3	1
CO5	3	3	3	3	2							2	3	1
Average	**3**	**3**	**3**	**3**	**1.25**		**2**					**2**	**3**	**1**

COURSE CONTENTS

Unit 1 Air-Standard cycle and their analysis, Comparison of cycles. Classification of engine and their application, Engine Design and operating parameters. Fuel-air cycles and their analysis. Thermochemistry of fuel air mixture. Properties of working fluids and thermodynamics charts. Actual cycles and their analysis of SI and CI Engine cycles.

Unit 2 **Fuel and Carburetion:** Important qualities of engine fuels and their chemical compositions. Energy enthalpy and heating values. Entropy and maximum work from Internal combustion and engine efficiency (Chemical equilibrium and Reaction rate) Carburetor fundamental and its type, Modern carburetor design and function and characteristics for automobiles. Fuel Injection system in SI engine and flow in intake manifold. Mean velocity and turbulence characteristics and swirl. Combustion in S.I. Engine: Combustion SI engine, Analysis of mixture of combustion flame structure and speed, factors influencing combustion and rate of pressure rise. Abnormal combustion, knock and surface ignition and fuel factor and mixture. Combustion chambers for SI Engine combustion models.

Injection system of SI Engine: Requirement and classification, Components Ignition system in SI engine its requirement. Modern Ignition system i.e. Electronic spark advance system and firing order in multi-cylinder engine.

Unit 3 Combustion in CI engine: Type of combustion system, Fuel spray behavior, ignition delay and factors effecting it. Phenomenon of knock in CI engine and its compression with SI engine. Combustion chambers for CI engine. Combustion models.

Unit 4 Pollutant formation and its control, Nature and extent of problem. Formation and control of Nitrogen oxides, Carbon mono oxides, Unburnt hydrocarbons and particulate of emission. Various emission control Standards, its measure and its prevention.

Modern trend in IC engine, Wankle rotary engine. Free piston engine and their application.

Unit 5 Engine friction and lubrication and cooling Mechanical friction and factor controlling it. Blow by losses, pumping losses. Lubrication of engine components. Lubrications systems, Properties of lubricants and additives used. Heat transfer and its parameters. Characteristics of efficient cooling and types of cooling system and their comparisons.

Performance and Testing: Engine operating characteristic and its parameters variable effecting SI and CI Improvements performance map.

Two Stroke Engine: Types of scavenging process and various terminology. Actual scavenging process. Advantage disadvantages of SI and CI engines and compression, Supercharging.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 John B. Heywood, I. C. Engines Fundamental, McGraw Hill Publication, 1988

2 Mathur & Sharma, I. C. Engine, Dhanpatrai Publication,2010

3 Ganeshan, I. C. Engine, Tata McGraw Publication, 2012

REFERENCE BOOKS

1 Ashely S. and Campbel, Thermodynamics & Analysis of Combustion Engines, Wiley, 1979

2 Taylor, The Internal Combustion in Engine in Theory and Practice, MIT Press, 1985

3 Benson, The I. C. Engine, Claredon Press Oxford, 1982

B. Tech. 3rd Year (Semester – 6)

IP36504: Industrial Engineering and Production Management

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
IP36504	Industrial Engineering and Production Management	3	-	-	3	-	70	30	-	-	100	IP36504

PRE-REQUISITES: Nil

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

CO 1 Distinguish the basic concepts of industrial engineering.
CO 2 Analyze the fundamentals of production management, PPC, and facilitiesplanning.
CO 3 Apply the quantitative models in aggregate production planning and scheduling.
CO 4 Explain the fundamentals of materials management.
CO 5 Explain the fundamentals of quality control.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO2	3	3	2	–	–	–	–	–	–	–	–	1	3	1
CO3	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO4	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO5	3	2	2	–	–	–	–	–	–	–	–	1	3	1
Average	3	2.2	2	–	–	–	–	–	–	–	–	1	3	1

COURSE CONTENTS

Unit 1 **Methods Engineering:** Introduction to work study and productivity, Method study, recording techniques, work measurement tools and techniques.

Workplace design: fundamentals of workplace design, Introduction to job evaluation and wage Incentive schemes.

Unit 2 **Production Management:** Introduction, Evolution of Operations Management, Decision making, Types of production systems, Facilities planning and design-Layout analysis.

Production Planning and Control: PPC Functions, Location decision, Production Control- process, methods/techniques, Forecasting- its methods, need, approaches and their utility.

Unit 3 **Aggregate Planning:** Introduction, objectives, framework, and various approaches, L.P. Model, transportation model, Master Production Schedule-RCCP.

Scheduling: Scheduling for different types of production systems, sequencing rules, Johnson's rule, machine

loading, shop loading, line balancing, L.O.B.

Unit 4 **Materials Management:** Purchasing - Objectives, significance, policies and methods. Stores - Objective, Policies, and procedures etc.

MRP and Inventory control: Introduction to MRP, Types of inventory control, E.O.Q. model, Selective inventory control, JIT and KANBAN concepts.

Unit 5 **Quality control:** Quality planning and quality control, operation, economics of quality control, process capability studies, and control charts for variables and attributes.

ASSESSMENT

1 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

2 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

TEXT BOOKS

1 Work Study by International Labour Organisation (ILO), Geneva.

2 Chase, Acquilino. Jacobs- Operations Management, Tata MC Hills, India.

3 P. Gopalkrishnan and M. Sundaresan- Materials Management: Integrated Approach, Prentice Hall, New Delhi.

REFERENCE BOOKS

1 B. Mahadevan , Operations Management, Himalaya publications, India

2 Norman Gaither , Operations Management, Cengage publications, India

B. Tech. 4th Year (Semester – 7)

ME46018: Automobile Engineering

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 46018	Automobile Engineering	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Basic of Mechanical Engineering

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

CO 1 Explain the fundamental of automotive systems.
CO 2 Apply engineering skills for analyze of automotive systems.
CO 3 Explain problem solving in domain of automobiles and equipments.
CO 4 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3.0	3.0	2.0	–	–	–	–	–	–	–	–	1.0	–	2.0
CO2	3.0	3.0	–	–	–	–	–	–	–	–	–	1.0	–	1.0
CO3	3.0	3.0	2.0	–	–	–	–	–	–	–	–	1.0	1.0	1.0
CO4	3.0	3.0	1.0	–	–	–	–	–	–	–	–	1.0	2.0	1.0
CO5	3.0	3.0	–	–	–	–	–	–	–	–	–	1.0		1.0
Average	**3.0**	**3.0**	**1.7**	–	–	–	–	–	–	–	–	**1.0**	**1.5**	**1.2**

COURSE CONTENTS

Unit 1 **Vehicle Structure:** Fine frame, integral body structure, engine, transmission and body structure mountings, sub frames collision safety, type of rubber flexible mounting.

Vehicle ride characteristics: Human response, vehicle ride.

Unit 2 Handling System and Steering System: Study state handling characteristics and response to input. Steering gear box fundamental design. Need for power steering, steering linkages ball and socket joints.

Suspension: Suspension geometry camber, Swivel & Castor angle. Suspension roll centres body roll stability. Antiroll stiffness. Rubber Spring pump or limiting stop. Axle location, front wheel drive, independent suspension, Macpherson stut & rear wheel. Hotchkiss drive springs & shock absorber.

Unit 3 **Pneumatic Tyre:** Mechanics of type forces, rolling resistance, tractive effort & step. Cornering properties & stiffness, Performance on roads. Tyre material & construction, Thread design & its marking identification.

Brakes, Braking fundamentals, Brake shoe & pad fundamentals brake & shoe expander & adjuster disc brakes. Dual brake system, anti-locking brakes air operated power brakes.

Unit 4 **Friction Clutch:** Clutch fundamentals, Angular driven plate, Cushioning &torsional damping, Friction material, clutch alignment, types of clutch – diaphragm, multiplate etc., hydraulically operated automatic transmission clutch.

Electrical System: Self-starting mechanism & battery charging system, Lighting & wiring system for horn, lamp indicators etc

General: Air conditioning, auto inspection motor vehicle acts, emission standard & its control.

Unit 5 **Transmission:** The necessity for a Gear box, five speed and reverse synchromesh, Gear box synchronization & engagement, remote controlled gear selection & engagement, splitter & range change gear box, over drive considerations setting gear ratios, Hydrokinetic fluid coupling & torque converter, final drive transmission, crown wheel & pinion axle adjustment, differential locks, skid reducing universal joint, four wheel drive & two wheel drive.

Performance Characteristics of Road Vehicles: Tractive effort weight & axle loads, aerodynamics forces, vehicle power plant & transmission characteristics & its prediction operating fuel economy.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Hinz, Advanced Automobile.

2 Crouse Anglin, Automotive Mechanics, TMH 10th Edition, 2006

REFERENCE BOOKS

1 Newton, Steeds & Garrett, The Motor Vehicle, Butterworth-Heinemann, 2001

2 Wong, Theory of Ground Vehicle, Wiley, 2008

3 The Series of Judge, The Modern Motor Engg., 1960

B. Tech. 4th Year (Semester – 7)

ME46051: Vibration & Noise Control

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 46051	Vibration & Noise Control	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Mechanics of Solids, Kinematics of Machine, Dynamics of Machine.

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

CO 1 Mathematical Modeling of SDOF Systems and estimation of natural frequencies, damping factors.

CO 2 Forced Vibration Analysis of SDOF Systems, Vibration isolation and vibration measuring instruments

CO 3 Mathematical modeling of 2DOF systems, design of undamped dynamic vibration absorber, fundamentals of modal analysis.

CO 4 Apply techniques of vibration monitoring and fundamentals of sound/noise

CO 5 Apply techniques of noise control for welfare of human being.

ARTICULATION MATRIX

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

COURSE CONTENTS

Unit 1 **Introduction:** Periodical motion, harmonic motion, the vector method of representing vibrations, displacement, velocity and acceleration in harmonic motion, work done in harmonic motion, superposition of simple harmonic motion, beat phenomenon, non harmonic periodic motions. Harmonic analysis

System having single degree of freedom, free vibration of systems without damping, Equilibrium and Energy Method for determining natural frequency. Reyleigh's Method, Equivalent Systems (systems with compound springs, shafts of different diameter Equivalent length, effects of mass of spring and shaft). Free vibration of systems with Viscous, Coulomb and Structural damping. Equations of motion – Discussion of its solutions.

Unit 2 Forced vibrations of systems with and without damping, Method of complex algebra, equivalent viscous damping, impressed force due to unbalance, transmissibility, support motion, Vibration isolation, commercial isolators.

Whirling of shafts: Whirling of light flexible shaft with an unbalance disk at the centre of its length with and without damping, discussion of the speeds above and below the critical speed, uniform shaft with and without unbalanced masses attached along its length (by Reyleigh Method) for simply supported and fixed ends.

Vibration & Noise Measurement: Principle of frequency, amplitude, velocity and acceleration measuring

instruments

Unit 3 System with two-degree of freedom: Torsional systems, Degenerate Systems, Coupled vibrations, vehicle suspension, Undamped dynamic vibration absorber, Centrifugal absorber, friction damper.

Modal Analysis, Orthogonality of Eigenvectors, Decoupling of Equations of Motion, Modal Mass, Modal Stiffness and Modal Damping, General solution in terms of normal mode (Normal Mode Summation) Introduction to Experimental Modal Analysis

Unit 4 Machine vibration data acquisition, Vibration Severity and Standards, analysis of vibration records, Vibration Monitoring

Noise and its causes, Subjective response to sound, sound pressure/ intensity/ power level and their inter- relation, Inverse Square Law, Decibel scale, Threshold of hearing, Audible Frequency Range, Sound wave propagation, Radiation Fields of Sound Source, Near field, Far field, Free field, Direct field, Reverberant field, Diffuse field, Loudness and equal loudness contours

Unit 5 **Noise Control:** Effect of machine / process noise on operators, employees and local residents. Standards of noise level and exposure limits. Frequencies of interest and Frequency Weighting networks, Sound spectra and octave band analysis, 1/1 and 1/3 Octave filters. Background noise, Measurement of noise, Acoustic Chambers, Anechoic Chamber, Reverberation chamber,

Sound absorbing materials, Sound Absorption and Reflection Coefficients, Noise reduction coefficient, Methods of industrial noise control.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.

3 **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.

4 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 J S Rao and K Gupta, Theory and Practice of Mechanical Vibrations, New Age international

2 Ambekar A.G., Mechanical Vibrations & Noise Engineering, Prentice Hall of India, 2006

3 C. Sujatha, Vibration & Acoustics, Mc Graw Hill Education

REFERENCE BOOKS

1 TseMorse & Hinkle, Mechanical Vibrations, CBS Publication, 2002

2 S. S. Rao, Mechanical Vibrations, Pearson

B. Tech. 4th Year (Semester – 7)

ME46020: Computer Aided Design

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME46020	Computer Aided Design	3	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: Engineering Graphics, Mathematics & Basic computer.

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

CO 1 Distinguish the application of CAD Hardware and Software.

CO 2 Explain the Mathematical modeling of curves representation for geometric modeling and geometric models transformation

CO 3 Design and application of parametric representation of curves for surface modeling.

CO 4 Apply solid modeling tools and understanding about reverse engineering

CO 5 Apply numerical methods for analysis of the various types of models

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	3	-	1	1	3	1	1	3	3	2
CO2	3	2	3	1	3	-	-	-	2	1	1	3	1	2
CO3	3	3	3	3	3	1	-	1	3	1	1	3	2	3
CO4	2	2	2	2	3	-	1	-	3	3	1	3	2	3
Average	2.8	2.4	2.6	2.2	3	1	1	1	2.8	1.8	1.2	3	2	2.6

COURSE CONTENTS

Unit 1 **CAD Hardware:** Types of systems, Systems evaluating criteria, Input devices, output devices. Hardware Integration, Networking.

CAD Software: Graphics standards, Modes of graphics operation, modelling and viewing, CAD data Exchange, overview of different solid modelling software.

Unit 2 **Geometric Modelling:** Types of Mathematical representation of curves, parametric representation of Analytic and synthetic curves, wire frame modelling.

Introduction of transformation of geometric models, visual realism.

Unit 3 **Surface Modelling:** Parametric representation of analytic and synthetic curves, surface manipulation, Design and engineering applications.

Unit 4 **Solid Modelling:** Boundary representation, constructive solid geometry, boundary representation, Sweep representation, Analytical solid modelling, brief overview of reverse engineering and rapid prototyping. Design and Engineering applications, prototyping

Unit 5 **Numerical Methods:** Solution of algebraic linear equation, Eigen Value problem, Differential equations, Convergence errors. Introduction to FEM and its application to simple 1-D problem

ASSESSMENT

1. **Class Work:** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work:** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination:** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination:** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1. V Ramammurthy, Computer-Aided Mechanical Design and Analysis, McGraw-Hill, 1998
2. Besant and Lui, CAD, East-west Press Pvt Ltd, 1986
3. Ibrahim Zeid, CAD/CAM: Theory & Practical, Tata Mc-Graw Hill, 2012
4. Faut & Pratt, Computational Solid Geometry, Villy storm Ltd, 2002
5. E. Mortenson, Geometric Modelling, Villy storm Ltd, 2002

REFERENCE BOOKS

1. Donald Hearn & M. Pauline Balear, Computer Graphics, Prentice Hall, 1997
2. Dean and Taylor, Computer-Aided Design, Addison Wesley, 1992
3. Herrington, S., Computer Graphics, McGraw Hill, 1987
4. K C Jain, Vikas Gohil, CAD/CAM/CIM, Khanna Publishers, 2014

B. Tech. 4th Year (Semester – 7)

ME46218: Mechatronics and Automation

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME46218	Mechatronics and Automation	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Basic Mechanical Engineering , Basic Electrical & Electronics Engineering

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

CO 1 Distinguish various control actions and apply the concepts of transfer functions for mathematical modeling mechanical and electrical system
CO 2 Explain system stability criteria, method and application of PID controller
CO 3 Discuss various types of solenoids, relays and electromechanical actuators and Demonstrate various hydraulic and pneumatic systems and their applications
CO 4 Apply different motion control techniques in various engineering applications.
CO 5 Explain signal conditioning and data acquisition process.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	-	2	-	-	-	-	-	-	2	2	2
CO2	2	3	3	2	2	-	-	-	-	-	-	1	3	2
CO3	2	1	-	-	-	-	-	-	-	-	-	1	3	-
CO4	2	2	2	-	-	-	-	-	-	-	-	2	2	-
CO5	2	-	-	-	-	-	-	-	-	-	-	1	2	-
Average	2	2	2.333	2	2	-	-	-	-	-	-	1.4	2.4	2

COURSE CONTENTS

Unit 1 **Control system and types:** Open loop and closed loop control systems. Block Diagrams representation of control system. Laplace Transform and Transfer Function. Mathematical modeling of mechanical and electrical system. Poles and zeros. Zero order, first order and second order systems and their dynamic response.

Unit 2 Routh Hurwitz stability criteria, Introduction to bode plot and root locus method. Basic control actions. Proportional, integral and derivative control. Op Amp based PID controller, PID control using MATLAB. Combinatorial and sequential logic. Simple logic networks.

Unit 3 **Electro-Mechanical Actuators:** Electro-mechanical actuators, solenoids and relays, types of electric motors and their characteristics, electrical drives and control of electric motor.

Hydraulic &Pneumatic Systems: Hydraulic & Pneumatic cylinders and Actuators, Pressure and Flow Control Valves, Direction Control Valves, Basic circuit, Reference circuit, Meter-in, Meter-out and Bleed off circuit, Accumulator circuit, Circuit Diagram representation,

Unit 4 **Motion Control:** Trajectory planning, motion controllers, point to point motion, co-ordinated multi-axis motion, electronic gearing,

Feedback devices: linear and rotary encoders, resolvers, tachometers and tacho-generators.

Unit 5 **Signal Conditioning & Data Acquisition:** Amplification. Filters. Operational amplifier and its applications. Analog to digital conversion. Data acquisition. Introduction of microcontrollers interfacing with micro-controller and micro-processor.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 K. Ogata, Modern Control Theory, PHI, 2004

2 Nakra & Choudhary, Instrumentation, Measurement and Analysis, TMH, 2004

3 Bolton, Mechatronics, Pearson Education India, 2004

4 Norman S. Nice, Control System engineering, John Wiley & Sons, Inc.

B. Tech. 4th Year (Semester – 7)

ME46219 : Advanced Machine Design

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 46219	Advanced Machine Design	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Machine Design – I , Machine Design -II

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

CO 1 Design analysis of rotating ring, disk and curved machine member and their applications in designing of different machine components.

CO 2 Design analysis of parts of unsymmetrical section

CO 3 Demonstrate reliability based design. Design of machine tool derives for different machines such as lathe, milling and drilling

CO 4 Explain optimum design analysis of simple machine members and human factors in design.

CO 5 Design analysis of automotive gear box.

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO2	3	3	2	–	–	–	–	–	–	–	–	1	3	1
CO3	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO4	3	2	2	–	–	–	–	–	–	–	–	1	3	1
CO5	3	2	2	–	–	–	–	–	–	–	–	1	3	1
Average	3	2.2	2	–	–	–	–	–	–	–	–	1	3	1

COURSE CONTENTS

Unit 1 **Rotating ring and disks:** Discs of uniform thickness and disc of uniform strength effect of drill hole and extra mass, design of flywheel and pulley, etc.

Design analysis of curved machine members: Crane hooks, chain link, open and close link, m/c frames.

Unit 2 **Design of parts of unsymmetrical sections**: Defining shear centre, parts subjected to unsymmetrical bending

Limit design analysis: Simple cases of deformations beyond elastic limits.

Unit 3 **Reliability based design:** Reliability based design of machine elements, design of elements subjected to tension, compression, bending and torsion

Design of machine tool drives: Design of machine tool drives for different machines such as lathe, milling machine, drilling machine, etc.

Unit 4 **Experimental method in design:** Introduction to experimental stress analysis techniques.

Human factors in design: Introduction to human – machine system, human factors, applications in system design, human physical activities, human control of systems, shapes, coding of control.

Unit 5 Design of automotive gear box-manual and automatic

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Mechanical Engineering Design, Shigley and Mischke, TMH, 2001

2 Introduction to Machine Design, V. Bhandari, TMH, 2004

3 Strength of Materials, S.S. Ratan, TMH. 2016.

4 Machine Tool Design and Numerical Control, TMH, 2013

5 Advanced Vehicle Technology, H. Heisler, Butterworth-Heinemann, 2e, 2002.

REFERENCE BOOKS

1 Fundamentals of Machine Component Design, R. C. Juvinall and K. M. Marshek, John Wiley, 2006

2 Engineering Optimization, Rao S.S., John Wiley, 1996

B. Tech. 4th Year (Semester – 7)

ME46220: Industrial Tribology and Maintenance

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME46220	Industrial Tribology and Maintenance	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Material Science

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

CO 1 Demonstrate the origin of tribology, its constituents, microscopic factors involved,surface topography and applications,

CO 2 Explain basics of friction, its laws, theories, mechanism, material andparameter influence.

CO 3 Explain basics of wear phenomenon, its types, wear equations andparameters.

CO 4 Categorize lubrication mechanisms, their mathematical aspects, designfactors, applications and types.

CO 5 Classify maintenance techniques and machine health monitoring

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	1	–	2	–	–	–	–	1	3	2
CO2	3	2	1	–	1	2	2	–	–	–	–	1	3	2
CO3	3	2	2	–	2	2	–	–	–	–	–	–	3	1
CO4	3	1	2	–	1	–	–	–	–	–	–	–	3	1
CO5	3	2	1	–	1	–	–	–	–	–	–	–	3	2
Average	3	1.8	1.4	–	1.2	2	2	–	–	–	–	1	3	1.6

COURSE CONTENTS

Unit 1 History of Tribology, Constituents of Tribology, Engineering surfaces, statistical nature of surfaces, surface examination, Tribological properties of surfaces, contact of surfaces. Tribological applications.

Unit 2 Genesis of Friction, static and kinetic friction, laws of Friction, theories of friction, friction control, stick-slip motion, parameters affecting friction behavior, Friction of various materials.

Unit 3 Definition of wear, various types of wear, mechanism of wear in adhesive, abrasive, erosive, fretting modes, wear equations, parameters affecting wear, wear prevention.

Unit 4 Lubrication mechanisms, Stribeck curve, Petroff's equation, Hydrodynamic, Hydrostatic, Elastohydrodynamic, Boundary Lubrications, Reynolds's equation and its limitations, idealized bearings, infinitely long and infinitely short (narrow) journal bearings, Types of lubricants.

Unit 5 Maintenance policies, Role of maintenance, Diagnostic maintenance, Maintenance techniques, Signature analysis, wear particle analysis, Oil analysis, Thermography.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Cameron, "Basic Lubrication Theory", Ellis Horwood Ltd, 1981.

2 Principles in Tribology, Edited by J. Halling, 1975.

REFERENCE BOOKS

1 Fundamentals of Fluid Film Lubrication– B. J. Hamrock, McGraw Hill International,1994 Model Curriculum of Engineering & Technology PG Courses [Vol -II].

2 D.D. Fuller, "Theory and Practice of Lubrication for Engineers", John Wiley and Sons, 1984.

3 Introduction to Tribology of Bearings– B. C. Majumdar, A. H. Wheeler &co. pvt. ltd 1985.

B. Tech. 4th Year (Semester – 7)

ME463xx: Design of Air Conditioning Equipment's

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 46xxx	Design of Air Conditioning Equipment's	3	-	-	3	-	3	70	30	-	-	3

PRE-REQUISITES: Thermodynamics, Heat Transfer.

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

CO 1 Distinguish various types of compressors, evaporators and condensers used in refrigeration industry.
CO 2 Explain Kyoto protocol and need for using eco-friendly refrigerants.
CO 3 Classify psychromeric properties and air washer.
CO 4 Analyze the size of air conditioning for a particular commercial application.
CO 5 Design air conditioning and air distribution to maintain indoor air quality.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	1	–	–	–	–	–	–	1	3	2
CO2	3	2	1	–	1	–	–	–	–	–	–	1	3	2
CO3	3	1	1	–	1	–	–	–	–	–	–	–	3	1
CO4	3	1	2	–	1	–	–	–	–	–	–	–	3	1
CO5	3	2	1	–	1	–	–	–	–	–	–	–	3	2
Average	3	1.6	1.2	–	1	–	–	–	–	–	–	1	3	1.6

COURSE CONTENTS

Unit 1 **Compressors:** Hermetic compressors-Reciprocating, Rotary, Scroll Compressors, Open type compressors Reciprocating, Centrifugal, Screw Compressors. Semi-hermetic compressors, Construction, working and Energy Efficiency aspects. Applications of each type.

Evaporators and condensers: Different types, capacity control, circuitry, Oil return, Oil separators Different types Refrigerant driers strainers, Receivers, Accumulators, Low pressure receivers, Air Washers, Spray ponds.

Unit 2 **Refrigerants:** Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact-Montreal / Kyoto protocols-Eco Friendly Refrigerants.

Psychrometry: Moist Air properties, use of Psychrometric Chart, Various Psychrometric processes, Air Washer, Adiabatic Saturation.

Unit 3 **Summer and Winter Air Conditioning:** Air conditioning processes-RSHF, summer Air conditioning, Winter Air conditioning, Bypass Factor. Applications with specified ventilation air quantity- Use of ERSHF, Application with low latent heat loads and high latent heat loads.

Load Estimation and Air Conditioning Control: Solar Radiation-Heat Gain through Glasses, Heat Transfer through Walls and Roofs-Total Cooling Load Estimation. Controls of Temperature, Humidity and Air flow.

Unit 4 **Air Distribution:** Flow through Ducts, Static & Dynamic Losses, Air outlets, Duct Design–Equal Friction Method, Duct Balancing, Indoor Air Quality, Thermal Insulation, Fans & Duct System Characteristics, Fan Arrangement, Variable Air Volume systems, Air Handling Units and Fan Coil units.

Water Circuits: Water piping in Chilled Water Systems, Multiple Fan Coil Units, Condensers-Multiple Condensers and Cooling Towers.

Unit 5 **Testing:** Testing of Air conditioners, Refrigerators, Visicoolers, Cold rooms, Calorimetric tests.

Applications: Air Conditioning in Automobiles, Railway Wagons, Marine Vessels, Aircraft and Other Commercial Applications.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Arora C.P., Refrigeration and Air Conditioning, Tata McGraw Hill Pub. Company, New Delhi - 2000.

2 Carrier Air Conditioning Co., Handbook of Air Conditioning Systems design, McGraw Hill, 1985.

REFERENCE BOOKS

1 Langley, Billy C. Refrigeration and Air Conditioning Ed. 3, Engie wood Cliffs (N.J) Prentice Hall 1986.

2 Jones, Air Conditioning Engineering, Edward Amold pub. 2001.

B. Tech. 4th Year (Semester – 7)

IP 46316: Operations Research

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
IP 46316	Operations Research	3	0	0	3	-	70	70	30	-	-	100

PRE-REQUISITES: Nil

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

CO 1 Analyze any real life system with limited constraints and depict it in a model form and convert the problem into a mathematical model

CO 2 Analyze and Simulate different real life probabilistic situations using Monte Carlo simulation technique.

CO 3 Analyze variety of problems such as linear programming, assignment, transportation, Game theory and Dynamic programming etc.

CO 4 Explain different queuing situations and find the optimal solutions using models for different situations

CO 5 Analyze any real life system with limited constraints and depict it in a model form and convert the problem into a mathematical model

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	–	1	1	–	–	–	–	1	1	2	2	1
CO2	2	3	–	1	1	–	–	–	1	1	1	1	2	1
CO3	2	3	–	1	1	–	–	–	1	1	2	2	2	1
CO4	2	3	–	1	1	–	–	–	-	1	2	1	2	1
CO5	2	3	–	1	1	–	–	–	1	1	1.5	1.5	2	1
Average	2	3	–	1	1	–	–	–	1	1	1.5	1.5	2	1

COURSE CONTENTS

Unit 1 **Introduction:** History and Development of O.R. present trend, Types of models, Effect of data availability on modelling, Computations and steps in tackling of problems. Linear Programming:

(a) Formulation of LPP, Simple LP model and its graphical solution, Development of simplex algorithm, Duality in LP and its interpretation, Sensitivity Analysis.

(b) Assignment models and applications.

(c) Transportation Models: finding initial basic feasible solution through North-West corner rule, Row minima method, column minima method, Vogel's approximation method, Finding optimal solution through MODI method.

Unit 2 **Competitive Strategy:** Game theory and its applications, concept and terminology, Pure and mixed strategies, 2x2 matrix game, 2xn game (graphical solution), mxn game solution through linear programming.

Unit 3 **Waiting Line Models & Their Applications:** Concepts, Definitions and notations, Single channel poisson

arrivals with exponential service rate (M/M/1), multi-server model (M/M/s)

Unit 4 **Dynamic Programming :** Concept, Principles of optimality, Stage Coach problem, Optimum route problem, Allocation of salesmen to territories, Maximizing Reliability with budget constraints, Application to inventory control.

Unit 5 Introduction to Integer Programming. Branch and Bound Algorithm. Simulation: Need for simulation, Monte Carlo method, Random Number Generation, Application to waiting line and Inventory control, Advantages and limitations.

ASSESSMENT

1 **Class Work:** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination:** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Taha, Operations Research.

2 Hira & Gupta, Operation Research, S. Chand.

3 Philips, Ravindran and Solburg, Operations Research.

4 Sharma S. D. , Operations Research

B. Tech. 4th Year (Semester – 7)

ME46315 Hydraulic, Pneumatic & Fluidic Control

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 46315	Hydraulic, Pneumatic & Fluidic Control	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Fluid Mechanics, Fluid Machinery

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

CO 1 Develop understanding the principles of operation of hydraulic, pneumatic and fluidic control systems.

CO 2 Categorize fluid power symbols; demonstrate knowledge of basic fluid power theory and fluid conditioning.

CO 3 Demonstrate mechanical aptitude to accomplish maintenance, testing and repair of hydraulic and pneumatic components and systems.

CO 4 Handle Programmable Logic Controllers, Basic logic operations, and feedback devices and sensors.

CO 5 Explain fluidic components, analogue and digital amplifiers and sensors.

ARTICULATION MATRIX														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	2	2	1	-	-	-	-	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	2	2	1	-	-	-	-	-	-	-	-	-
CO5	2	2	2	2	1	-	-	-	-	-	-	-	-	-
Average	2.8	1.6	1.6	2	1	–	–	–	–	–	–	-	-	-

COURSE CONTENTS

Unit 1 Characteristics of hydraulic components, control valves, sources of hydraulic power, hydraulic motors, cylinders,

Unit 2 Elements of circuit design, accumulator, control circuits such as position control and speed control circuits, flow control methods, sequence operation, regenerative circuit

Unit 3 Pneumatic systems and components, conditioning of compressed air, air lubricator, pressure regulators, filters, pneumatic cylinders and motors, cylinder cushioning.

Unit 4 Steady state analysis of pneumatic components and circuits, applications in industrial process control, proportional, derivative controllers etc.

Unit 5 Principles of fluidics, fluidic components, analogue and digital amplifiers and sensors, equivalent electric circuits, graphical characteristics, logic gates and applications.

ASSESSMENT

1 **Class Work:** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination:** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Vicker Sparry, *Hand Book - Industrial Hydraulics.*

2 Lewis Stern, *Design of Hydraulic Control Systems, McGraw-Hill.*

3 S R Majumdar, *Oil Hydraulic Systems, TMH.*

4 D McCloy, H R Marin, *Control of Fluid Power (Analysis & Design), Ellis Horwood*

B. Tech. 4th Year (Semester – 7)

ME 46xxx Bio Mechanics

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 46xxx	Bio Mechanics	3	-	-	3	-	3	70	30	0	0	100

PRE-REQUISITES: Physics, Biology

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

- **CO 1** Explain the mechanical functioning of human body.
- **CO 2** Discussion of through and expression in the field of biomechanics.
- **CO 3** Application of biomechanical in biomechanical system of human body.
- **CO 4** Categorize the biomechanical system for human devil development.
- **CO 5** Explain the application of force, torque etc. to human body.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	-	-	-	-	-	-	-	3	2
CO2	3	2	2	2	1	-	-	-	-	-	-	-	3	2
CO3	3	1	1	-	-	-	-	-	-	-	-	-	3	1
CO4	3	2	2	2	1	-	-	-	-	-	-	-	3	1
CO5	2	2	2	2	1	-	-	-	-	-	-	-	3	1
Average	2.8	1.6	1.6	1.75	1	-	-	-	-	-	-	-	3	1.4

Unit no.	COURSE CONTENTS
Unit 1	Overview of Biomechanics, Bone structure and composition mechanical properties of bone visco elastic properties, Maxwell and voight models-anisotropy-electrical properties of bone-fracture mechanism and crack propagation, Bone fractures fixators repairing of bones mechanical properties of collagen rich tissues, teeth.
Unit 2	Structure and function of cartilages, tendon, ligaments-biomechanics of joints, Human locomotiongait analysis, foot pressure measurement, Pedobarograph, force platform, Mechanics of foot, Mechanics of plantar ulcer arthritis, biomechanical treatment.
Unit 3	Biomechanics of human heart and its functioning, its mechanical and electric properties. Artificial heart valves, biological mechanical valves development, hetro graft, homograft-testing of valves. Total Hip Prosthesis requirements-different types of components-stress analysis and instrumentation, knee prosthesis.
Unit 4	Biomechanics of spines, Scoliosis-measurements-biomechanical treatment-instrumentation Muscle mechanic-Exoskeletal system for paraplegics-powered wheel chair-crutches and canes.
Unit 5	Monitoring device, Catheter mathematical model, responses to a sinusoidal input. Tonometry different type's

respiratory sound measurement.

ASSESSMENT

1 **Class Work:** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination:** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Alexander R. Mc Neil, Biomechanics, Chapman & Hall, 1975

2 V. C. Hayes, Basic Orthopedics Biomechanics, Lippincott-raven publ.

REFERENCE BOOKS

1 D.N. Ghista, Biomechanics of medical devices, Macel Dekker, 1982

2 A. Z. Tohen & C. T. Thomas, Manual of Mechanical Orthopedics

3 D. N. Ghista and Roaf, Orthopedic Mechanics, Academic Press

B. Tech. 4th Year (Semester – 7)

ME463**: Manufacturing Automation & CAM

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME463**	Manufacturing Automation & CAM	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES:

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

CO 1 Explain the basic elements, functions, and levels of an automated system, including control logic and safety operations in industrial automation.

CO 2 Identify and select appropriate hardware components such as sensors, actuators, drives, and I/O devices for designing and controlling automated systems.

CO 3 Develop basic CNC part programs and describe the structure, functions, and industrial applications of CNC machines and robotic systems.

CO 4 Analyze and select suitable material handling, storage, and automatic identification technologies to improve efficiency in manufacturing systems.

CO 5 Apply the concepts of Group Technology, Cellular Manufacturing, and Flexible Manufacturing Systems to optimize automated production processes.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	1	2	-	-	-	-	-	3	2
CO2	3	3	2	2	2	-		-	-	-	-	-	3	2
CO3	2	2	3	2	3	-	-	-	2	2	1	1	3	3
CO4	2	2	2		2	-	-	-	-	-	-	1	2	2
CO5	2	3		2	2	-	-	-	-	2	-	2	3	2
Average	2.4	2.4	2.25	2	2.2	1.0	2	-	2	2	1	1.5	2.8	2.2

COURSE CONTENTS

Unit 1 Introduction to Automation

Basic Elements of an Automated System: Power to Accomplish the Automated Process, Program of Instructions & Control System. Advanced Automation Functions: Safety Monitoring, Maintenance and Repair Diagnostics, Error Detection and Recovery. Levels of Automation

Unit 2 Hardware Components for Automation and Process Control

Sensors, transducers, relays, timers, and switches. Drives: Servo motors, stepper motors – selection and working. Mechanisms: Ball screws, cams, linear motion bearings, tool magazines. Hydraulic & Pneumatic systems – valves, cylinders, circuit design. Analog–Digital Conversions: Analog-to-Digital Converters, Digital-to-Analog Converters. Input/output Devices for Discrete Data: Contact Input/Output Interfaces, Pulse Counters and Generators.

Unit 3 **CNC Technology & Industrial robots**

Fundamentals, Computers and Numerical Control: The CNC Machine Control Unit, CNC Software, Distributed Numerical Control, Applications of CNC. Analysis of Positioning Systems. Part Programming. Robot Anatomy and Related Attributes, Robot Control Systems, End Effectors, Grippers & Tools. Applications of Industrial Robots. Robot Programming.

Unit 4 **Material Handling, Storage & Identification**

Overview of Material Handling, Automated Guided Vehicles, Analysis of Material Transport Systems. Automated storage systems. Automatic Identification Methods, Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies.

Unit 5 Automated Assembly, GT, Cellular and Flexible Manufacturing system

Components and Types of Manufacturing System, Automated Assembly Systems. Part Families and Machine Groups, Cellular Manufacturing, Applications of Group Technology. Analysis of Cellular Manufacturing. Flexible Manufacturing System: Components, application and analysis.

ASSESSMENT

1 **Theory Examination** (70 marks) on the basis of end term theory paper examination (from Units 1 to 5)

2 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

TEXT BOOKS

1 *Automation, Production Systems and CIM* – M. P. Groover

2 *CAD/CAM Principles and Applications* – P. N. Rao

3 *Mechatronics* – W. Bolton

4 *CNC Programming Principles and Applications* – Mike Mattson

5 Manufacturer Datasheets: Siemens, Allen Bradley, Festo, etc.

B. Tech. 4th Year (Semester – 7)

ME46327: Data Science and Machine Learning

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME46327	Data Science and Machine Learning	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Mathematics

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

CO 1 Demonstrate understanding of the mathematical foundations needed for data science.

CO 2 Collect, explore, clean, munge and manipulate data.

CO 3 Implement models such as k-nearest Neighbors, Naive Bayes, linear and logistic regression, decision trees, neural networks and clustering.

CO 4 Build data science applications using Python based toolkits.

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	–	–	1	–	–	–	–	–	–	1	1	1
CO2	3	2	–	–	1	–	–	–	–	–	–	1	1	1
CO3	3	2	–	2	1	–	–	–	–	–	–	1	1	1
CO4	3	2	2	–	1	–	–	–	–	–	–	1	2	1
CO5	3	2	1	–	1	–	–	–	–	–	–	1	2	1
Average	3	2	1.5	2	1	–	–	–	–	–	–	1	1.4	1

COURSE CONTENTS

Unit 1 **Introduction to Data Science:** Concept of Data Science, Traits of Big data, Web Scraping, Analysis vs Reporting.

Unit 2 **Introduction to Programming Tools for Data Science**: (a) Toolkits using Python: Matplotlib, NumPy, Scikit- learn, NLTK

Visualizing Data: Bar Charts, Line Charts, Scatterplots (c) Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction

Unit 3 **Mathematical Foundations**:

a) Linear Algebra: Vectors, Matrices,

b) Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation

c) Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem

d) Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, Phacking, Bayesian

Inference.

Unit 4 **Machine Learning**: Overview of Machine learning concepts, Over fitting and train/ test splits, Types of Machine learning, Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks Learning and Generalization, Overview of Deep Learning.

Unit 5 **Case Studies of Data Science Application**: Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.

ASSESSMENT

1 **Class Work:** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination:** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media

2 Aurelien Geron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, O'Reilly Media

3 Jain V.K., “Data Sciences”, Khanna Publishing House, Delhi.

4 Jain V.K., “Big Data and Hadoop”, Khanna Publishing House, Delhi.

5 Jeeva Jose, “Machine Learning”, Khanna Publishing House, Delhi.

6 Chopra Rajiv, “Machine Learning”, Khanna Publishing House, Delhi.

7 Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press

8 Jiawei Han and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Morgan Kaufmann Publishers

B. Tech. 4th Year (Semester – 7)

ME 46314: Power Plant & Energy Management

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 46314	Power Plant & Energy Management	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Thermodynamics , Heat Transfer , Fluid Mechanics

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

CO 1 Enhancement of power plant & energy management

CO 2 Analyze problem in domain of power plant.

CO 3 Exposure to application oriented problem solving and building capabilities to formulate and solve such problems.

CO 4 Inculcation of sense of social responsibility

CO 5 Explain the importance of sustainable development and evolving approaches for it.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	–	1	1	–	–	–	–	–	–	2	2	1
CO2	3	2	–	1	1	–	–	–	–	–	–	2	2	1
CO3	3	2	–	2	1	–	–	–	–	–	–	1	2	1
CO4	3	2	2	–	1	–	–	–	–	–	–	1	2	1
CO5	3	2	1	–	1	–	–	–	–	–	–	1	2	1
Average	3	2	1.5	1.33	1	–	–	–	–	–	–	1.4	2	1

COURSE CONTENTS

Unit 1 **Introduction to Various Energy Conversion System:** Conventional and commercial power plants,

e.g. principles of energy conversion in thermal, hydro, nuclear and Internal Combustion Engine Plants. Principle of Direct Energy Conversion Systems including Materials Processes, and applications, of Thermoelectric Converter, Thermion convertors, Photovoltaic Cells, Magneto-Hydro Dynamic Generators and Fuel Cells, properties of semiconductor material and plasma. Introduction to Renewable Energy Conversion Systems like solar energy, wind energy, geothermal energy tidal energy etc.

Selection: Economic and other considerations in the selection of site for thermal, hydro, nuclear and other types of power plant.

Thermodynamic Cycles of Steam Power Plant. Analysis and calculation of reheat. Regenerative & Binary Cycles

Unit 2 **Thermal Power Plant:** Description of the principle and the working of the units of Fossil, Fuel Fire Thermal Power Plant e.g. Boilers, Coal Firing Systems, Turbines, Condensers, Draft Pump Water Treatment Plant, Coal And Ash Handling System, cooling towers, Dust Collection etc. Introduction to Super Critical Pressure Plants.

Design of Components of Thermal Power Plants: To calculate capacity and major dimensions of boiler,

fuel firing system, water treatment plants, economics of super-heaters feed water heaters, reheaters, condensers, pumps, cooling towers etc.

Unit 3 **Hydro Power Plants:** Estimation of power available from hydrological data, selection of water turbines, layout of different types of plants. Introduction to pumped storage plants. Principles of economic consideration of hydro and steam power plant.

Internal Combustion Engine Power Plant: Introduction to various systems and components of Diesel Engine Power Plant e.g. Engine, Air, Intake and Exhaust gas systems, Fuel and lube oil systems, cooling water system etc. calculations of capacity of engine, fuel and lube oil requirements, efficiencies, cooling water quantities etc.

Unit 4 Principles of working of gas turbines cycles. Efficiencies and output of gas turbines, Reheating regenerative and multistage compression.

Introduction to Stationary Gas Turbine Power Plant and their components, combined cycles and cogeneration plants.

Unit 5 **Nuclear Power Plants:** nuclear reactions used for power generation elements of a slow and a fast reactor, Different types of power reactors, calculations of fuel feed rate, cooling water rate, quantity of steam supplied etc.

Power Station Economics: Definitions and application of load curves, load factor, plant capacity factor, plant utilization factor, diversity factor and demand factor. Introduction to energy audit. Elements of fixed and operating costs, power and various tariff.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Yadav, R., Steam & Gas Turbine, Standard Publishers, 2007

2 Cohen, Rogers, & Saravanamuttoo, Gas Turbine Theory, Prentice Hall, 2001

3 Domkundwar & Arora, A Course in Power Plant Engineering, Dhanpat Rai and Sons, 2005

4 Rajput R.K., A textbook of Power Plant Engineering, Laxmi Publications, 2005

5 Nag P.K., Power Plant Engineering, Tata McGraw-Hill Education, 2002

REFERENCE BOOKS

1 Noeb Hussain, Steam turbine theory and Design, Tata McGraw-Hill, 1984
2 Yahaya S.M., Turbine Compressors & Fans, Tata McGraw Hill, 2005
3 Khajuria & Dubey, Gras Turbine & Propulsive System, Dhanpat Rai and Sons, 1984
4 Black & Veatch,Power Plant Engineering, Springer, 1996
5 Angrist, S.W., Direct Energy Conversion, Allyn and Bacon, 1976
6 Skrotzki and Vopat, Power stations engineering and economy, Tata McGraw-Hill Education, 1960

B. Tech. 4th Year (Semester – 8)

ME46667 : Composite Materials

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 46667	Composite Materials	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Material Science

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

CO 1 Discuss the development of composite materials, their importance, its engineering potential and classification of composites.

CO 2 Identify constituents of composites with their types, role, development, selection and their influence on mechanical properties.

CO 3 Describe fundamentals of manufacturing processes used for development of composites, their types, methods, parameter to be controlled, relative advantages and limitations.

CO 4 Categorize micro-mechanical concepts of composites, stress-strain characteristics of FRP composites, anisotropic/orthotropic materials, and their transformation.

CO 5 Discuss the strength and failure concept in composites, failure mechanics of composites, and know about composite codes & standards and testing.

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

COURSE CONTENTS

Unit 1 **Introduction to Composites**: General Introduction and Concept, Historical development of composites, Concept of Composite materials, importance of composite material & its engineering applications, Comparison with traditional materials, Advantages & Limitations of Composites. Classification of Composites on the Basis of matrix and reinforcement.

Unit 2 **Basic constituents of Composites**: Types of Reinforcements, Role and Selection of reinforcement materials, Mechanical properties of fibres and whiskers, Manufacturing of various fibers, comparison of reinforcements, Functions of a Matrix, Desired Properties of a Matrix, Types of matrix materials.

Unit 3 **Manufacturing Processes of composites**: Fundamentals of Manufacturing, Manufacturing of Polymer, Metal, Ceramic and Carbon Composites, Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method, Autoclave method, Filament winding method,

Compression moulding , Reaction injection moulding . Properties and applications.

Unit 4 **Mechanics of composites**: Micromechanical analysis of composites, volume and weight fractions, Longitudinal and transverse modulus, Shear modulus, Elastic Properties of Lamina, Stress-Strain relationship of composite materials, Isotropic materials. Orthotropic materials, Compliance and stiffness matrices, Fiber reinforced composites, Transformation of stress-strain.

Unit 5 **Strength and failure concept in composites**: Strength of laminates, Failure Mechanics of composites, Macro-mechanical failure theories. Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai-Wu theory. Composite codes & standards. Testing of Composites.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Fiber Reinforced composites, Materials, Manufacturing and Design, P K Mallick, CRC Press

2 Mechanics of composite materials, Auter Jaw

3 Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.

REFERENCE BOOKS

1 Mechanics of composite materials, R. Jones, Taylor & Francis

2 Hand Book of Composite Materials-ed-Lubin.

3 Composite Materials – K.K.Chawla.

4 Composite Materials Science and Applications – Deborah D.L. Chung.

B. Tech. 4th Year (Semester – 8)

ME46668: Renewable Energy Sources

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME46668	Renewable Energy Sources	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Physics

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

CO 1 Discuss the potential impacts of harnessing energy sources.
CO 2 Measure solar radiation and understand methods of utilizing solar energy.
CO 3 Classify of wind turbines and its subsystems.
CO 4 Classify of biomass and bio-energy.
CO 5 Distinguish the methods of harnessing ocean, geothermal and hydel energy.

ARTICULATION MATRIX

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

COURSE CONTENTS

Unit 1 **Energy and Environment:** Primary energy sources, world energy resources, Indian energy scenario, energy cycle of the earth, environmental aspects of energy utilisation, CO2 emissions and Global warming, renewable energy resources and their importance. Potential impacts of harnessing the different renewable energy resources.

Unit 2 **Solar Energy:** Principles of solar energy collection, solar radiation, measurements, instruments, data and estimation, types of collectors, characteristics and design principles of different type of collectors, performance of collectors, testing of collectors. Solar thermal applications, water heaters and air heaters, performance and applications, simple calculations, solar cooling, solar drying, solar ponds, solar tower concept, solar furnace.

Unit 3 **Wind energy Systems:** Orientation systems and regulating devices, design of blades, Aerodynamic configuration of rotor and determination of blade structure, Description and performance of Vertical axis wind mills. Use of wind energy for water pumping and generation of electricity, Installation operation and maintenance of small wind energy conversion systems.

Unit 4 **Ocean Energy:** Energy from tides and waves, working principles of tidal plants and ocean thermal energy

conversion plants,

Geothermal Energy: Introduction to geothermal power, principle of working of geothermal power plants.

Hydel Energy: Small, mini and Micro hydro system, concepts, types of turbine, hydrological analysis.

Unit 5 **Bio Energy:** Energy from bio mass and bio gas plants, various types, design principles of biogas plants, applications. Energy from wastes, waste burning power plants, utilization of industrial and municipal wastes, energy from the agricultural wastes.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Rai G.D, Non-conventional Energy sources, Khanna Publishers, New Delhi, 1999.

2 Ashok V Desai, Non-conventional Energy, Wiley Eastern Ltd, New Delhi, 1990.

3 Khan B.H., Non-Conventional Energy Resources,Tata McGraw-Hill Education, 2006.

4 Sawhney, G.S., Non-Conventional Energy Resources, PHI Learning

REFERENCE BOOKS

1 Loulou, Waaub & Zaccour, Energy and Environment, Springer.

2 Sukhatme & Nayak,Solar Energy: Principles of Thermal Collection and Storage, McGraw-Hill Education.

3 Tiwari G. N., Solar Energy: Fundamentals, Design, Modelling and Applications, CRC Press.

4 Jain Pramod, Wind Energy Engineering, McGraw Hill Professional.

5 Lee & Shah, Biofuels and Bioenergy: Processes and Technologies, CRC Press.

B. Tech. 4th Year (Semester – 8)

IP46669 : Industrial Inspection & Quality Control

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
IP46669	Industrial Inspection And Quality Control	3	0	0	3	-	3	70	30	-	-	100

PRE-REQUISITES: Nil

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

CO 1 Understand measurement principles, limits, fits, tolerances, and gauge design using ISI/ISO systems.
CO 2 Use tools for angular, surface, and geometric measurements, and inspect threads and gears.
CO 3 Explain quality control concepts and its role in industrial applications.
CO 4 Apply control charts and process capability studies for quality monitoring.
CO 5 Select and implement suitable acceptance sampling plans and analyze their economics.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	3	3		2	3									
CO3	3	3	2					2						
CO4	3	3		3	2									
CO5	3	3	2	2	2									
Average	3	2.8	2	2.3333	2.3333	0	0	2	0	0	0	0	0	0

COURSE CONTENTS

Unit 1 Principles of Measurement: Limit gauging, various systems of limits, Fits and tolerance, ISI and ISO system.

Basic principles of design of gauges, types of gauges and their design.

Optical instruments like projector, autocolimeter, use of interferometry for linear measurement.

Unit 2 Angular measurement, angle gauges, sine-bar, clinometers, measurement of straightness, flatness and squareness.

Surface topography - primary & secondary texture, measurement of surface roughness. Inspection of screw threads and gears.

Unit 3 Place of quality control in industries, quality control organization, difference between inspection and quality control. Application of quality control.

Unit 4 Theory of control charts, sample size and frequency of sampling, out of control criteria. Variable control charts, control charts for X, and R, process capability studies.

Control charts for fraction defective and number of defects.

Unit 5 Acceptance sampling, single sampling plans, double sampling and sequential sampling plans, Sampling plans continuous production.

Selection of sampling plans for different situations. Economics of acceptance sampling.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Hume, Engineering Metrology.

2 Judge, Engineering Precision Measurement.

3 Jain R.K., Engineering Metrology.

4 Sharp K.W.P., Engineering Metrology.

5 Grant, Statistical Quality Control.

6 Hanson, Quality Control.

7 Duncon, Quality Control.

8 Juran, Quality Planning & Analysis.

B. Tech. 4th Year (Semester – 8)

ME46670 : Finite Element Method

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 46670	Finite Element Method	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Mathematics, Machine Design

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

CO 1 Evaluate of problems by approximate methods over the whole domain.
CO 2 Apply FEM to formulate and solve 1-D problems.
CO 3 Solve truss, beam and frame problems by finite element method
CO 4 Write shape functions two dimensional and quadrilateral elements and solve two dimensional problems.
CO 5 Solve problems of bars for free vibration, forced vibration and transient vibration

ARTICULATION MATRIX

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

COURSE CONTENTS

Unit 1 Solution to engineering problems, mathematical modeling, discrete and continuum modeling, need for numerical methods of solution, relevance and scope of finite element methods, engineering applications of FEA, Initial value and boundary value problems.

Weighted residual methods, weak formulation of the weighted residual statement, principle of stationary total potential, Rayleigh Ritz method.

Unit 2 **1-D Elements:** Formulation for 1-D applications, linear bar element, quadratic element, shape functions. Application to thermal and fluid flow problems

Unit 3 Beam element, thin beam approximation, Euler Bernoulli's beam element, Shear locking, Timoshenko beam element for thick beam, shape functions, Applications to truss and frame problems.

Unit 4 **2-D Analysis:** triangular, rectangular and quadrilateral elements, higher order elements, natural coordinates and coordinate transformations, iso-parametric formulation, plane stress and plane strain problems, axi-symmetric problems, Gausss quadrature formula, natural coordinates,

Unit 5 **DYNAMIC ANALYSIS:** vibration problems, equations of motion, longitudinal vibration of bars, consistent mass matrices, eigenvalue problems, normal modes, forced vibration, transient vibrations, modeling of damping, mode superposition technique.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 P. Seshu, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi.

2 Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Ed., Prentice-Hall of India.

REFERENCE BOOKS

1 J.N. Reddy, "An Introduction to the Finite Element Method", McGraw-Hill International Editions, 1993.

2 David V. Hutton,, 'Fundamentals of Finite Element Analysis', Tata McGraw-Hill Edition, 2005.

3 Cook, Robert. D., Plesha, Michael. E & Witt, Robert. J., "Concepts and Applications of Finite Element Analysis", Wiley Student Edition, 2004.

4 J.N. Reddy, "An Introduction to the Finite Element Method", McGraw-Hill International Editions, 1993.

B. Tech. 4th Year (Semester – 8)

ME46672 : Robotics

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME46672	Robotics	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Physics , Mathematics

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

CO 1 Classify basic terminologies and concepts associated with Robotics and Automation.
CO 2 Categorize robot kinematics and dynamics to explain motion and force analysis in robotics.
CO 3 Application of different types of sensors and actuating system in robotics.
CO 4 Apply concept of control system in robotics
CO 5 Application of AI and Embedded systems in Robotics

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	–	1	1	–	–	–	–	–	2	1
CO2	3	2	1	1	–	–	–	–	–	–	–	–	2	1
CO3	3	1	1	–	–	–	–	–	–	–	–	–	1	1
CO4	3	1	1	–	–	–	–	–	–	–	–	–	1	1
CO5	3	1	1	–	–	–	–	–	–	–	–	–	1	1
Average	3	1.4	1	1	–	1	1	–	–	–	–	–	1.4	1

COURSE CONTENTS

Unit 1 Introduction to Robotics

Introduction to Robotics, Types and components of a robot, Classification of robots, Kinematics systems; Definition of mechanisms and manipulators, Degrees of Freedom. Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Robotics and Automation for Industry 4.0.

Unit 2 Robot Kinematics and Dynamics

Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Forward and inverse kinematics, Jacobian, Singularity, and Statics.

Dynamic Modelling: Forward and inverse dynamics, Equations of motion using Euler-Lagrange formulation, Newton Euler formulation.

Unit 3 Robot Sensors and Actuating systems

Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations Vision

applications in robotics.

Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.

Unit 4 Control Systems

Basics of control: open loop- closed loop, Transfer functions, block diagram, Laplace Transformation, Mathematical modelling of mechanical and electrical system and Control laws: P, PD, PID Linear and Non-linear controls.

Unit 5 AI and Embedded systems in Robotics

Applications in unmanned systems, defense, medical, industries, etc. Microcontroller Architecture and integration with sensors, actuators, components, Programming Applications for Industrial robot - programming in – VAL II

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Saha, S.K., “Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.

2 Industrial Robotics: M. P. Groover, Ashish Dutta, McGraw Hill

3 Craig, J.J., “Introduction to Robotics: Mechanics and Control”, Pearson, New Delhi.

4 Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, “Robot Modelling and Control”, John Wiley

5 Robotics Engineering: R. Klafter, PHI

B. Tech. 4th Year (Semester – 8)

ME46673 : Rotor Dynamics

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 46671	Rotor Dynamics	3	0	0	3	-	3	70	30	-	-	100

PRE-REQUISITES: Fluid Mechanics , Strength of Material, Mathematics

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

CO 1 Classify rotor systems and model them using Jeffcott rotor model
CO 2 Model rotor systems using lumped parameter approach as a multi dof system.
CO 3 Analyze rotor systems including gyroscopic and tangential forces.
CO 4 balance rotors in field as well as on balancing machines
CO 5 Apply Signal processing techniques.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	0	0	0	0	0	0	0	0	0	0	0
CO2	3	3	2	0	0	0	0	0	0	0	0	0	0	0
CO3	3	3	3	2	0	0	0	0	0	0	0	0	0	0
CO4	2	2	3	2	3	0	0	0	0	0	0	0	0	0
CO5	2	2	0	3	3	0	0	0	0	0	0	0	0	0
Average	2.6	2.6	2	1.4	1.2	0	0	0	0	0	0	0	0	0

Unit no.	COURSE CONTENTS
Unit 1	History of rotor dynamics. Types of vibration in rotor systems, Critical speed of rotor system, Self- centering, unbalance response study using Jeffcott rotor model. Types of bearings used to support rotating machines, Classification of rotor models.
Unit 2	Simple lumped parameter models of rotor systems (Extended Jeffcott rotor). Offset disc on flexible shaft on hinged support, rigid rotor supported on flexible bearing. Effect of anisotropic bearings on modal analysis, Development of code for rotor dynamic analysis.
Unit 3	Effect of gyroscopic and tangential forces on dynamics of rotor systems. Use of finite element analysis software to study dynamics of rotating machines.
Unit 4	Vibration monitoring of rotating machinery. Measurement techniques. Vibration signature analysis, rotor balancing.
Unit 5	Condition indicators (features), time domain, frequency domain and time-frequency domain features Data classification, application of of machine learning in rotor fault diagnosis. Use of software tool boxes for predictive maintenance.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 R. Tiwari, Rotor systems: analysis and identification, 2017 ed. CRC Press, 2017.

2 M. I. Friswell, J. E. T. Penny, S. D. Garvey, and A. W. Lees, Dynamics of Rotating Machines (Cambridge Aerospace Series). Cambridge: Cambridge University Press, 2010.

REFERENCE BOOKS

1 J. S. Rao, Rotor Dynamics, Third ed., New Age, New Delhi, 1996

2 A. Muszynska, Rotor dynamics, 2005 ed. CRC Press, Taylor and Francis 2005.

B. Tech. 4th Year (Semester – 8)

ME 46671 : Artificial Intelligence

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
XX 46671	Artificial Intelligence	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Mathematics, Basic Computer science

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

- **CO 1** Build intelligent agents for search and games
- **CO 2** Solve AI problems through programming with Python
- **CO 3** Compute optimization and inference algorithms for model learning
- **CO 4** Design and develop programs for an agent to learn and act in a structured environment
- **CO 5** Apply the principle of reinforcement learning

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	1	1	2	–	–	–	–	1	3	2
CO2	3	2	1	2	2	2	2	–	–	–	–	1	3	2
CO3	3	2	1	–	2	2	–	–	–	–	–	–	3	1
CO4	3	2	1	–	1	1	–	–	–	–	–	–	3	1
CO5	3	2	1	–	1	–	–	–	–	–	–	–	3	2
Average	3	2	1	–	1.4	1.5	2	–	–	–	–	1	3	1.6

COURSE CONTENTS

Unit 1 **Introduction:** Concept of AI, history, current status, scope, agents, environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree.

Unit 2 **Search Algorithms:** Random search, Search with closed and open list, Depth first and Breadth first search, Heuristic search, Best first search, A* algorithm, Game Search.

Unit 3 **Probabilistic Reasoning:** Probability, conditional probability, Bayes Rule, Bayesian Networks-representation, construction and inference, temporal model, hidden Markov model.

Unit 4 **Markov Decision process:** MDP formulation, utility theory, utility functions, value iteration, policy iteration and partially observable MDPs.

Unit 5 **Reinforcement Learning:** Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active reinforcement learning- Q learning.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall

2 Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill

3 Trivedi, M.C., "A Classical Approach to Artificial Intelligence", Khanna Publishing House, Delhi.

4 Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, 2011

5 David Poole and Alan Mackworth, "Artificial Intelligence: Foundations for Computational Agents", Cambridge University Press 2010.

B. Tech. 4th Year (Semester – 8)

ME46708 : Gas Dynamics & Fluid Flow

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
XX 46708	Gas Dynamics & Fluid Flow	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: T hermodynamics, Fluid Mechanics

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

CO 1 Discuss the types of flows through the nozzle and diffusers and factors affecting them.
CO 2 Classify the boundary layer theory including drag and lift.
CO 3 Classify the hydrodynamics lubrication and selection of lubrications for specific purpose.

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	1	-	-	-	-	-	-	-	2	1
CO2	3	2	2	1	-	-	-	-	-	-	-	-	2	1
CO3	3	2	1	2	-	-	-	-	-	-	-	-	2	1
Average	3	2	1	2	1	0	0	0	0	0	0	0	2	1

COURSE CONTENTS

Unit 1 **Fundamental Aspects of Gas Dynamics:** Introduction and review of thermodynamics; Differences between compressible and incompressible flow; Ideal gas, speed of sound, Mach number, Mach Cone.

Unit 2 **1-D, adiabatic, isentropic duct flow of an ideal gas:** Isentropic relations; One-D compressible adiabatic duct flow, critical properties; Converging nozzles, choking, converging-diverging nozzles and diffuser

Unit 3 **Normal shocks:** Normal shocks in converging-diverging nozzles, property changes across shocks, Fanno Rayleigh curves, Pitot probes, moving normal shocks

Unit 4 **1-D duct flow with heat transfer:** Rayleigh flow and equations, T-s diagrams, choked Rayleigh flow, 1-D duct flow with friction: Fanno flow, choked Fanno flow; Comparison/summary of 1- D flows

Unit 5 **Fluid Flow:** Boundary Layer Theory, Physical Concept of Laminar and Turbulent boundary layer. Friction drag, pressure drag and profile drag. Determination of drag. Separation of boundary layer and its prevention, Kutta-Joukawsky Law, Prandtl Boundary layer Equation. Von-Karman Integral Momentum Equation.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Yahya S.M, Fundamentals of Compressible Flow: Aircraft and Rocket Propulsion, New Age Science.

2 Shapiro A.H., The Dynamics and Thermodynamics of Compressible Fluid Flow, Krieger Pub. Co.

REFERENCE BOOKS

1 H. W. Liepmann, and A. Roshko, Elements of Gas Dynamics, Dover Pub, 2001

2 L.D.Landau and E..M.Lifshitz, Fluid Mechanics. 2nd ed., Butterworth-Heinemann, 1995

3 P. H. Oosthuizen and W. E. Carscallen. Compressible Fluid Flow. NY, Mc Graw-Hill, 1997

4 M.A.Saad, Compressible Fluid Flow. 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 1993

B. Tech. 4th Year (Semester – 8)

ME46705: Engineering Optimization

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME46705	Engineering Optimization	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Mathematics

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

CO 1 Define basic technology and applying classical optimization technique to a given problem.
CO 2 Solve optimization problem using linear programming techniques.
CO 3 Apply single variable optimization search technique to given problem.
CO 4 Explain and apply various methods for non-linear programming problem.
CO 5 Apply the application of other techniques of optimization like genetic algorithms, artificial neural network, simulated annealing etc.

ARTICULATION MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	–	1	1	–	–	–	–	–	2	1
CO2	3	2	1	2	–	1	1	–	–	–	–	–	2	1
CO3	3	1	1	1	–	1	1	–	–	–	–	–	2	1
CO4	3	1	1	1	–	–	–	–	–	–	–	–	2	1
CO5	3	1	1	1	–	–	–	–	–	–	–	–	2	1
Average	3	1.4	1	1.4	–	1	1	–	–	–	–	–	2	1

COURSE CONTENTS

Unit 1 Introduction and Classical Optimization Techniques, Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems. Optimization Techniques.

Unit 2 Classical Optimization Techniques. Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints. Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints. Kuhn-Tucker Conditions, Constraint Qualification.

Unit 3 Unconstrained optimization Techniques, Introduction; Standard form of the problem and basic terminology; Direct search method- Simplex method, Random search method, Univariate and pattern search method Indirect search method-Steepest Descent (Cauchy) method, Conjugate gradient method, Newton's method, Application to engineering problems

Unit 4 Constrained Optimization Introduction; Standard form of the problem and basic terminology; Direct method: Sequential Linear Programming; Generalized Reduced gradient method, Methods of feasible direction Indirect method: Penalty function method Interior and exterior penalty function method, Convex programming problem, Check for convergence Application to engineering problems

Unit 5 Introduction to non-traditional methods, Genetic Algorithm: Introduction, Representation of design variables, objective function and constraints, Genetic operators and numerical results. Introduction to Neural network based optimization.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Engineering Optimization (Theory and Practice) by S. S. Rao, New Age Int. (P) Ltd, 2002.

REFERENCE BOOKS

1 Optimization Methods in Operations Research and systems Analysis – by K.V. Mital and C. Mohan, New Age Int. Publishers, 1996.

2 Operations Research: An Introduction by H.A. Taha, PHI Pvt. Ltd.

3 Introductory Operations Research by H.S. Kasene & K.D. Kumar, Springer (India).

B. Tech. 4th Year (Semester – 8)

ME46704 : Design of Thermal Systems

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 46704	Design of Thermal Systems	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Thermodynamics , Heat Transfer , Fluid Mechanics

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

CO 1 Distinguish various types of heat exchangers and terminologies related to them.
CO 2 Design shell and tube type heat exchanger for particular industrial applications.
CO 3 Design evaporator, cooling towers and condensers.
CO 4 Discuss the fouling phenomenon, prevention and mitigation.
CO 5 Design a heat exchanger using different software.

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	2	1	-	-	-	-	-	-	-	3	2
CO2	3	3	2	1	-	-	-	-	-	-	-	-	3	2
CO3	3	3	2	3	-	-	-	-	-	-	-	-	3	2
CO4	3	3	2	2	-	-	-	-	-	-	-	-	3	2
CO5	3	1	1	1	1	2	1	-	-	-	-	-	3	2
Average	3	2.6	1.6	1.8	1	2	1	-	-	-	-	-	3	2

COURSE CONTENTS

Unit 1 **Introduction:** Types of heat exchangers, heat transfer laws applied to heat exchangers, convection Coefficients, resistance caused by the walls and by fouling, overall heat transfer coefficient.

Unit 2 **Thermal & hydraulic design of commonly used heat exchangers**: LMTD & NTU Methods, correction factors, Double pipe heat exchangers, shell and tube heat exchangers, condensers, Evaporators ,Cooling and dehumidifying coils ,cooling towers, evaporative condensers ,design of air washers, desert coolers.

Unit 3 **TEMA standard:** Tubular heat exchangers TEMA standard heat-exchanger nomenclature, selection criteria for different types of shells and front and rear head ends; geometrical characteristics of TEMA heat exchangers.

Unit 4 **Review of mechanical Design,** Materials of Construction, corrosion damage, testing and inspection.

Unit 5 **Heat Pipe:** Basics & its mathematical model, micro Heat Exchangers, Use of Software in heat exchanger design.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 Kern D Q, Kraus A D; Extended Surface Heat Transfer, McGraw Hill Education Pvt. Ltd.

2 Kokac, Heat Exchangers- Thermal Hydraulic fundamentals and design, McGraw Hill Pvt. Ltd.

3 Kays, Compact Heat Exchangers, McGraw Hill Education Pvt. Ltd.

4 Shah and Sekulic, Fundamentals of Heat Exchanger Design, John Wiley & Sons.

B. Tech. 4th Year (Semester – 8)

ME 46707 : Computational Fluid Dynamics

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
ME 46707	Computational Fluid Dynamics	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Fluid Mechanics , Mathematics

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

CO 1 Discuss different methods and techniques to analysis of fluid mechanics and heat transfer problems.

CO 2 Distinguish the interaction of physical processes and numerical techniques. Contemporary methods for boundary layers, incompressible viscous flows, and inviscid compressible flows.

CO 3 Apply Finite differences and finite volume techniques

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	3	-	3	-	-	-	-	-	-	-	-	-
Average	3	2	2	2	3	0	0	0	0	0	0	0	0	0

COURSE CONTENTS

Unit 1 **Governing Equations And Boundary Conditions:** Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

Unit 2 **Finite Difference Method:** Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – solution methods for finite difference equations – Elliptic equations –Iterative solution Methods – Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations.

Unit 3 **Finite Volume Method (FVM) For Diffusion:** Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank – Nicolson and fully implicit schemes.

Unit 4 **Finite Volume Method For Convection Diffusion:** Steady one-dimensional convection and diffusion – Central, upwind differencing schemes-properties of discretization schemes – Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, QUICK Schemes.

Unit 5 **Calculation Flow Field By FVM:** Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models.

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

TEXT BOOKS

1 T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002.

2 Versteeg, H. K., & Malalasekera, W., An Introduction to Computational Fluid Dynamics, The finite volume Method, Longman, 1998.

3 Ghoshdastidar , P. S., Computer Simulation of Flow and Heat Transfer, Tata McGraw Hill Publishing Company Ltd., 1998.

REFERENCE BOOKS

1 Patankar, S.V., Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 2004.

2 Muralidhar, K., and Sundararajan, T., Computationsl Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 1995.

3 Ghoshdastidar P.S., Heat Transfer, OxfordUniversity Press, 2005.

4 Prodip Niyogi, Chakrabarty .S.K., Laha .M.K., Introduction to Computational Fluid Dynamics, Pearson Education, 2005.

5 Introduction to Computational Fluid Dynamics, Anil W. Date, Cambridge University Press, 2005.

B. Tech. 4th Year (Semester – 8)

ME46706: 3D Printing and Design

CODE	SUBJECT NAME	Hours per Week			Credits			Maximum Marks				
								Theory		Practical		Total
		L	T	P	T	P	Total	Th.	CW	SW	Pr.	
XX 46706	3D Printing And Design	3	-	-	3	-	3	70	30	-	-	100

PRE-REQUISITES: Computer Aided Design

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

CO 1 Develop CAD models for 3D printing
CO 2 Import and Export CAD data and generate .stl file.
CO 3 Select a specific material for the given application
CO 4 Select a 3D printing process for an application.
CO 5 Build a product using 3D Printing or Additive Manufacturing (AM).

ARTICULATION MATRIX														
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	–	3	–	–	–	–	–	–	1	3	2
CO2	3	2	3	–	–	–	–	–	–	–	–	1	3	2
CO3	3	2	3	–	–	–	1	–	–	–	–	1	3	2
CO4	3	3	2	–	–	–	–	–	–	–	–	1	3	2
CO5	3	2	2	–	3	–	–	–	–	–	–	1	3	2
Average	3	2.2	2.4	–	3	–	1	–	–	–	–	1	3	2

COURSE CONTENTS

Unit 1 CAD for Additive Manufacturing: CAD Data formats, Data translation, Data loss, STL file format & its importance

3D Printing (Additive Manufacturing): Introduction, Process, Classification, Advantages, Additive v/s Conventional Manufacturing processes, Applications.

Unit 2 Additive Manufacturing Techniques:

- Process, Process parameter, Process Selection for various applications.
- Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools
- Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.

Unit 3 Materials

- Polymers, Metals, Non-Metals, Ceramics
- Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties.
- Support Materials

Unit 4 Additive Manufacturing Equipment

- Process Equipment- Design and process parameters, Laser in additive manufacturing.
- Governing Bonding Mechanism
- Common faults and troubleshooting
- Process Design

Unit 5 Post Processing: Requirement and Techniques Product Quality

- Inspection and testing
- Defects and their causes

ASSESSMENT

1 **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.

2 **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

REFERENCE BOOKS

1 Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

2 Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.

3 Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.

4 CK Chua, Kai Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.

5 J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science, 2013.

6 L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.