NETAJI SUBHAS UNIVERSITY

Estd. Under Jharkhand State Private University Act, 2018

Department of Mechanical Engineering

Bachelor of Technology in Mechanical
Course Curriculum
(with CO, PO Structure)

w.e.f. 2023

Head
Department of Mechanical
Netaji Subhas University

Dean Academics
Netaji Subhas University
Jamshedpur, Jharkhand

VISION

To strive for excellence in education, research, and entrepreneurship, with the ultimate goal of becoming a global hub for innovation. Committed to advancing scientific and technological services, we aim to contribute meaningfully to society.

MISSION

- To provide high-quality education that nurtures innovation, entrepreneurship, and ethical values, shaping future professionals equipped for a globally competitive landscape.
- To collaborate with stakeholders by sharing institutional expertise in education and knowledge, fostering mutual growth in technical learning.
- To Cultivate an environment that encourages fresh ideas, groundbreaking research, and academic excellence, paving the way for future leaders, innovators, and entrepreneurs.
- To drive socio-economic progress by offering impactful scientific and technological solutions to society.

PROGRAMME EDUCATION OBJECTIVES (PEOs)

PEO1: The Graduates of Mechanical Engineering Programme will develop solution of complex engineering problems related to the society in their profession and career.

PEO2: The Graduates of Mechanical Engineering Programme will pursue continuing education.

PEO3: The Graduates of Mechanical Engineering Programme will demonstrate and exemplify team work and ethical practices in their career.

PROGRAMME OUTCOMES (POs)

PO1. Ability to acquire and apply knowledge of science and mechanical engineering fundamentals.
PO2. Ability to design and conduct experiments for complex mechanical engineering problems.
PO3. Ability to design system, components, and process by meeting the constraints such as safety, public health and environment.
PO4. Ability to communicate effectively using a variety of appropriate mediums.
PO5. Ability to identify problem and formulate solution in mechanical engineering.
PO6. Ability to use modern engineering tools to solve mechanical engineering problems.
PO7. Ability to perform effectively in team working environment.
PO8. Recognize the need to undertake life-long learning and acquire the capacity to do so.
PO9. Comprehend global perspective on social, cultural and environmental responsibilities aligned with professional codes of ethics.
PO10. Comprehend the principles of sustainable development.
PO11. Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
PO12. Demonstrate understanding of project management and finance principles.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: Ability to analyse and design physical systems and components using AUTOCAD, CATIA and ANSYS etc. software.

PSO2: To work professionally in manufacturing, design, thermal engineering and software industries.

Course Structure of B.Tech Mechanical Engineering

I SEMESTER

Code No	Name of the Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT101	Engineering Mathematics-I	3	1	-	4	30	70	100
BT102	Engineering Physics	4	-	-	4	30	70	100
BT103	Programming in C	4	-	-	4	30	70	100
BT104	Elements of Mechanical Engineering	3	-	-	4	30	70	100
BT105	Basic of Electrical Engineering	3	-	-	4	30	70	100
BT106	Professional Communication Skill	3	-	-	3	30	70	100
	Practical							
BT107L	Engineering Physics Lab	-	-	3	2	15	35	50
BT108L	Programming in C Lab	-	-	3	2	15	35	50
	TOTAL	**20**	**1**	**6**	**27**	**210**	**490**	**700**

II SEMESTER

Code No	Name of the Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT 201	Engineering Mathematics-II	4	1	-	4	30	70	100
BT 202	Engineering Chemistry	4	-	-	4	30	70	100
BT 203	Elements of Civil Engineering and Mechanics	4	-	-	4	30	70	100
BT 204	Computer Aided Engineering Drawing	4	-	-	4	30	70	100
BT 205	Basic Electronics	4	-	-	3	30	70	100
BT 206	Software Engineering	3	1	-	3	30	70	100
	Practical							
BT207L	Engineering Chemistry Lab	-	-	3	2	15	35	50
BT208L	Workshop Practice	-	-	3	2	15	35	50
	TOTAL	**22**	**2**	**6**	**26**	**210**	**490**	**700**

III SEMESTER

Code No	Name of the Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT301	Engineering Mathematics	3	1	-	4	30	70	100
BT3ME02	Material Science	4	-	-	4	30	70	100
BT3ME03	Basic Thermodynamics	4	-	-	4	30	70	100
BT3ME04	Mechanics Of Materials	4	-	-	4	30	70	100
BT3ME05	Metal Casting & Welding	4	-	-	4	30	70	100
BT3ME06	Computer Aided Machine Design	4	-	-	4	30	70	100
	Practical							
BT3ME07L	Material Testing Lab	-	-	3	2	15	35	50
BT3ME08L	Machine Shop	-	-	3	2	15	35	50
	TOTAL	**23**	**1**	**6**	**28**	**210**	**490**	**700**

IV SEMESTER

Code No	Name of the Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT401	Engineering Mathematics – IV	3	1	-	4	30	70	100
BT4ME02	Kinematics Of Machine	4	-	-	4	30	70	100
BT4ME03	Applied Thermodynamics	4	-	-	4	30	70	100
BT4ME04	Fluid Mechanics	4	-	-	4	30	70	100
BT4ME05	Machine Tool and Operations	4	-	-	4	30	70	100
BT4ME06	Mechanical Measurements and Metrology	4	-	-	4	30	70	100
	Practical							
BT4ME07L	Mechanical Measurements and Metrology Lab	-	-	3	2	15	35	50
BT4ME08L	Manufacturing Lab	-	-	3	2	15	35	50
	TOTAL	**23**	**1**	**6**	**28**	**210**	**490**	**700**

V SEMESTER

Code No	Name of the Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT5ME01	Management and Engineering Economics	4	-	-	4	30	70	100
BT5ME02	Dynamics of Machines	4	-	-	4	30	70	100
BT5ME03	Turbo machines	4	-	-	4	30	70	100
BT5ME04	Design of Machine Elements-I	4	-	-	4	30	70	100
BT5ME05	Refrigeration and Air conditioning	4	-	-	4	30	70	100
BT5ME06	Elective-I	4	-	-	4	30	70	100
	Practical							
BT5ME07L	Fluid Mechanics and Machinery Lab	-	-	3	2	15	35	50
BT5ME08L	Energy Lab	-	-	3	2	15	35	50
	TOTAL	**24**	**0**	**6**	**28**	**210**	**490**	**700**

Elective – I
Theory Of Elasticity
Human Resource Management
Non-Traditional Machine
Energy Environment

VI SEMETER

Code No.	Name of Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT6ME01	Finite Element Analysis	4	-	-	4	30	70	100
BT6ME02	Computer integrated Machine	4	-	-	4	30	70	100
BT6ME03	Heat Transfer	4	-	-	4	30	70	100
BT6ME04	Design Of Machine-II	4	-	-	4	30	70	100
BT6ME05	Total Quality Management	4	-	-	4	30	70	100
BT6ME06	Elective - II	4	-	-	4	30	70	100
	Practical							
BT6ME07L	Heat Transfer Lab			3	2	15	35	50
BT6ME08L	Modelling And Analysis Lab			3	2	15	35	50
Total		**24**	**0**	**6**	**28**	**210**	**490**	**700**

Elective -II
Computational Fluid Dynamics
Industrial Safety
Metal Forming
Automobile Engineering

1st SEMESTER

Code No.	Name of the Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT 101	Engineering Mathematics-I	3	1	-	4	30	70	100
BT 102	Engineering Physics	4	-	-	4	30	70	100
BT 103	Programming in C	4	-	-	4	30	70	100
BT 104	Elements of Mechanical Engineering	3	-	-	4	30	70	100
BT 105	Basic of Electrical Engineering	3	-	-	4	30	70	100
BT 106	Professional Communication Skill	3	-	-	3	30	70	100
	Practical							
BT 107L	Engineering Physics **Lab**	-	-	4	2	15	35	50
BT 108L	Programming in C **Lab**	-	-	4	2	15	35	50
	Total	**20**	**1**	**8**	**27**	**210**	**490**	**700**

ENGINEERING MATHEMATICS-I (BT 101)

Subject Code	**BT 101**	**IA Marks**	**30**
Number of Lecture Hours/Week	**04**	**Term End Exam Marks**	**70**
Total Number of Lecture Hours	**60**	**CREDITS**	**04**

Course Objectives:

To enable the students to apply the knowledge of Mathematics in various engineering fields by making them to learn the following:

- nth derivatives of product of two functions and polar curves.
- Partial derivatives
- Vector calculus
- Reduction formulae of integration; to solve First order differential equations.
- Solution of system of linear equations, quadratic forms.

Module – 1

Differential Calculus -1: Determination of n^{th} order derivatives, Leibnitz's theorem (Without proof)- problems.

Taylor's and Maclaurin's theorems for function of one variable (statement only)- problems. Evaluation of Indeterminate forms.

Partial derivatives – Definition and simple problems, Euler's theorem (without proof) –

problems, total derivatives, partial differentiation of composite functions- problems. Definition and evaluation of Jacobians

Hours – 12

Module -2

Differential Calculus -2

Polar Curves - angle between the radius vector and tangent, angle between two curves, Pedal equation of polar curves. Derivative of arc length - Cartesian, Parametric and Polar forms (without proof)- problems. Curvature and Radius of Curvature – Cartesian, Parametric, Polar and Pedal forms (without proof) - problems

Hours - 10

Module-3

Integral Calculus:

Reduction formulae - $\int Sin^n x\ dx, \int Cos^n x\ d, \int Sin^m x\ Cos^n x\ dx$, (m and n are positive integers), evaluation of these integrals with standard limits (0 to $\pi/2$) and problems.

Hours-10

Module-4

First order Differential Equations:

Exact, reducible to exact and Bernoulli's differential equations. Orthogonal trajectories in Cartesian and polar form. Simple problems on Newton's law of cooling.

Hours - 12

Module-5

Linear Algebra

Rank of a matrix by elementary transformations, solution of system of linear equations - Gauss-elimination method, Gauss–Jordan method and Gauss-Seidel method, Linear transformation, Eigen values and Eigen vectors. diagonalization of a square matrix. Reduction of Quadratic form

Hours - 11

Course Outcomes:

- **CO-1:** On completion of this course, students are able to Use partial derivatives to calculate rates of change of multivariate functions.
- **CO-2:** Analyze position, velocity, and acceleration in two or three dimensions using the calculus of vector valued functions.

- **CO-3:** Recognize and solve first-order ordinary differential equations, Newton's law of cooling
- **CO-4:** Use matrices techniques for solving systems of linear equations in the different areas of Linear Algebra.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	On completion of this course, students are able to Use partial derivatives to calculate rates of change of multivariate functions	K_1
CO2	Analyze position, velocity, and acceleration in two or three dimensions using the calculus of vector valued functions	K_3
CO3	Recognize and solve first-order ordinary differential equations, Newton's law of cooling	K_4
C04	Use matrices techniques for solving systems of linear equations in the different areas of Linear Algebra.	K_5

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3					2	1		
CO2	2				1		1		3	3		
CO3	3		2	3					1	1		
CO4												
CO Average	2.66		2	3			1		2	1.66		

Text Books:

1. B.S Grewal **"Higher Engineering Mathematics"**, Khanna publishers, 42nd edition, 2013.
2. Erwin Kreyszig, **"Advanced Engineering Mathematics**, Wiley, 2013

Reference Books:

1. B.V. Ramana, **"Higher Engineering Mathematics"**, Tata Mc Graw-Hill, 2006
2. N.P. Bali and Manish Goyal, **"A text book of Engineering mathematics"**, Laxmi publications, latest edition.
3. H.K. Dass and Er. Rajnish Verma, **"Higher Engineering Mathematics"**, S.Chand publishing, 1st edition, 2011.

ENGINEERING PHYSICS (BT102)

Subject Code	**BT 102**	**IA Marks**	**30**
Number of Lecture Hours/Week	**04**	**Term End Exam Marks**	**70**
Total Number of Lecture Hours	**60**	**CREDITS**	**04**

Course Objectives:

The Objective of this course is to make students learn and understand basic concepts and principles of physics to analyze practical engineering problems and apply its solutions effectively and meaningfully. To understand building up of models, design issues, practical oriented skills and problem solving challenges are the great task of the course. To know about shock waves and practical applications is the prime motto to introduce new technology at the initial stage of Engineering.

Module-1: Quantum Mechanics

Introduction to quantum physics, Black body radiation, Planck's law, Photoelectric effect, Compton effect, de-Broglie's hypothesis, Wave-particle duality, Davisson and Germer experiment, Heisenberg's Uncertainty principle, Born's interpretation of the wave function, Schrodinger's time independent wave equation, Particle in one dimensional box.

Hours-10

Module-2: Semiconductor Physics

Intrinsic and Extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature, Carrier generation and recombination, Carrier transport: diffusion and drift, Hall effect, p-n junction diode, Zener diode and their V-I Characteristics, Bipolar Junction Transistor (BJT): Construction, Principle of operation.

Hours-10

Module-3: Optoelectronics

Radiative and non-radiative recombination mechanisms in semiconductors, LED and semiconductor lasers: Device structure, Materials, Characteristics and figures of merit, Semiconductor photodetectors: Solar cell, PIN and Avalanche and their structure, Materials, working principle and Characteristics.

Hours-10

Module-4: Lasers and Fibre Optics

Lasers: Introduction to interaction of radiation with matter, Coherence, Principle and working of Laser, Population inversion, Pumping, Types of Lasers: Ruby laser, Carbon dioxide (CO_2) laser, He- Ne laser, Applications of laser. Fibre Optics: Introduction, Optical fibre as a dielectric wave guide, Total internal reflection, Acceptance angle, Acceptance cone and Numerical aperture, Step and Graded index fibres, Losses associated with optical fibres, Applications of optical fibres.

Hours-15

Module-5: Electromagnetism and Magnetic Properties of Materials

Laws of electrostatics, Electric current and the continuity equation, Ampere's and Faraday's laws, Maxwell's equations, Polarisation, Permittivity and Dielectric constant, Internal fields in a solid, Clausius-Mossotti equation, Ferroelectrics and Piezoelectrics. Magnetisation, permeability and

susceptibility, Classification of magnetic materials, Ferromagnetism and ferromagnetic domains, Hysteresis, Applications of magnetic materials.

Hours-15

Course Outcomes:

On Completion of this course, students are able to –

CO-1: Learn and understand more about basic principles and to develop problem solving skills and implementation in technology.

CO-2: Gain Knowledge about Modern physics and quantum mechanics will update the basic concepts to implement the skills.

CO-3: Study of material properties and their applications is the prime role to understand and use in engineering applications and studies.

CO-4: Study Lasers and Optical fibers and its applications are to import knowledge and to develop skills and to use modern instruments in the engineering applications.

CO-5: Understand Crystal structure and applications are to boost the technical skills and its applications.

CO-6: Expose shock waves concept and its applications will bring latest technology to the students at the first year level to develop research orientation programs at higher semester level.

CO-7: Understand basic concepts of nano science and technology.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Learn and understand more about basic principles and to develop problem solving skills and implementation in technology.	K_1
CO2	Gain Knowledge about Modern physics and quantum mechanics will update the basic concepts to implement the skills.	K_2
CO3	Study of material properties and their applications is the prime role to understand and use in engineering applications and studies.	K_3
CO4	Study Lasers and Optical fibers and its applications are to import knowledge and to develop skills and to use modern instruments in the engineering applications.	K_4
CO5	Understand Crystal structure and applications are to boost the technical skills and its applications.	K_4
CO6	Expose shock waves concept and its applications will bring latest technology to the students at the first year level to develop research orientation programs at higher semester level.	K_5
CO7	Understand basic concepts of nano science and technology.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		3	2						
CO2	3	3	3		3	2						
CO3	3	3	3		3	2						
CO4	3	3	3		3	2						
CO5	3	3	3		3	2						
CO6	3	3	3		3	2						
CO7	3	3			3	2						
CO (Average)	3	3	3		3	2						

3 -High; 2 -Medium; 1 –Low

Text Books:

1. Wiley precise Text, **Engineering Physics,** Wiley India Private Ltd., New Delhi. Book series – 2014,
2. Dr. M.N Avadhanulu, Dr. P.G.Kshirsagar, Text Book of Engineering Physics, S Chand Publishing, New Delhi – 2012

PROGRAMMING IN C (BT103)

Subject Code	**BT 103**	**IA Marks**	**30**
Number of Lecture Hours/Week	**04**	**Term End Exam Marks**	**70**
Total Number of Lecture Hours	**60**	**CREDITS**	**04**

Course Objectives:

- Design solutions to simple engineering problem by applying the basic programming principles of C language and basic mathematical knowledge.
- Choose a suitable C-construct to develop C code for a given problem.
- Recognize the bugs in the C program.
- Apply the C-language syntax rules to correct the bugs in the C program.
- Develop simple C programs to illustrate the applications of different data types such as arrays, pointers, functions.

Module 1

Basics of Computer Hardware and Software

Basics of Computer Architecture: processor, Memory, Input& Output devices

Application Software & System software: Compilers, interpreters, High level and low level languages, Introduction to structured approach to programming, Flow chart Algorithms, Pseudo code (*bubble sort, linear search - algorithms and pseudo code*)

Hours-10

Module 2

Program Basics

Basic structure of C program: Character set, Tokens, Identifiers in C, Variables and Data Types, Constants, Console IO Operations, printf and scanf

Operators and Expressions: Expressions and Arithmetic Operators, Relational and Logical Operators, Conditional operator, size of operator, Assignment operators and Bitwise Operators. Operators Precedence, Preprocessor directive

Control Flow Statements: If Statement, Switch Statement, Unconditional Branching using go to statement, While Loop, Do While Loop, For Loop, Break and Continue statements. (Simple programs covering control flow)

Hours-10

Module 3

Arrays and strings

Arrays Declaration and Initialization, 1-Dimensional Array, 2-Dimensional Array

String processing: In built String handling functions (strlen, strcpy, strcat and strcmp, puts, gets). Linear search program, bubble sort program, simple programs covering arrays and strings

Hours-10

Module 4

Pointers

Basics of Pointer: declaring pointers, accessing data though pointers, NULL pointer, array accessing pointers, pass by reference effect

Hours-10

Module-5

Working with functions

Introduction to modular programming, writing functions, formal parameters, actual parameters Pass by Value, Recursion, Arrays as Function Parameters structure, union, Storage Classes, Scope and life time of variables, *simple programs using functions*

Hours-15

Module 6

Structure & Union

Introduction, Declaration and Initialization, Array of Structures, Unions.

Hours-5

File Handling

File Operations: open, close, read, write, append

Sequential access and random access to files: In built file handling functions (*rewind() fseek(), ftell(),feof(), fread(), fwrite()*), *simple programs covering pointers and files.*

Course Outcomes:

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

CO1: Illustrate and explain the basic computer concepts and programming principles of C language.

CO2: Develop C programs to solve simple mathematical and decision making problems.

CO3: Develop C programs to solve simple engineering problems using looping constructs.

CO4: Develop C programs to demonstrate the applications of derived data types such as arrays, pointers, strings and functions.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Illustrate and explain the basic computer concepts and programming principles of C language.	K_2
CO2	Develop C programs to solve simple mathematical and decision making problems.	K_3
CO3	Develop C programs to solve simple engineering problems using looping constructs.	K_4
CO4	Develop C programs to demonstrate the applications of derived data types such as arrays, pointers, strings and functions.	K_6

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1									3	3
CO2	2	1			2							1
CO3	1						2	1				2
CO4		1		2		2				2		
CO (Average)	2	1		2	2	2	2	1		2	2.5	2

3 -High; 2 -Medium; 1 –Low

Text Books

1. Schaum Series, Gottfried B.S.,Tata McGraw Hill,Programming with C
2. E. Balagurusamy, Mcgraw Hill,Programming in ANSI C
3. Asok N Kamthane, Pearson,Programming in C
4. Anita Goel, Pearson, Computer Fundamentals

ELEMENTS OF MECHANICAL ENGINEERING (BT104)

Subject Code	BT104	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lecture Hours	60	CREDITS	04

Course objectives:

- Students belonging to all branches of Engineering are made to learn certain fundamental topics related to mechanical engineering so that they will have a minimum understanding of mechanical systems, equipment and process.

Module -1

Energy Resources: Non-renewable and renewable energy resources, Petroleum based solid, liquid and gaseous fuels, Calorific values of fuels, Combustion and combustion products of fuels.

Solar Power: Solar Radiation, Solar constant (definition only), Solar Thermal energy harvesting, ex: liquid flat plate collectors, solar ponds (principle of operation only), Solar photovoltaic principle.

Wind Power: principle of operation of a typical windmill.

Hydro Power: Principles of electric power generation from hydro power plants,

Nuclear Power: Principles of Nuclear power plants,

Bio Fuels: introduction to bio fuels, examples of various biofuels used in engineering applications, Comparison of biofuels withpetroleum fuels in terms of calorific value and emission.

Hours-10

Module- 2

Turbines and IC Engines and Pumps Steam turbines: Classification, Principle of operation of Impulse and reaction turbines, Gas turbines: Classification, Working principles and Operations of Open cycle and closed cycle gas turbines.

Water turbines: Classification, Principles and operations of Pelton wheel, Francis turbine and Kaplan turbine

Internal Combustion Engines: Classification, I.C. Engines parts, 2 Stroke and 4 stroke Petrol engines, 4 stroke diesel engines. P-V diagrams of Otto and Diesel cycles. Problems on indicated power, brake power, indicated thermal efficiency, brake thermal efficiency, mechanical efficiency, and specific fuel consumption.

Hours-10

Module- 3

Machine Tools Operations: Turning, facing, knurling, Thread cutting, Taper Turning, Drilling, Boring, Reaming, Tapping, Counter Sinking, Counter Boring, - Plane milling,

End milling, Slot milling. (No sketches of Machine tools, sketches to be used only for explaining operations.)

Hours-10

Module-4

Engineering materials and joining processes: Engineering Materials: Types and applications of Ferrous & Nonferrous metals and alloys, Composites: Definition, Classification and applications (Air craft and Automobiles)

Soldering, Brazing and Welding:

Definitions, classification and method of soldering, Brazing and welding. Differences between soldering, Brazing and Welding. Description of Electric Arc Welding and Oxy-Acetylene Welding.

Hours-15

Module-5

Refrigeration, Air-Conditioning:

Refrigerants: properties of refrigerants, list of commonly used refrigerants. Refrigeration – Definitions – Refrigerating effect, Ton of Refrigeration, Ice making capacity, COP, Relative COP, unit of Refrigeration. Principle and working of vapor compression refrigeration and vapour absorption refrigeration: Principles and applications of air conditioners, Room air conditioner.

Hours-15

Course Outcomes:
Students shall demonstrate knowledge associated with,

CO-1: Various Energy sources, Boilers, Prime movers such as turbines and IC engines, refrigeration and air-conditioning systems
CO-2: Metal removal process using Lathe, drilling, Milling Robotics and Automation.
CO-3: Fair understanding of application and usage of various engineering materials.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Various Energy sources, Prime movers such as turbines and IC engines, refrigeration and air-conditioning systems	K_1
CO2	Metal removal process using Lathe, drilling, Milling Robotics and Automation.	K_3
CO3	Fair understanding of application and usage of various engineering materials.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3					2	1		
CO2	2				1		1		3	3		
CO3	3		2	3					1	1		
CO Average	2.66		2	3			1		2	1.66		

3 - High 2 - Medium; 1 –Low

Text Books:

1. V.K.Manglik, "Elements of Mechanical Engineering", PHI Publications, 2013. (Module-1,2,4,5)
2. Mikell P.Groover, "Automation, Production Systems & CIM", 3rd Edition, PHI (Module -3)
3. K.R.Gopalkrishna, "A text Book of Elements of Mechanical Engineering"- Subhash Publishers, Bangalore. (Module -1,2,3,4,5)

BASIC OF ELECTRICAL ENGINEERING (BT105)

Subject Code	**BT105**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	60	**CREDITS**	04

Course objectives:

- Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.
- Provide working knowledge for the analysis of basic DC and AC circuits used in electrical and electronic devices.
- Develop selection skill to identify the type of generators or motors required for particular application.
- Highlight the importance of transformers in transmission and distribution of electric power.
- Emphasize the effects of electric shock and precautionary measures.
- Improve the ability to function on multi-disciplinary teams.

Module -1

Ohm's law and Kirchhoff's laws, analysis of series, parallel circuit by independent voltage sources,

concept of power and energy, definition of magnetic circuit and analogy between electric and magnetic circuits, faradays laws of electromagnetic induction, concept of Network Theorem.

Hours-10

Module -2

Single Phase A.C. Circuits: Average value, R.M.S. value, form factor and peak factor for sinusoidal wave form, Steady State Analysis of series R-L-C circuits. Concept of Reactance, Impedance, Susceptance, Admittance, Concept of Power Factor, Real, Reactive and Complex power, Illustrative Problems

Hours-15

Module - 3

Single phase transformers: principle of operation, constructional features and emf equation. DC. Generator: principle of operation, constructional features, emf equation.
DC Motor: principle of operation, Back emf, torque equation.

Hours-10

Module- 4

Three phase Induction Motor: principle of operation, types; Synchronous Machines: principle of operation of Synchronous generator and motor. EMF equation, Voltage regulation, Applications and starting of Synchronous motor. Introduction to single-phase induction Motor.

Hours-10

Module-5

Electrical Installations: Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, Types of Wires and Cables, Earthing. Elementary calculations for energy consumption and battery backup.
Measuring Instruments: Construction and Principle of operation of dynamometer type wattmeter and single-phase induction type energy meter

Hours-15

Course Outcomes:
After the completion of the course, the student should be able
CO-1: To predict the behaviour of electrical and magnetic circuits.
CO-2: Select the type of generator / motor required for a particular application.
CO-3: Realize the requirement of transformers in transmission and distribution of electric power and other applications.
CO-4: Practice Electrical Safety Rules & standards.
CO-5: To function on multi-disciplinary teams.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	To predict the behaviour of electrical and magnetic circuits.	K_1
CO2	Select the type of generator / motor required for a particular application.	K_3
CO3	Realize the requirement of transformers in transmission and distribution of electric power and other applications.	K_4

CO4	Practice Electrical Safety Rules & standards.	K_5
C05	To function on multi-disciplinary teams.	K_5

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		3			3		3		3	3
CO2	3	2					3		3		3	3
CO3	3	2	2	3	3		3		2		3	3
CO4	2	2	2				3		2		3	3
CO5	2		3	3			3		2		3	3
CO (Average)	2.6	1.75	2.33	3	3		3		2.4		3	3

3 -High; 2 -Medium; 1 –Low

Text books:

1. V. N. Mittal and Arvind Mittal;, " Basic Electrical Engineering" McGraw Hill
2. Vincent DelToro, " Electrical engineering Fundamentals", PHI second edition 2011
3. Bolestaad, :"Electronics Devices and Circuits Theory", Pearson Education India
4. Edward Hughes, " Electrical Technology,", Pearson Education
5. D.P. Kothari and Nagrath " Theory and Problems in electrical Engineering", PHI edition 2011

PROFESSIONAL COMMUNICATION SKILL (BT106)

Subject Code	**BT106**	**IA Marks**	30
Number of Lecture Hours/Week	03	**Term End Exam Marks**	70
Total Number of Lecture Hours	45	**CREDITS**	03

Course Objective:

To enable students how to improve communication skills.

- To develop Writing skills in preparing business letters, report, memos, and proposals. To develop Oratory skills through public speaking. To understand importance of professional attire in corporate environment.
- To get knowledge on various business etiquette and inculcate the etiquette for corporate fit.

Module-1: Concepts of Communications

Introduction: Definition and Process of Communication - Forms of Verbal and Non-verbal Communication.
Barriers of Communication: Communication Barriers and Overcoming Communication Barriers - Guidelines for Effective Communication.
Business Writing: Direct and Indirect approaches to Business Writing - Five Main Stages of Writing Business Messages.
Exercise: Role Play, Square Talk Activity.

Hours-10

Module-2: Written Business Communication

External Communication: The Seven C's of Letter writing - Kinds of Business Letters - Business Reports and Proposals - Purpose of Business Reports.
Internal Communication: Format and Principles of Writing Memos - General Warning - Cautions.
Exercise: Preparation of Reports on different issues.

Hours-10

Module-3: Oral Communication

Public Speaking: Types of Public Speaking - importance of Public Speaking.
Power Point Presentation: Planning the Presentation - Delivering the Presentation - Developing & Displaying Visual Aids - Handling Questions from the Audience.
Listening: Definition - Types of Listening Skills - Features of a Good Listener - Causes and effects of Poor Listening.
Exercise: Elocution and Extempore

Hours-10

Module-4: Behavioral Techniques

Body Language: Facial Expressions - Body Posture - Gestures - Eye Movement - Touch and the use of Personal Space.
Business Attire and Grooming: Different types of Attire - Guidelines for Business Attire. Exercise: Power of Body Language, Charades.

Hours-5

Module-5: Etiquettes

Etiquettes: Greeting Etiquette - Corporate Etiquette - Telephone Etiquette - E-mail Etiquette – Meeting Etiquette - Netiquette - Personal Etiquette - Social Etiquette - Dining Etiquette. Exercise: Introduction and Art of Conversation, Telephonic Activity.

Hours-10

Course Outcomes:
At the end of the course, the students would be able to:

CO-1: Develop knowledge, skills, and judgment around human communication that facilitate their

ability to work collaboratively with others.
CO-2: Understand and practice different techniques of communication.
CO-3: Practice and adhere to the 7Cs of Communication.
CO-4: Familiarize with different types of Communication.
CO-5: Understand and practice Interview Etiquettes.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Develop knowledge, skills, and judgment around human communication that facilitate their ability to work collaboratively with others.	K_1
CO2	Understand and practice different techniques of communication.	K_3
CO3	Practice and adhere to the 7Cs of Communication.	K_4
CO4	Familiarize with different types of Communication.	K_2
C05	Understand and practice Interview Etiquettes.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		3			3		3		3	3
CO2	3	2					3		3		3	3
CO3	3	2	2	3	3		3		2		3	3
CO4	2	2	2				3		2		3	3
CO5	2		3	3			3		2		3	3
CO (Average)	2.6	1.75	2.33	3	3		3		2.4		3	3

3 -High; 2 -Medium; 1 –Low

TEXT BOOKS:

1. Meenakshi Raman and Prakash Singh, Business Communication, Oxford
2. **Lesikar:** Basic Business Communication, TMH
3. **David Irwin:** Effective Business Communications, Viva- Thorogood. Rajendra Pal, J S Korlaha
4. **III:** Essentials of Business Communication: Sultan Chand & Sons, New Delhi

2nd SEMESTER

Code No.	Name of the Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT 201	Engineering Mathematics-II	3	1	-	4	30	70	100
BT 202	Engineering Chemistry	4	-	-	4	30	70	100
BT 203	Elements of Civil Engineering and Mechanics	4	-	-	4	30	70	100
BT 204	Computer Aided Engineering Drawing	4	-	-	4	30	70	100
BT 205	Basic Electronics	4	-	-	3	30	70	100
BT 206	Software Engineering	3	1	-	3	30	70	100
	Practical							
BT 207L	Engineering Chemistry **Lab**	-	-	4	2	15	35	50
BT 208L	Workshop Practice	-	-	4	2	15	35	50
	Total	**22**	**2**	**8**	**26**	**210**	**490**	**700**

ENGINEERING MATHEMATICS-II (BT201)

Subject Code	**BT201**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	60	**CREDITS**	04

Course objectives:

To enable students to apply the knowledge of Mathematics in various engineering fields by making them to learn the following

- Ordinary differential equations
- Partial differential equations
- Double and triple integration
- Laplace transform

Module – I

Linear differential equations with constant coefficients: Solutions of second and higher order differential equations - operator method, method of undetermined coefficients and method of variation of parameters.

Hours-10

Module -2

Differential equations-2:

Linear differential equations with variable coefficients: Solution of Cauchy's and Legendre's linear differential equations.

Nonlinear differential equations - Equations solvable for p, equations solvable for y, equations solvable for x, general and singular solutions, Clairauit's equations and equations reducible to Clairauit's form.

Hours-10

Module – 3

Partial Differential equations:

Formulation of Partial differential equations by elimination of arbitrary constants/functions, solution of non-homogeneous Partial differential equations by direct integration, solution of homogeneous Partial differential equations involving derivative with respect to one independent variable only.

Derivation of one dimensional heat and wave equations and their solutions by variable separable method.

Hours-10

Module-4

Integral Calculus:

Multiple integrals: Beta and Gamma functions: definitions, Relation between beta and gamma functions and simple problems.

Evaluation of double and triple integrals. Evaluation of double integrals by changing the order of integration and by changing into polar co-ordinates. Applications of multiple integrals to find area and volume.

Hours-15

Module-5

Laplace Transform

Definition and Laplace transforms of elementary functions, Linearity, first and second shifting, change of scale.

Laplace transforms of derivatives, integral, multiplication and division by ***t,*** periodic functions.

Inverse Laplace Transform

Inverse Laplace Transform - problems, Convolution theorem to find the inverse Laplace transforms (without proof) and problems, solution of linear differential equations using Laplace Transforms.

Hours-15

Course Outcomes:

On completion of this course, students are able to,

CO-1: Solve differential equations of electrical circuits, forced oscillation of mass springand elementary heat transfer.
CO-2: Solve partial differential equations fluid mechanics, electromagnetic theory andheat transfer.
CO-3: Evaluate double and triple integrals to find area, volume, mass and moment ofinertia of plane and solid region.
CO-4: Use curl and divergence of a vector valued functions in various applications of electricity, magnetism and fluid flows.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Solve differential equations of electrical circuits, forced oscillation of mass spring and elementary heat transfer.	K_4
CO2	Solve partial differential equations fluid mechanics, electromagnetic theory and heat transfer.	K_3
CO3	Evaluate double and triple integrals to find area, volume, mass and moment of inertia of plane and solid region.	K_4
CO4	Use curl and divergence of a vector valued functions in various applications of electricity, magnetism and fluid flows.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1									3	3
CO2	2	1			2							1
CO3	1						2	1				2
CO4		1		2		2				2		
CO (Average)	2	1		2	2	2	2	1		2	2.5	2

3 -High; 2 -Medium; 1 –Low

Text Books:

1. B. S. Grewal," Higher Engineering Mathematics", Khanna publishers,42nd edition, 2013.
2. Kreyszig, "Advanced Engineering Mathematics" -Wiley, 2013

Reference Books:

1. B.V.Ramana "Higher Engineering M athematics" Tata Mc Graw-Hill, 2006
2. N P Bali and Manish Goyal, "A text book of Engineering mathematics" , Laxmi publications, latest edition.
3. H. K Das and Er. Rajnish Verma,"Higher Engineering Mathematics", S. Chand publishing,1st edition, 2011.

ENGINEERING CHEMISTRY (BT202)

Subject Code	BT202	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lecture Hours	60	CREDITS	04

Course objectives:

To provide students with knowledge of engineering chemistry for building technical competence industries, research and development in the following fields

- Electrochemistry & Battery Technology.
- Corrosion & Metal Finishing.
- Fuels & Solar energy.
- Polymers.
- Water Technology & Nano Materials.

Module -1

Electrochemistry and Battery Technology

Electrochemistry: Introduction, Derivation of Nernst equation for electrode potential. Reference electrodes: Introduction, construction, working and applications of calomel and Ag / AgCl electrodes. Measurement of electrode potential using calomel electrode. Ion selective electrode: Introduction; Construction and working of glass electrode, determination of pH using glass electrode. Concentration cells: Electrolyte concentration cells, numerical problems.

Battery Technology: Introduction, classification - primary, secondary and reserve batteries. Characteristics - cell potential, current, capacity, electricity storage density, energy efficiency, cycle life and shelf life. Construction, working and applications of Zinc- Air, Nickel- metal hydride batteries. Lithium batteries: Introduction, construction, working and applications of Li-MnO_2 and Li-ion batteries.

Fuel Cells: Introduction, difference between conventional cell and fuel cell, limitations & advantages. Construction, working & applications of methanol-oxygen fuel cell with H_2SO_4 electrolyte.

Hours-15

Module -2

Corrosion and Metal Finishing:

Corrosion: Introduction, electrochemical theory of corrosion, galvanic series. Factors affecting the rate of corrosion: ratio of anodic to cathodic areas, nature of metal, nature of corrosion product, nature of medium – pH, conductivity, and temperature. Types of corrosion- Differential metal, differential aeration (Pitting and water line) and stress. Corrosion control: Inorganic coatings- Anodizing of Al and phosphating; Metal coatings-Galvanization and Tinning. Cathodic protection (sacrificial anodic and impressed current methods).

Metal Finishing: Introduction, Technological importance. Electroplating: Introduction, principles governing-Polarization, decomposition potential and overvoltage. Factors influencing the nature of electro deposit-current density, concentration of metal ion & electrolyte; pH, temperature & throwing power of plating bath; additives- brighteners, levellers, structure modifiers & wetting agents. Electroplating of Nickel (Watt's Bath) and Chromium(decorative and hard). Electro less plating: Introduction, distinction between electroplating and electro less plating, electro less plating of copper & manufacture of double sided Printed Circuit Board with copper.

Hours-15

Module – 3

Fuels and Solar Energy:

Fuels: Introduction, classification, calorific value- gross and net calorific values, determination of calorific value of fuel using bomb calorimeter, numerical problems. Cracking: Introduction, fluidized catalytic cracking, synthesis of petrol by Fishcher-Tropsch process, reformation of petrol, octane and cetane numbers., anti knocking agents, power alcohol & biodiesel.

Solar Energy: Introduction, utilization and conversion, photovoltaic cells- construction and working. Design of PV cells: modules, panels & arrays. Advantages & disadvantages of PV cells. Production of solar grade silicon: Union carbide process, purification of silicon (zone refining), doping of silicon-diffusion technique (n&p types).

Hours-10

Module - 4

Polymers:

Introduction, types of polymerization: addition and condensation, mechanism of polymerization- free radical mechanism taking vinyl chloride as an example. Molecular weight of polymers: number average and weight average, numerical problems. Glass transition temperature (Tg): Factors influencing Tg-Flexibility, inter molecular forces, molecular mass, branching & cross linking and stereo regularity. Significance of Tg. Structure property relationship: crystallinity, tensile strength, elasticity & chemical resistivity. Synthesis, properties and applications of PMMA (plexi glass), Polyurethane and polycarbonate. Elastomers: Introduction, synthesis, properties and applications of Silicone rubber.

Hours-10

Module-5

Water Technology and Nano materials:

Water Technology: Introduction, boiler troubles with disadvantages & prevention methods-scale and sludge formation, priming and foaming, boiler corrosion(due to dissolved O2, CO2 and MgCl2).

Determination of DO, BOD and COD, numerical problems on COD. Sewage treatment: Primary, secondary (activated sludge method) and tertiary methods. Softening of water by ion exchange process

Nano Materials: Introduction, properties (size dependent). Synthesis-bottom up approach (sol-gel, precipitation, gas condensation & chemical vapour condensation processes). Nano scale materials-carbon nano tubes, nano wires, fullerenes, dendrimers, nano rods, & nano composites.

Hours-10

Course Outcomes:

On completion of this course, students will have knowledge in:

CO-1: Electrochemical and concentration cells. Classical & modern batteries and fuel cells.
CO-2: Causes & effects of corrosion of metals and control of corrosion. Modification of surface properties of metals to develop resistance to corrosion, wear, tear, impact etc. by electroplating and electro less plating.
CO-3: Production & consumption of energy for industrialization of country and living standards of people. Utilization of solar energy for different useful forms of energy.
CO-4: Replacement of conventional materials by polymers for various applications.
CO-5: Boiler troubles; sewage treatment and desalination of sea water,
CO-6: Over viewing of synthesis, properties and applications of Nano materials.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Electrochemical and concentration cells. Classical & modern batteries and fuel cells.	K_1
CO2	Causes & effects of corrosion of metals and control of corrosion. Modification of surface properties of metals to develop resistance to corrosion, wear, tear, impact etc. by electroplating and electro less plating.	K_2
CO3	Production & consumption of energy for industrialization of country and living standards of people. Utilization of solar energy for different useful forms of energy.	K_3
CO4	Replacement of conventional materials by polymers for various applications.	K_3
CO5	Boiler troubles; sewage treatment and desalination of sea water,	K_4
CO6	Over viewing of synthesis, properties and applications of Nano materials.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2		2	2						
CO2	3	2	2		2	2						
CO3	3	3	2		2	3						
CO4	3	3	2		2	3						
CO5	3	3	2		2	3						
CO6	3	2	2		2	3						
CO Average)	3	2.5	2		2	3						

3 -High; 2 -Medium; 1 –Low

Text Books:

1. B.S.Jai Prakash, R.Venugopal, Sivakumaraiah & Pushpa Iyengar, **"Chemistry for Engineering Students"**, Subhash Publications, Bangalore.
2. R.V.Gadag & A.Nityananda Shetty., **"Engineering Chemistry"**, I K International Publishing House Private Ltd. New Delhi.
3. P.C.Jain & Monica Jain.,**"Engineering Chemistry"**, Dhanpat Rai Publications, New Delhi.

Reference Books:

1. O.G.Palanna,**"Engineering Chemistry"**,Tata McGraw Hill Education Pvt.Ltd. New Delhi, Fourth Reprint.
2. G.A.Ozin & A.C. Arsenault, **"Nanochemistry A Chemical Approach to Nanomaterial's"**, RSC publishing, 2005.
3. **"Wiley Engineering Chemistry"**, Wiley India Pvt. Ltd. New Delhi. Second Edition.

ELEMENTS OF CIVIL ENGINEERING AND MECHANICS (BT203)

Subject Code	**BT203**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	60	**CREDITS**	04

Course Objectives:

The objectives of this course is to make students to learn basics of Civil Engineering concepts and infrastructure development, solve problems involving Forces, loads and Moments and know their applications in allied subjects. It is a pre-requisite for several courses involving Forces, Moments, Centroids, Moment of inertia and Kinematics.

Module 1: Introduction to Civil Engineering & Engineering Mechanics

Introduction to Civil Engineering

Scope of different fields of Civil Engineering - Surveying, Building Materials, Construction Technology, Geotechnical Engineering, Structural Engineering, Hydraulics, Water Resources and Irrigation Engineering, Transportation Engineering, Environmental Engineering.

Infrastructure: Types of infrastructure, Role of Civil Engineer in the Infrastructural Development, Effect of the infrastructural facilities onsocio-economic development of a country. Roads: Classification of Roads and their functions, Comparison of Flexible and Rigid Pavements (Advantages and Limitations)

Bridges: Types of Bridges and Culverts, RCC, Steel and Composite Bridges

Dams: Different types of Dams based on Material, Structural behavior and functionality with simple sketches.

Introduction to Engineering Mechanics: Basic idealizations - Particle, Continuum and Rigid body; Newton's laws-Force and its characteristics, types of forces-Gravity, Lateral and its distribution on surfaces, Classification of force systems, Principle of physical independence, superposition, transmissibility of forces, Introduction to SI units. Couple, Moment of a couple, Characteristics of couple, Moment of a force, Equivalent force - Couple system; Numerical problems on moment of forces and couples, on equivalent force - couple system.

Hours-15

Module 2: Analysis of Concurrent Force Systems

Concepts: Resultants and Equilibrium

Composition of forces - Definition of Resultant; Composition of coplanar - concurrent force system, Parallelogram Law of forces, Principle of resolved parts; Numerical problems on composition of coplanar concurrent force systems.

Equilibrium of forces - Definition of Equilibrant; Conditions of static equilibrium for different force systems, Lami's theorem; Numerical problems on equilibrium of coplanar – concurrent and non-concurrent force systems.

Application- Static Friction in rigid bodies in contact

Types of friction, Laws of static friction, Limiting friction, Angle of friction, angle of repose; Impending motion on horizontal and inclined planes; Numerical Problems on single and two blocks on inclined planes

Hours-15

Module - 3 Analysis of Non-Concurrent Force Systems

Concepts: Resultants and Equilibrium

Composition of coplanar - non-concurrent force system, Varignon's principle of moments; Numerical problems on composition of coplanar non-concurrent Force system.

Application-Support Reaction in beams

Types of Loads and Supports, statically determinate beams, Numerical problems onsupport reactions for statically determinate beams with Point load (Normal and inclined) and uniformly distributed and uniformly varying loads and Moments.

Hours-10

Module - 4 Centroids and Moments of Inertia of Engineering Sections:

Centroids

Introduction to the concept, centroid of line and area, centroid of basic geometrical figures, computing centroid for–T,L,I,Z and full/quadrant circular sections and their built up sections. Numerical problems

Moment of Inertia

Introduction to the concept, Radius of gyration, Parallel axis theorem, Perpendicular axis theorem, Moment of Inertia of basic planar figures, computing moment of Inertia for – T, L, I, Z and full/quadrant circular sections and their built up sections. Numerical problems

Hours-10

Module 5: Kinematics

Concepts and Applications

Definitions – Displacement – Average velocity – Instantaneous velocity – Speed – Acceleration - Average acceleration – Variable acceleration – Acceleration due to gravity – Newton's Laws of Motion.

Rectilinear Motion–Numerical problems.

Curvilinear Motion – Superelevation – Projectile Motion – Relative motion – Numerical problems.

Motion under gravity – Numerical problems.

Hours-10

Course Outcomes:

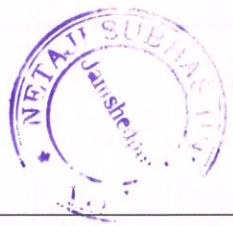
After a successful completion of the course, the student will be able to:

CO-1: Know basics of Civil Engineering, its scope of study, knowledge about Roads, Bridges and Dams;

CO-2: Comprehend the action of Forces, Moments and other loads on systems of rigid bodies;

CO-3: Compute the reactive forces and the effects that develop as a result of the external loads;

CO-4: Locate the Centroid and compute the Moment of Inertia of regular cross- sections.



CO-5: Express the relationship between the motions of bodies.

CO-6: Equipped to pursue studies in allied courses in Mechanics.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Know basics of Civil Engineering, its scope of study, knowledge about Roads, Bridges and Dams;	K_1
CO2	Comprehend the action of Forces, Moments and other loads on systems of rigid bodies;	K_2
CO3	Compute the reactive forces and the effects that develop as a result of the external loads;	K_3
CO4	Locate the Centroid and compute the Moment of Inertia of regular cross-sections.	K_3
CO5	Express the relationship between the motions of bodies.	K_4
CO6	Equipped to pursue studies in allied courses in Mechanics.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2		2	2						
CO2	3	2	2		2	2						
CO3	3	3	2		2	3						
CO4	3	3	2		2	3						
CO5	3	3	2		2	3						
CO6	3	2	2		2	3						
CO Average)	3	2.5	2		2	3						

3 -High; 2 -Medium; 1 –Low

TEXT BOOKS:

1. Elements of Civil Engineering and Engineering Mechanics by M.N. Shesha Prakash and Ganesh. B. Mogaveer, PHI Learning, 3rd Revised edition (2014)

2. Engineering Mechanics-Statics and Dynamics by A Nelson, Tata McGraw Hill Education Private Ltd, New Delhi, 2009.

3. Elements of Civil Engineering (IV Edition) by S.S. Bhavikatti, New Age International Publisher, New Delhi, 3rd edition 2009.

REFERENCES:

1. Engineering Mechanics by S.Timoshenko, D.H.Young, and J.V.Rao, TATA McGraw-Hill Book Company, New Delhi
2. Beer FP and Johnson ER, "Mechanics for Engineers- Dynamics and Statics"- 3rd SI Metric edition, Tata McGraw Hill. - 2008

COMPUTER AIDED ENGINEERING DRAWING (BT204)

Subject Code	BT204	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lecture Hours	60	CREDITS	04

Course objectives:

- Engineering drawing is an important tool for all Engineers and for many others professionals. It is the language of Engineers. Engineering Drawing communicates all needed information from the engineer who designed a part to the workers who will manufacture it.
- The aim of the subject is to equip students with the fundamentals of Computer Aided Engineering Drawing and to further the ability to communicate information by graphical means.

Module -1

Introduction to Computer Aided Sketching

Introduction, Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning and free hand practicing. Computer screen, layout of the software, standard tool bar/menus and description of most commonly used tool bars, navigational tools. Co-ordinate system and reference planes. of HP, VP, RPP & LPP. of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination and perpendicularity. Dimensioning, line conventions, material conventions and lettering.

Hours-15

Module -2

Orthographic projections

Introduction to Orthographic projections. Conversion of pictorial view into Orthographic Views (First Angle Projection Method Only). Dimensioning technique as per SP-46. Conversion of orthographic views into isometric View/projection (Simple objects). Projection of Straight Lines and Planes. (First Angle Projection Method Only). Lines inclined to one

reference plane only and limited to both ends in One quadrant.

Hours-15

Module-3

Projections of Planes (First angle Projection only)

Introduction, Definitions – Projections of right regular tetrahedron, hexahedron (cube), prisms, pyramids, cylinders and cones in different positions

Hours-5

Module-4

Projections of Solids (First angle Projection only)

Introduction, Definitions – Projections of right regular tetrahedron, hexahedron (cube), prisms, pyramids, cylinders and cones in different positions (No problems on octahedrons and combination solid).

Hours-10

Module-5

Isometric Projection (Using Isometric Scale Only)

Introduction, Isometric scale, Isometric projection of simple plane figures, Isometric projection of tetrahedron, hexahedron(cube), right regular prisms, pyramids, cylinders, cones, spheres, cut spheres and combination of solids (Maximum of three solids).

Hours-15

Course Outcomes:

After studying this course,

CO -1: Students will be able to demonstrate the usage of CAD software.

CO-2: Students will be able to visualize and draw Orthographic projections, Sections of solids and Isometric views of solids.

CO-3: Students are evaluated for their ability in applying various concepts to solve practical problems related to engineering drawing.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Students will be able to demonstrate the usage of CAD software.	K_2
CO2	Students will be able to visualize and draw Orthographic projections, Sections of solids and Isometric views of solids.	K_2
CO3	Students are evaluated for their ability in applying various concepts to solve practical problems related to engineering drawing	K_5

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3	3			
CO2	2	3			2		1		1			
CO3	2		2					3				
CO Average)	2	3	2		2		1	3	2			

3-High; 2 -Medium; 1 -Low

TEXT BOOKS:

1. Engineering Drawing – N.D. Bhatt & V.M. Panchal, 48th edition, 2005 Charotar Publishing House, Gujarat.

2. "Computer Aided Engineering Drawing"by Dr. M H Annaiah, Dr C N Chandrappa and Dr B Sudheer Premkumar Fifth edition, New Age International Publishers

REFERENCE BOOKS:

1. Computer Aided Engineering Drawing – S. Trymbaka Murthy, - I.K. International Publishing House Pvt. Ltd., New Delhi, 3rd revised edition-2006.
2. Engineering Graphics - K.R. Gopalkrishna, 32nd edition, 2005- Subash Publishers Bangalore.

BASIC ELECTRONICS (BT205)

Subject Code	**BT205**	**IA Marks**	30
Number of Lecture Hours/Week	03	**Term End Exam Marks**	70
Total Number of Lecture Hours	45	**CREDITS**	03

Course Objectives:

- To study in detail about construction of several electronic devices.
- To analyses the characteristics of various electronic devices and circuits.
- To understand the internal structure and characteristics of Op-amp.
- To learn about the linear and non-linear applications of Op-amp.

Module – 1: Semi-Conductors and Diodes:

Conductors, Semiconductors, Intrinsic Semiconductors, Extrinsic Semi-Conductors. Diode Theory: Basic Ideas, The ideal Diode, Forward and Reverse Bias, Diode

Equation, Volt-Ampere Characteristic. Special diodes: symbol of zener diode, operation, V-I characteristics, symbol of photo diode, working principle, LED symbol and principle. **Hours-10**

Module – 2: Rectifiers:

Half-wave Rectifier, Full-wave and Bridge Rectifier, derivation of Ripple factor, efficiency of Half- wave, full-wave and Bridge rectifiers. Merits and demerits of Half-wave, full-wave and Bridge rectifiers, Comparisons of rectifiers. **Hours-10**

Module- 3: Bipolar Junction Transistors:

Symbols of pnp and npn transistors and their working principles, Transistor currents, input and output characteristics of Common base configuration, Common Emitter configuration Transistor Switch, Amplifiers: working principles of Common base amplifier, Common Emitter amplifier, Common collector amplifier and their applications.

Hours-15

Module- 4 Characteristics of Op-Amps:

Introduction to OP-amp, Op-amp Block Diagram, ideal and practical Op-amp specifications, 741 op- amp & its features, Op-Amp parameters & Measurement, Input & Out put off set voltages & currents, slew rates, CMRR, PSRR.

Hours-7

Module-5: Applications of Op-Amps:

Inverting and Non-inverting amplifier, Integrator and differentiator, Comparators.

Course Outcomes:

Students will be able to

CO-1: Understand the semiconductor physics of the intrinsic, p and n materials

CO-2: Understand the function and operation of diodes, transistors and amplifiers.

CO-3: Students will be aware of the architecture, functions & their applications of IC 741 OP-Amp

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand the semiconductor physics of the intrinsic, p and n materials	K_2
CO2	Understand the function and operation of diodes, transistors and amplifiers.	K_2
CO3	Students will be aware of the architecture, functions & their applications of IC 741 OP-Amp	K_4, K_5

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3	3			
CO2	2	3			2		1		1			
CO3	2		2					3				
CO Average)	2	3	2		2		1	3	2			

3-High; 2 -Medium; 1 -Low

Text Books:

1. Electronic Principles, Albert Malvino and David J Bates, 7th Edition, Tata McGraw – Hill.
2. Electronic Devices and Circuits Theory, Boyelstad, Pearson Education, 8th Edition, September 2011.
3. Op-Amps and Linear Integrated Circuits , - Ramakanth A. Gayakwad, PHI, 4th Edition, 2009
4. Linear Integrated Circuits – D. Roy Chowdhury, New Age International Pvt.Ltd., 2nd Edition, 2003.

SOFTWARE ENGINEERING (BT206)

Subject Code	**BT206**	**IA Marks**	30
Number of Lecture Hours/Week	03	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	03

Course Objectives:

- Understand the software life cycle models
- Understand the importance of the software development process
- Understand the importance of modeling and modeling languages
- Design and develop correct and robust software products

Module-I

Introduction:

Introduction to Software Engineering, Software Components, Software Characteristics, Software Crisis, Software Engineering Processes, Similarity and Differences from Conventional Engineering Processes, Software Quality Attributes. Software Development Life Cycle (SDLC) Models: Water Fall Model, Prototype Model, Spiral Model, Evolutionary Development Models, Iterative Enhancement Models.

Hours-10

Module-II

Software Requirement Specifications (SRS) Requirement Engineering Process: Elicitation, Analysis, Documentation, Review and Management of User Needs, Feasibility Study, Information Modeling, Data Flow Diagrams, Entity Relationship Diagrams, Decision Tables, SRS Document, IEEE Standards for SRS.
Software Quality Assurance (SQA): Verification and Validation, SQA Plans, Software Quality Frameworks, ISO 9000 Models, SEI-CMM Model.

Hours-10

Module-III

Software Design: Basic Concept of Software Design, Architectural Design, Low Level Design: Modularization, Design Structure Charts, Pseudo Codes, Flow Charts, Coupling and Cohesion Measures, Design Strategies: Function Oriented Design, Object Oriented Design, Top-Down and
Bottom-Up Design. Software Measurement and Metrics: Various Size Oriented Measures: Halestead's Software Science, Function Point (FP) Based Measures, Cyclomatic Complexity Measures: Control Flow Graphs.

Hours-10

Module-IV

Software Testing: Testing Objectives, Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Testing for Functionality and Testing for Performance, Top-Down and Bottom- Up Testing Strategies: Test Drivers and Test Stubs, Structural Testing (White Box Testing), Functional Testing (Black Box Testing), Test Data Suit Preparation, Alpha and Beta Testing of Products. Static Testing Strategies: Formal Technical Reviews (Peer Reviews), Walk Through, Code Inspection, Compliance with Design and Coding Standards.

Hours-10

Module-V

Software Maintenance and Software Project Management Software as an Evolutionary Entity, Need for Maintenance, Categories of Maintenance: Preventive, Corrective and Perfective Maintenance, Cost of Maintenance, Software Re-Engineering, Reverse Engineering. Software Configuration Management Activities, Change Control Process, Software Version Control, An Overview of CASE Tools. Estimation of Various Parameters such as Cost, Efforts, Schedule/Duration, Constructive Cost Models (COCOMO), Resource Allocation Models, Software Risk Analysis and Management.

Hours-10

Course Outcomes:
At the end of the course the student should be able to:
CO 1: Identify the need for engineering approach to software development and various processes of requirements analysis for software engineering problems.
CO 2: Analyze various software engineering models and apply methods for design and development of software projects.
CO 3: Work with various techniques, metrics and strategies for Testing software projects.
CO 4: Identify and apply the principles, processes and main knowledge areas for

Software Project Management

CO 5: Proficiently apply standards, CASE tools and techniques for engineering software projects

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Identify the need for engineering approach to software development and various processes of requirements analysis for software engineering problems.	K_1, k_2
CO2	Analyze various software engineering models and apply methods for design and development of software projects.	K_4
CO3	Work with various techniques, metrics and strategies for Testing software projects.	K_4
CO4	Identify and apply the principles, processes and main knowledge areas for Software Project Management	K_3
CO5	Proficiently apply standards, CASE tools and techniques for engineering software projects	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6-Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		3			3		3		3	3
CO2	3	2					3		3		3	3
CO3	3	2	2	3	3		3		2		3	3
CO4	2	2	2				3		2		3	3
CO5	2		3	3			3		2		3	3
CO (Average)	2.6	1.75	2.33	3	3		3		2.4		3	3

3 -High; 2 -Medium; 1 –Low

Text books:

1. R. S. Pressman, Software Engineering: A Practitioners Approach, McGraw Hill.
2. Rajib Mall, Fundamentals of Software Engineering, PHI Publication.
3. K. K. Aggarwal and Yogesh Singh, Software Engineering, New Age International Publishers.

1. 4. Pankaj Jalote, Software Engineering, Wiley
5.Deepak Jain,"Software Engineering:Principles and Practices", Oxford University Press.

B. TECH – III SEMESTER, MECHANICAL ENGINEERING

Code No	Name of the Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT301	Engineering Mathematics	3	1	-	4	30	70	100
BT3ME02	Material Science	4	-	-	4	30	70	100
BT3ME03	Basic Thermodynamics	4	-	-	4	30	70	100
BT3ME04	Mechanics Of Materials	4	-	-	4	30	70	100
BT3ME05	Metal Casting & Welding	4	-	-	4	30	70	100
BT3ME06	Computer Aided Machine Design	4	-	-	4	30	70	100
	Practical							
BT3ME07L	Material Testing Lab	-	-	3	2	15	35	50
BT3ME08L	Machine Shop	-	-	3	2	15	35	50
	TOTAL	**23**	**1**	**6**	**28**	**210**	**490**	**700**

ENGINEERING MATHEMATICS – III (BT301)

Subject code	BT301	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number Of Lecture Hours	50	CREDITS-04	04

Course objectives:

This course will enable students to

1. Comprehend and use of analytical and numerical methods in different engineering fields Apprehend and apply Fourier series
2. Realize and use of Fourier transforms and Z-Transforms
3. Use of statistical methods in curve fitting applications
4. Use of numerical methods to solve algebraic and transcendental equations, vector integration and calculus of variation

Module-1

VECTOR DIFFE.RENTIATION: Scalar and vector point functions - Del applied to scalar point functions - Directional derivative - Del applied to vector point functions - Physical interpretation of divergence and curl - Del applied twice to point functions - Del applied to products of point functions.

HOURS-10

Module-2

VECTOR INTEGRATION: Integration of vectors - Line integral, circulation, work done - Surface integral, flux - Green's theorem in the plane •- Stoke's theorem - Yalu.me integral •- Gauss divergence theorem (all theorems without proofs) - Irrotational and solenoidal fields.

Hours-10

Module-3

PARTIAL DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS: Introduction - Formation of partial differential equations by eliminating arbitrary constants and functions - Solutions of a partial differential equations by direct Integration - Linear equations of the first order (Lagrange's linear equations).

Applications: Method of separation of variables - Vibrations of a stretched string: Wave equation
- One dimensional heat flow equation($\partial u/\partial t=c^{(2)}(\partial^2 u)/(\partial x^2)$), and two dimensional heat flow equation (i.e. Laplace equation : $(\partial^2 u)/(\partial x^2)+(\partial^2 u)/(\partial y^2)=O\}$.

Hours-10

Module-4

FOURIER SERIES: Introduction - Euler's formulae - Conditions for a Fourier expansion - Functions having points of discontinuity - Change of interval - Even and odd functions - Half range series - Parseval's formula.

HOURS-10

Module -5

FOURIER TRANSFORMS: Introduction - Definition - Fourier integral theorem (without proof) - Fourier sine and cosine integrals - Fourier transforms - Properties of Fourier transforms - Convolution theorem - Parseval's identity for Fourier transforms - Relation between Fourier and Laplace transforms
- Fourier transforms of the derivatives of a function - Applications of transforms to boundary value problems.

Hours-10

Course Outcomes:

The student will be able to:

CO- 1: Apply gradient, divergence & curl to scalar and vector point functions and also physically interpret their meaning.

CO- 2: Apply the concepts of Vector calculus & the corresponding theorems to evaluate line, surface and flux integrals.

CO- 3: Solve both first & higher order partial differential equations by different techniques and apply to two dimensional heat conduction equations, vibrations of a string etc.

CO- 4: Apply infinite Fourier series to represent discontinuous function which occurs in signal processing & electrical circuits.

CO- 5: Apply the principles of Fourier transforms to Boundary value problems.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		3			3		3		3	3
CO2	3	2					3		3		3	3
CO3	3	2	2	3	3		3		2		3	3
CO4	2	2	2				3		2		3	3
CO5	2		3	3			3		2		3	3
CO (Average)	2.6	1.75	2.33	3	3		3		2.4		3	3

3- High; 2- Medium; 1- Low

Test Books:

1. Peter V. O'Neil, Advance Engineering Mathematics Thomson (Cengage) Learning, 2007.
2. 2. Jain Iyenger & Jain, Numerical Methods for Scientific and. Engineering Computation, New Age International, New Delhi.
3. JN Kapur, Mathematical Statistics, S. Chand & company Ltd.
4. BS Grewal, Higher Engineering Mathematics, Khanna Publishers

Material Science

B. Tech III Semester, Mechanical Engineering

Subject code	BT 302	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number Of Lecture Hours	50	CREDITS-04	04

Course Objectives:

1. Identify the Crystal Structures of Metallic Materials.
2. Correlate the Microstructure with Properties, Processing and Performance of metals.
3. Apply core concepts in material science to solve engineering problems.

Module-I

Basics, Mechanical Behavior, Failure of Materials: Introduction to Crystal Structure - Coordination number, atomic packing factor, Simple Cuhie, BCC, FCC and HCP Structures, Crystal imperfection's - point, line, surface and volume imperfections, Atomic Diffusion: Phenomenon, Fick's laws of diffusion; Factors affecting diffusion.

Mechanical Behavior: Stress-strain diagrams showing ductile and brittle behavior of materials, Engineering and true strains, Linear and non-linear elastic behavior and properties, Mechanical properties in plastic range. Stiffness, Yield strength, Offset Yield strength,

Ductility, Ultimate Tensile strength, Toughness, Plastic deformation of single crystal by slip and twinning, Mechanisms of strengthening in metals.

Fracture: Type I, Type II and Type III,

Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, Fatigue properties, S-N diagram, Fatigue testing. Creep: Description of the phenomenon with examples, three stages of creep, creep properties, Stress relaxation. Concept of fracture toughness:

Hours-10

Module- 2

Alloys, Steels, Solidification: Concept of formation of alloys: Types of alloys, solid solutions, factors affecting solid solubility (Hume Rothery rules) Binary phase diagrams: Eutectic, and Eutectoid systems Lever rule, Substitutional and interstitial solid solutions, Intermediate phases, Gibbs phase rule Effect of non- equilibrium cooling, Coring and Homogenization Iron-Carbon (Cementite) diagram: description of phases, Specifications of steels. Solidification: Mechanism of solidification, Homogenous and Heterogeneous nucleation, Crystal growth, Numerical on lever rule.

Hours-10

Module-3

Heat Treatment, Ferrous and Non-Ferrous Alloys: Heat treating of metals: Time-Temperature-Transformation (TTT) curves, Continuous Cooling Transformation (CCT) curves, Annealing: Recovery, Recrystallization and Grain growth, Types of annealing, Normalizing, Hardening, Tempering, Martempering, Austempering, Concept of hardenability, Factors affecting it hardenability, surface hardening methods: carburizing, cyaniding, nitriding flame hardening and induction hardening, Age hardening of aluminum-copper alloy sand PH steels. Ferrous materials: Properties, Compositions and uses of Grey cast iron, Malleable iron, SG iron and steel,

Hours-10

Module-4

Other Materials, Material Selection Ceramics: Structure types and properties and applications of ceramics. Mechanical / Electrical behavior and processing of Ceramics. Plastics: Various types of polymers/plastics and their applications, Mechanical behaviors and processing of plastics, Failure of plastics. Other materials: Smart materials and Shape Memory alloys, properties and applilcations.

Hours-10

Module-5

Composite Materials

Composite materials - Definition, classification, types of matrix materials & reinforcements, Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs), Particulate-reinforced and fiber-reinforced composites, Fundamentals of production of composites, Processes for production of composites, Constitutive relations of composites, Numerical problems on determining properties of composites.

Hours-10

Course Outcomes:

1. Basic Engineering Thermodynamics, A.Venkatesh, Universities Press, 2008
2. Basic and Applied Thermodynamics, P.K.Nag, 2nd Ed., Tata McGraw Hill Pub. 2,002

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Identify the Crystal Structures of Metallic Materials.	K_1
CO2	Correlate the Microstructure with Properties, Processing and Performance of metals.	K_2
CO3	Apply core concepts in material science to solve engineering problems.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		3	3	3			1			
CO2	3	3		2	3	3	3		2			
CO3	3	3		2	3	3			1			
CO Average)	3	2.6		2.6	3	3			1.3			

3 –High; 2 –Medium; 1 –Low

REFERENCE BOOKS:

1. Thermodynamics, An Engineering Approach, Yu.nusA.Cenegal and Michael A.Boles, Tata McGraw Hill publications, 2002
2. Engineering Thermodynamics, J.B.Jones and G.A.Hawkins, John Wiley and Sons..
3. Fundamentals of Classical Thermodynamics, G.J.VanWylen and R.E.Sonntag,Wiley Eastern.
4. An Introduction to Thermodynamcis, Y.V.C.Rao, Wiley Eastern, 1993, B. K Venkanna, Swati B. Wadavadagi "Basic Thermodynamics, PHI, New Delhi, 2010

BASIC THERMODYNAMICS –

Subject code	BT 3ME03	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number Of Lecture Hours	50	CREDITS-04	04

Course Objectives:

1. Learn about thermodynamic systems and boundaries.
2. Study the basic laws of thermodynamics including, conservation of mass, conservation of energy or first law, second law and Zeroth law.
3. Understand various forms of energy including heat transfer and work.
4. Identify various types of properties (e.g., extensive, and intensive properties)
5. Use tables, equations, and charts, in evaluation of thermodynamic properties.
6. Apply conservation of mass, first law, and second law in thermodynamic analysis of systems (e.g., turbines, pumps, compressors, heat exchangers. etc.)
7. Enhance their problem-solving skills in thermal engineering.

Module - 1

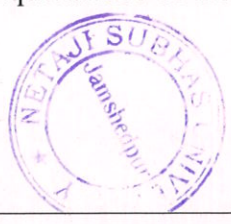
Fundamental Concepts & Definitions: Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive , extensive properties, specific properties, pressure, specific volume Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diatherrnic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. Work and Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention.

Hours-10

Module - 2

First Law of Thermodynamics: Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes., energy, energy as a property, modes of energy, s t e ad y flow energy equation(SFEE), important applications.

Second Law of Thermodynamics: limitations of first law of thermodynamics, Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir, Direct heat engine; schematic representation and efficiency. Kelvin - Planck statement of the Second law of Thermodynam.ics; PMM I and PMM II, C1ausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles.



Hours-10

Module - 3

Reversibility: Definitions of a reversible process, reversible heat engine, importance and superiority of a reversible heat engine and irreversible processes; factors that make a process irreversible, reversible heat engine. Unresisted expansion, remarks on Carnot's engine, internal and external reversibility, Definition of the thermodynamic temperature scale. Problems

Entropy: Clasius inequality, Statement- proof, Entropy- definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy, entropy as a coordinate.

Hours-10

Module - 4

Availability, Irreversibility and General Thermodynamic relations. Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailab1e energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, in•eversibility, second law efficiency.

Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter.

Hours-10

Module - 5

Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, A1nagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties.

Real gases - Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, contractibility factor; compressibility chart. Difference between Ideal and real gases.

Hours-10

Course Outcomes:

1. Explain thermodynamic systems, properties, Zeroth law of thermodynamics, temperature scales and energy interactions.
2. Determine heat, work, internal energy, enthalpy for flow & non flow process using

First and Second Law of Thermodynamics.

3. Interpret behavior of pure substances and its applications to practical problems.
4. Determine change in internal energy, change in enthalpy and change in entropy using TD relations for ideal gases.
5. Calculate Thermodynamics properties of real gases at all ranges of pressure, temperatures using modified equation of state including Vander Waals equation, Redlich Wong equation and Beattie-

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Explain thermodynamic systems, properties, Zeroth law of thermodynamics, temperature scales and energy interactions.	K_1
CO2	Determine heat, work, internal energy, enthalpy for flow & non flow process using First and Second Law of Thermodynamics.	K_2
CO3	Interpret behavior of pure substances and its applications to practical problems.	K_2
CO4	Determine change in internal energy, change in enthalpy and change in entropy using TD relations for ideal gases.	K_3
CO5	Calculate Thermodynamics properties of real gases at all ranges of pressure, temperatures using modified equation of state including Vander Waals equation, Redlich Wong equation and Beattie.	K_5

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3				2		3		3		
CO2	3	2				3		2		3		
CO3	3	2				3		2		3		
CO4	3	2				3		2		3		
CO5	3	1				2		3		3		
CO Average)	3	2				2.6		2.4		3		

3 – High; 2 – Medium; 1 – Low

TEXTBOOKS:

1. Basic Engineering Thermodynamics, A.Venkatesh, Universities Press, 2008
2. Basic and Applied Thermodynamics, P.K.Nag, 2nd Ed., Tata McGraw Hill Pub. 2002
3. Basic and Applied Thermodynamics, P.K.Nag, 2nd Ed., Tata McGraw Hill Pub. 2002.

REFERENCE BOOKS:

1. Thermodynamics, An Engineering Approach, YunusA.Cenegal and Michael A.Boles, Tata McGraw Hill publications, 2002
2. Engineering Thermodynamics, J.B.Jones and! G.A.Hawkins, John Wiley and Sons..
3. Fundamentals of Classical Thermodynamics, G.J.VanWylen and R.E.Sonntag, Wiley Eastern.
4. An Introduction to Thermodynamcis, Y.V.C.Rao, Wiley Eastern, 1993,
5. B.K Venkanna, Swati B. Wadavadagi "Basic Thermodynamics, PHI, New Delhi, 2010

MECHANICS OF MATERIALS

Subject code	BT 3ME04	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number Of Lecture Hours	50	CREDITS-04	04

Course Objectives:

1. Classify the stresses into various categories and define elastic properties of materials and compute stress and strain intensities caused by applied loads in simple and compound sections and temperature changes.
2. Derive the equations for principal stress and maximum in-plane shear stress and calculate their magnitude and direction. Draw Mohr circle for plane stress system and interpret this circle.
3. Determine the shear force, bending moment and draw shear force and bending moment diagrams, describe behavior of beams under lateral loads.
4. Explain the structural behavior of members subjected to torque, Calculate twist and stress induced in shafts subjected to bending and torsion.
5. Understand the concept of stability and derive crippling loads for columns.
6. Understand the concept of strain energy and compute strain energy for applied loads.

Module - 1

Stress and Strain: Introduction, Hooke's law, Calculation of stresses in straight, Composite sections, Stresses due to temperature change Shear stress and strain, Lateral strain and Poisson's ratio, Generalized Hooke's law, Bulk modulus, Relationship between elastic constants.

Hours-10

Module - 2

Analysis of Stress and Strain: Plane stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear stress, Mohr circle for plane stress conditions. Cylinders: Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, Thick cylinders: Lames equations.

Hours-10

Module - 3

Shear Forces and Bending Moments: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads and uniformly• distributed constant/ varying loads.

Hours-10

Module - 4

Torsion: Circular solid and hallow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections.
Columns: Buckling and stability, Critical load, Columns with pinned ends, Effective length of columns.

Hours-10

Module - 5

Strain Energy: Strain energy due to normal stresses, Shear stresses, Modulus of resilience, Strain energy due to bending and torsion.
Theories of Failure: Maximum Princip.al stress theory, Maximum shear stress theory.

Hours-10

Course Outcomes:

1. Understand simple, compound, thermal stresses and strains their relations, Poisson's ratio, Hooke's law, mechanical properties including elastic constants and their relations.
2. Determine stresses, strains and deformations in bars with varying circular and rectangular cross-sections subjected to normal and temperature loads
3. Determine plane stress, principal stress, maximum shear stress and their orientations using analytical method and Mohr's circle
4. Determine the dimensions of structural members including beams, bars and rods using Energy methods and also stress distribution in thick and thin cylinders
5. Draw SFD and BMD for different beams including cantilever bea.ms, simply supported beams and overhanging beams subjected to UDL, UVL, Point loads and couples
6. Determine dimensions, bending stress, shear stress and its distribution in beruns of circular, rectangular, symmetrical I and T sections subjected to point loads and UDL
7. Determine the dimensions of shafts based on torsional strength, rigidity and flexibility and also elastic stability of columns using Rankin's and Euler's theory

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand simple, compound, thermal stresses and strains their relations, Poisson's ratio, Hooke's law, mechanical properties including elastic constants and their relations.	K_2
CO2	Determine stresses, strains and deformations in bars with varying circular and rectangular cross-sections subjected to normal and temperature loads.	K_4

CO3	Determine plane stress, principal stress, maximum shear stress and their orientations using analytical method and Mohr's circle.	K_4
CO4	Determine the dimensions of structural members including beams, bars and rods using Energy methods and also stress distribution in thick and thin cylinders.	K_4
CO5	Draw SFD and BMD for different beams including cantilever beams, simply supported beams and overhanging beams subjected to UDL, UVL, Point loads and couples.	K_3
CO6	Determine dimensions, bending stress, shear stress and its distribution in beams of circular, rectangular, symmetrical I and T sections subjected to point loads and UDL.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		2							
CO2	3	3	3		2							
CO3	3	3	2		2							
CO4	3	2	2		2							
CO5	3	2	2		2							
CO6	3	3	1		2							
CO Average)	3	2.6	2.16		2							

3 – High; 2 – Medium; 1 – Low

TEXTBOOKS:

1. James M Gere, Barry J Goodno, Strength of Materia]s, Indian Edition, Cengage Learning, 2009.
2. R Subramanian, Strength of Materials, Oxford, 2005.

REFERENCE BOOKS:

1. S S Rattan, Strength of Materials, Second Edition, McGraw Hill, 2011.
2. Ferdinand Beer and Russell Johston, Mechanics of materials, Tata McGraw Hill, 2003.

METAL CASTING AND WELDING

Subject code	BT 3ME05	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number Of Lecture Hours	50	CREDITS-04	04

Course Objectives:

1. To provide detailed information about the moulding processes.
2. To provide knowledge of various casting process in manufacturing.
3. To impart knowledge of various joining process used in manufacturing.
4. To provide adequate knowledge of quality test methods conducted on welded and casted components.

Module-I

Introduction & basic materials used in foundry
Introduction: Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy.
Introduction to casting process & steps involved. Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.
Sand molding: Types of base sand, requirement of base sand. Binder, Additives definition, need and types. Preparation of sand molds: Molding machines- Jolt type, squeeze type and Sand slinger.
Study of important molding process: Green sand, core sand, dry sand, sweep mold, CO2 mold, shell mold, investment mold, And plaster mold, cement bonded mold. Cores: Definition, need, types. Method of making cores, concept of gating (top, bottom, parting line horn gate) and risering (open, blind) Functions and types.

Hours-10

Module-2

Melting & metal mold casting methods
Melting furnaces: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Co,reless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace.
Casting using metal molds: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixo casting, and continuous casting Processes.

Hours-10

Module-3

Solidification & nonferrous foundry practice
Solidification: Definition, Nucleation, solidification variables, Directional solidification- need and methods. Degasification in liquid metals-Sources of gas, degasification methods.
Fettling and cleaning of castings: Basic steps involved. Sand Casting defects- causes, features and remedies. Advantages & limitations of casting process. Nonferrous foundry practice: Aluminum castings - Advantages, limitations, melting of aluminum using lift-out type crucible furnace. Hardeners used, dossing, gas absorption, and fluxing and flushing, grain refining, pouring temperature. Stir casting set up, procedure, uses, advantages and limitations.

Hours-10

Module-4

Welding process: Definition, Principles, Classification, Application, Advantages & limitations of welding. Arc welding: Principle, Metal arc welding (MAW), Flux Shielded

Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW).
Special type of welding: Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and electron beam welding.

Hours-10

Module-5

Soldering, brazing and metallurgical aspects in welding
Structure of welds, Formation of different zones during welding, Heat Affected Zone (HAZ), Parameters affecting HAZ. Effect of carbon content on structure and properties of steel, Shrinkage in welds& Residual stresses, Concept of electrodes, filler rod and fluxes. Welding defects- Detection, causes & remedy.
Soldering, brazing. Gas welding: Soldering, Brazing, Gas Welding: Principle, oxy-Acetylene welding, oxy-hydrogen welding, air-acetylene welding, Gas cutting, powder cutting. Inspection methods: Methods used for inspection of casting and welding. Visual, magnetic particle, fluorescent particle, ultrasonic. Radiography, eddy current, holography methods of inspection.

Hours-10

Course Outcomes:

1. Describe the casting process, preparation of Green, Core, dry sand molds and Sweep, Shell, Investment and plaster molds.
2. Explain the Pattern., Core, Gating, Riser system and Jolt, Squeeze, Sand Slinger Molding Machines.
3. Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces.
4. Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings.
5. Explain the Solidification process and Casting of Non-Ferrous Metals.
6. Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes used in manufacturing.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Describe the casting process, preparation of Green, Core, dry sand molds and Sweep, Shell, Investment and plaster molds.	K_1
CO2	Explain the Pattern, Core, Gating, Riser system and Jolt, Squeeze, Sand Slinger Molding Machines.	K_2
CO3	Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces.	K_2
CO4	Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings.	K_2
CO5	Explain the Solidification process and Casting of Non-Ferrous Metals.	K_2
CO6	Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes used in manufacturing	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2		2	2						
CO2	3	2	2		2	2						
CO3	3	3	2		2	3						
CO4	3	3	2		2	3						
CO5	3	3	2		2	3						
CO6	3	2	2		2	3						
CO Average)	3	2.5	2		2	3						

3 –High; 2 –Medium; 1 –Low

TEXT BOOKS:

1. 1."Manufacturing Process-I", Dr.K.Radhakrishna, Sapna Book Hou.se,5th Revised Edition 2009.
2. "Manufacturing & Technology": Foundry Forming and Welding.,P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.

REFERENCE BOOKS:

1. "Process and Materials of Manufacturing", Roy A Lindberg, 4th Ed.Pearson Edu. 2006.
2. "Manufacturing Technology", SeropeKalpakjian, Steuen. R. Sechmid,Pearson Education Asia, 5th Ed. 2006.
3. "Principles of metal casting", Rechard W. Heine, Carl R. LoperJr., Philip C. Rosenthal, Tata McGraw Hill Education Private Limited Ed.1976.

COMPUTER AIDED MACHINE DRAWING

Subject code	BT 3ME06	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number Of Lecture Hours	50	CREDITS-04	04

Course Objectives:

1. To acquire the knowledge of CAD software and its features.
2. To inculcate understanding of the theory of projection and make drawings using orthographic projections and sectional views
3. To familiarize the students with Indian Standards drawing practices.

4. To impart knowledge of thread forms, fasteners, keys, joints and couplings.
5. To make the students understand and interpret drawings of machine components so as to prepare assembly drawings either manually and using CAD packages.
6. To acquire the knowledge of limits, tolerances and fits pertaining to machine drawings.

Module-I

Introduction to computer aided sketching
Review of graphic interface of the software. Review of basic sketching commands and navigational commands.
Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on, axis inclinations, spheres and hollow solids) True shape of section.
Thread forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal and External), square, Acme and Sellers thread, American Standard thread.
Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

Module-2

Keys and Joints: Parallel, Taper, Feather Key, Gib head key and Woodruff key
Riveted joints: Single and double riveted lap joints, Butt joints with single/double cover straps (Chain and zigzag using snap head riveters).
Joints: Cotter joint (socket and spigot), Knuckle joint (pin joint) for two rods.8 Hours
Couplings: Split muff coupling. Protected type flange coupling, Pin (bush) type flexible coupling, Oldham's coupling and Universal coupling (Hook's Joint).

Hours-10

Module-3

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry.

1. Plummer block (Pedestal Bearing)
2. I.C. Engine connecting rod
3. Screw jack (Bottle type)
4. Tailstock of lathe
5. Machine vice
6. Lathe square tool post

Hours-10

Course Outcomes:

1. Sections of pyramids prisms, cubes, cones and cylinders resting on their bases in 2D
2. Orthographic views of machine parts with and without sectioning in 2D.
3. Sectional views for threads with terminologies of ISO Metric, BSW, square and acme, sellers and American standard threads in 2D.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Sections of pyramids, prisms, cubes, cones and cylinders resting on their bases in 2D.	K_1
CO2	Orthographic views of machine parts with and without sectioning in 2D.	K_2
CO3	Sectional views for threads with terminologies of ISO Metric, BSW, square and acme, sellers and American standard threads in 2D.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									
CO2	3	3	3									
CO3	3	3	3									
CO Average)	3	3	3									

3 – High; 2 – Medium; 1 – Low

TEXT BOOKS:

1. 'A Primer on Computer Aided Machine Drawing-2007', Published by VTU Belgaum.
2. 'Machine Drawing', N.D.Bhat & V.M.Parnchal, Published by Charotar Publishing House, 1999.
3. 'Machine Drawing', N.Siddeshwar, P.Kannaih, V.V.S. Sastri, published by Tata Mc.Grawhill, 2006.

REFERENCE BOOKS

1. 1."A Text Book of Computer Aided Machine Drawing", S. Trymbakaa Murthy, CBS Publishers, New Delhi, 2007.
2. 'Machine Drawing', K.R. Gopala Krishna, Subhash publication.

B.TECH – IV SEMESTER, MECHANICAL ENGINEERING

Code No	Name of the Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT401	Engineering Mathematics – IV	3	1	-	4	30	70	100
BT4ME02	Kinematics Of Machine	4	-	-	4	30	70	100
BT4ME03	Applied Thermodynamics	4	-	-	4	30	70	100
BT4ME04	Fluid Mechanics	4	-	-	4	30	70	100
BT4ME05	Machine Tool and Operations	4	-	-	4	30	70	100
BT4ME06	Mechanical Measurements and Metrology	4	-	-	4	30	70	100
	Practical							
BT4ME07L	Mechanical Measurements and Metrology Lab	-	-	3	2	15	35	50
BT4ME08L	Manufacturing Lab	-	-	3	2	15	35	50
	TOTAL	**23**	**1**	**6**	**28**	**210**	**490**	**700**

ENGINEERING MATHEMATICS – IV (BT-401)

Subject Code	**BT401**	**IA MARS**	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	60	**CREDITS**	04

Course Objective:

1. The knowledge of Mathematics is necessary for a better understanding of almost all the engineering and science subjects.
2. Here our intention is to make the students acquainted with the concept of basic topics from Mathematics, which they need to pursue their engineering degree in different disciplines.
3. The statistical methods of studying data samples, hypothesis testing and statistical quality control, control charts and their properties.

Module-1: FUNCTIONS OF A COMPLEX VARIABLE

Introduction - Limit of a complex function - Derivative of (z) - Analytic functions Harmonic functions – Applications to flow problems. Complex Integration – Cauchy's theorem - Cauchy's integral formula – Series of complex tems (Statements of Taylor's and Laurent's Series without proof) - Zeros of an analytic function – Residues Calculation of residues – Evaluation of real definite integrals (Integration around the unit circle, Integration around the small semi-circle, indenting the contours having poles on the real axis).

Geometric representation of (z), Some standard transformations (=z+ c, w = cz , w=^{1}
W= $^{az+b}$).cz+d

Module-2: FINITE DIFFERENCES & INTERPOLATION

Finite differences - Forward differences - Backward differences Central differences Differences of a polynomial- Factorial notation –Other difference operators To find one or more missing terms – Newton's interpolation formulae Central difference interpolation formulae - Interpolation with n equal intervals - Lagrange's interpolation formula - Inverse interpolation.

15 Hours

Module-3: NUMERICAL DIFFERENTIATION AND INTEGRATION

Numerical differentiation - Formulae for derivatives Maxima and minima of a tabulated function - Numerical integration- Newton-Cotes quadrature formula - Trapezoidal rule - - rule, Simpson's
Simpson's -rule.

Hours-10

Module-4: Z- TRANSFORMS

Introduction – Definition – Some standard Z-transforms - Linearity property -Damping rule Some standard results Shifting Un to the right, Shifting Un to the left - Two basic theorems (Initial value theorem and Final value theorem) - Convolution theorem Convergence of Z-transforms - Two sided Z-transform of Un Evaluation of inverse Z transforms (Power series method, Partial fraction method, Inverse integral method) –
Applications to difference equations

. Hours-10

Module-5: SAMPLING THEORY

Introduction - Sampling distribution - Testing a hypothesis - Level of significance-Confidence limits – Test of significance of large samples (Test of significance of single mean, difference of means) – Confidence limits for unknown – Small samples - Students t distribution-Significance test of a sample mean - Significance test of difference between sample means -Chi-Square (y2) Test - Goodness of fit.

Hours-10

Course Outcomes:

At the end of the course student will be able to

CO-1: Understand, interpret and use the basic concepts: Analytic function, harmonic function, Taylor and Laurent Series, Singularity, Residues and evaluation of improper integrals.

CO-2: Familiarize the concepts of Finite Differences and Interpolation techniques.

CO-3: Familiarize the concept of Differentiation and Integration by numerical methods.

CO-4: Understand the characteristics and properties of Z-transforms and its applications. Analyze the Statistical data by using statistical tests and to draw valid inferences about the population parameters.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand, interpret and use the basic concepts: Analytic function, harmonic function, Taylor and Laurent Series, Singularity, Residues and evaluation of improper integrals.	K_2
CO2	Familiarize the concepts of Finite Differences and Interpolation techniques.	K_2

CO3	Familiarize the concept of Differentiation and Integration by numerical methods.	K_3
CO4	Understand the characteristics and properties of Z-transforms and its applications. Analyze the Statistical data by using statistical tests and to draw valid inferences about the population parameters.	K_2

1. KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
2. K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1									3	3
CO2	2	1			2							1
CO3	1						2	1				2
CO4		1		2		2				2		
CO (Average)	2	1		2	2	2	2	1		2	2.5	2

3 -High; 2 -Medium; 1 -Low

REFERENCE BOOKS:

1. **Dr. N.P. Bali, Dr. Ashok Saxena, Dr. N.Ch. S. Narayana**, "A Text book on Engineering Mathematics", Laxmi Publications (P)Ltd., New Delhi.
2. **HK. Dass**,"Advanced Engineering Mathematics:,S. Chand and Company Ltd.
3. **Erwin Kreyszig**, "Advanced Engineering Mathematics"',John Wiley and Sons, NewYork.
4. **Dr. B.S. Grewal**,"Higher EgineeringMathematics",43 edition,Khanna Publishers,New Dehli.

KINEMATICS OF MACHINES

Subject Code	**BT4ME02**	**IA MARS**	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. Familiarize with mechanisms and motion analysis of mechanisms.
2. Understand methods of mechanism motion analysis and their characteristics.
3. Analyse motion of planar mechanisms, gears, gear trains and cams.

Module- 1

Introduction: Definitions: Link, kinematic pairs,kinematic chain, mechanism, structure, degrees of freedom, Classification links, Classification of pairs based on type of relative motion, Grubler's criterion, mobility of mechanism, Groshoff's criteria, inversions of Grashoff's chain.

Mechanisms: Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Oldham's coupling, Straight line motion mechanisms, Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism,toggle mechanism, pantograph, condition for correct steering, Ackerman steering gear mechanism.

Hours-10

Module- 2

Velocity and Acceleration Analysis of Mechanisms (Graphical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Corioli's component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem, Determination of linear and angular velocity using instantaneous center method.

Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism.

Hours-10

Module- 3

Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method.

Freudenstein's equation for four bar mechanism and slider crank mechanism. Function Generation for four bar mechanism.

Hours-10

Module- 4

Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference.

Gear Trains: Simple gear trains, compound gear trains.

Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.

Hours-10

Module-5

Cams: Types of cams, types of followers. displacement, velocity and acceleration curves for uniform velocity, Simple Harmonic Motion, Uniform Acceleration, Retardation and Cycloidal motion.

Cam profiles: disc cam with reciprocating followers such as knife-edge, roller and flat-face followers, inline and offset.

Analysis of Cams: Analysis of arc cam with flat faced follower.

Hours-10

Course Outcomes:

1. Identify mechanisms with basic understanding of motion,
2. Comprehend motion analysis of planar mechanisms, gears, gear trains and cams.
3. Carry out motion analysis of planar mechanisms, gears, gear trains and cams.

TEXT B00KS:

1. Rattan S.S, Theory of Machines, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4th Edition, 2014.
2. Ambekar A. G., Mechanism and Machine Theory, PHI, 2009

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Identify mechanisms with basic understanding of motion.	K_1
CO2	Comprehend motion analysis of planar mechanisms, gears, gear trains and cams.	K_4
CO3	Carry out motion analysis of planar mechanisms, gears, gear trains and cams.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		2							
CO2	3	3	2		3							
CO3	2	1			1							
CO Average)	2.66	2.33	2.5		2							

3 – High; 2 – Medium; 1 – Low

APPLIED THERMODYNAMICS
B. Tech IV Semester, Mechanical Engineering

Subject Code	BT4ME03	IA MARS	30
Number of Lecture	04	Term End Exam Marks	70

Hours/ Week			
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. To have a working knowledge of basic performance of Gas power cycles.
2. To Calculate the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy
3. To understand and evaluate the performance of steam power cycles their various Engineering applications
4. To know how fuel burns and their thermodynamic properties.
5. To Understand mechanism of power transfer through belt, rope, chain and gear drives in IC Engines
6. To determine performance parameters of refrigeration and air-conditioning systems.
7. Evaluate the performance parameters of reciprocating air compressor as a function of receiver pressure.

Module-1

Gas Power Cycles: Air standard cycles; Carnot, Otto, Diesel, Dual and Stirling cycles, p-v and T -s diagrams, description, efficiencies and mean effective pressures. Comparison of Otto and Diesel cycles. Gas turbine (Brayton) cycle; description and analysis. Regenerative gas turbine cycle. Inter-cooling and reheating in gas turbine cycles. Jet propulsion: Introduction to the principles of jet propulsion.

Hours-10

Module- 2

Vapour Power Cycles: Carnot vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T-s diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pre sure and temperature on Rankine cycle performance. Actual vapour power cycles. Ideal and practical regenerative Rankine cycles, open and closed feed water heaters. Reheat Rankine cycle. Characteristics of an Ideal working fluid in Vapour power cycles, Binary Vapour cycles.

Hours-10

Module-3

Combustion Thermodynamics: Theoretical (Stoichiometric) air for combustion of fuels. Excess air, mass balance, Exhaust gas analysis, AF ratio. Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion. Combustion efficiency. Dissociation and equilibrium, emissions.

IC.Engines: Classification of IC engines, Combustion of SI engine and CI engine, Detonation and factors affecting detonation, Performance analysis of I.C Engines, heat balance, Morse test, IC Engine fuels, Ratings and Alternate Fuels.

Hours-10

Module- 4

Refrigeration Cycles: Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties, alternate Refrigerants. Any one case study on cold storage or

industrial refrigerator. Air cycle refrigeration; reversed Carnot cycle, reversed Brayton cycle, Vapour absorption refrigeration system. Steam jet refrigeration.

Pscychrometrics and Air-conditioning Systems: Properties of Atmospheric air, and Psychometric properties of Air, Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams. Cooling towers.

Hours-10

Module- 5

Reciprocating Compressors: Operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, saving in work, Optimum intermediate pressure, Inter-cooling, Minimum work for compression.

Steam nozzles: Flow of steam through nozzles, Shape of nozzles, effect of friction, Critical pressure ratio, Supersaturated flow.

Hours-10

Course Outcomes:

1. Apply thermodynamic concepts to analyze the performance of gas power cycles including propulsion systems.
2. Evaluate the performance of steam turbine components.
3. Understand combustion of fuels and combustion processes in IC engines including alternate fuels and pollution effect on environment.
4. Apply thermodynamic concepts to analyze turbo machines.
5. Determine performance parameters of refrigeration and air-conditioning systems.
6. Understand the principles and applications of refrigeration systems.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Apply thermodynamic concepts to analyse the performance of gas power cycles including propulsion systems.	K_2
CO2	Evaluate the performance of steam turbine components.	K_5
CO3	Understand combustion of fuels and combustion processes in IC engines including alternate fuels and pollution effect on environment.	K_2
CO4	Apply thermodynamic concepts to analyse turbo machines.	K_3
CO5	Determine performance parameters of refrigeration and air-conditioning systems.	K_5
CO6	Understand the principles and applications of refrigeration systems.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										
CO2	3	3									2	
CO3	2							3	3	3		
CO4	1											
CO5	2											
CO6	3										1	
CO Average)	2.3	3						3	3	3	1.5	

3 – High; 2 – Medium; 1 – Low

TEXT B00KS:

1. Rattan S.S, Theory of Machines, Tata McGraw-Hill Publishing Company Ltd., Ncw Delhi, 4th Edition, 2014.
2. Ambekar A. G., Mechanism and Machine Theory, PHI, 2009. Thermodynamics an engineering approach, by Yunus A. Cenegal and Michael A. Boles. Tata McGraw hill Pub. Sixth edition, 2008.
3. Basic and Applied Thermodynamics'"by P.K. Nag,Tata McoGraw Hil, 2nd Edi. 2009
4. Fundamentals of Thermodynamics by G.J. Van Wylen and R.E. Sonntag, Wiley Eastern. Fourth edition 19993.

FLUID MECHANICS

B. Tech IV Semester, Mechanical Engineering

Subject Code	**BT4ME04**	**IA MARS**	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. To have a working knowledge of the basic properties of fluids and understand the continuum approximation
2. To Calculate the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy
3. To understand the flow characteristic and dynamics of flow field for various Engineering applications
4. To know how velocity changes and energy transfers in fluid flows are related to forces and torques and to understand why designing for minimum loss of energy in fluid flows is so important.
5. To discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.
6. Understand the concept of dynamic similarity and how to apply it to experimental modeling
7. To appreciate the consequences of compressibility in gas flow and understand the

effects of friction and heat transfer on compressible flows

Module- 1

Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc, pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, Absolute, gauge, atmospheric and vacuum pressures pressure measurement by simple, differential manometers and mechanical gauges. Fluid Statics: Total pressure and centre of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid. Buoyancy, centre of buoyancy, meta centre and meta centric height its application in shipping, stability of floating bodies.

Hours-10

Module-2

Fluid Kinematics and Dynamics:

Fluid Kinematics: Types of Flow-steady , unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates. Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net, Problems.

Fluid Dynamics: Momentum equation, Impacts of jets- force on fixed and moving vanes, flat and curved. Numerical Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venturimeter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc., related numericals.

Hours-10

Module- 3

Laminar and turbulent flow: Reynods Number, Entrance flow and Developed flow, Naiver Stokes Equation (no derivation), Laminar flow between parallel plates, Poiseuille equation – velocity profile, Couette flow, Fully developed laminar flow in circular pipes, Hagen - Poiseuille equation, related numericals. Energy consideration in pipe flow, Loss of Pressure Head due to Fluid Friction, Darcy Weishach formula, major and minor losses in pipes, Commercial pipe, Colebrook equation, Moody equation/ diagram. Pipes in series, parallel, equivalent pipe, Related Numericals and simple pipe design problems.

Hours-10

Module- 4

Flow over bodies: Development of boundary layer, Prandtl's boundary layer equations, Blasius solution, laminar layer over a flat plate, boundary layer separation and its control.

Basic concept of Lift and Drag, Types of drag, Co-efficient of drag and lift,streamline body and bluff body, flow around circular bodies and airfoils, Lift and drag on airfoil, Numerical problems.

Dimensional analysis: Need for dimensional analysis, Dimensions and units, Dimensional Homogeneity and dimensionless ratios, methods of

dimensional analysis, Rayleigh's method, Buckingham Pi theorem, Similitude and Model studies. Numerical problems

Hours-10

Module- 5

Compressible Flows: Introduction, themodynamic relations of perfect gases, internal energy and enthalpy, speed of sound, pressure field due to a moving source, basic Equations for one dimensional flow, stagnation and sonic Properties, normal and oblique shocks.

Introduction to CFD: Necessity, limitations, philosophy behind CFD, and applications.

Hours-10

Course Outcomes:

1. Identify and calculate the key fluid properties used in the analysis of fluid behavior.
2. Understand and apply the principles of pressure, buoyancy and floatation
3. Apply the knowledge of fluid statics, kinematics and dynamics while addressing problems of mechanical and chemical engineering.
4. Understand and apply the principles of fluid kinematics and dynamics.
5. Understand the concept of boundary layer in fluid flow and apply dimensional analysis to form dimensionless numbers in terms of input output variables.
6. Understand the basic concept of compressible flow and CFD

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Identify and calculate the key fluid properties used in the analysis of fluid behavior.	K_1
CO2	Understand and apply the principles of pressure, buoyancy and floatation	K_2
CO3	Apply the knowledge of fluid statics, kinematics and dynamics while addressing problems of mechanical and chemical engineering.	K_3
CO4	Understand and apply the principles of fluid kinematics and dynamics.	K_2
CO5	Understand the concept of boundary layer in fluid flow and apply dimensional analysis to form dimensionless numbers in terms of input output variables.	K_2
CO6	Understand the basic concept of compressible flow and CFD	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

3 – High; 2 – Medium; 1 – Low

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2				3						
CO2	3	2				2						
CO3	2		2		3	2				3		
CO4	2					3				2		
CO5	3					2						
CO6	2					3						
CO Average)	2.5	2	2		3	2.5				2.5		

TEXT BOOKS:

1. Fluid Mechanics (SI Units), Yunus A. Cengel John M.Cimbala, 3rd Ed., Tata • McGraw Hill, 2014.
2. Fluid Mechanics, FM White, McGraw Hill Publications Eighth edition, 2016
3. Mechanics of Fluids, Merle C. Potter, Devid C. Wiegert, Bassem H. Ramadan, Cengage learning, Fourth editions 2016.

MACHINE TOOLS AND OPERATIONS

B. Tech IV Semester, Mechanical Engineering

Subject Code	**BT4ME05**	**IA MARS**	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. To introduce students to different machine tools in order to produce components having different shapes and sizes.
2. To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
3. To develop the knowledge on mechanics of machining process and effect of various parameters on economics of machining.

Module- 1

MACHINE TOOLS

Introduction, Classification, construction and specifications of lathe, drilling machine, milling machine, boring machine, broaching machine, shaping machine, planning machine, grinding machine [Simple sketches showing major parts of the machines]

Hours-10

Module- 2

MACHINING PROCESSES

Introduction, Types of motions in machining, turning and Boring, Shaping, Planningand Slotting, Thread cutting, Drilling and reaming, Milling, Broaching, Gear cutting and Grinding, Machining parameters and related quantities.

[Sketches pertaining to relative motions between tool and work piece only]

Hours-10

Module-3

CUTTING TOOL MATERIALS, GEOMETRY AND SURFACE FINISH:

Introduction, desirable Properties and Characteristics of cutting tool materials, cutting tool geometry, cutting fluids and its applications, surface finish, effect of machining parameters on surface finish.

Machining equations for cutting operations: Turning, Shaping, Planing, slab milling, cylindrical grinding and internal grinding, Numerical Problems Hours-10

Module- 4

MECHANICS OF MACHINING PROCESSES

Introduction, Chip formation, Orthogonal cutting, Merchants model for orthogonal cutting, Oblique cutting, Mechanics of turning process, Mechanics of drilling process, Mechanics of milling process, Numerical problems.

Hours-10

Module- 5

TOOL WEAR, TO0L LIFE:

Introduction, tool wear mechanism, tool wear equations, tool life equations, effect of process parameters on tool life, machinability, Numerical problems

ECONOMICS OF MACHNING PROCESSES:

Introduction, choice of feed, choice of cutting speed, tool life for minimum cost and minimum production time, machining at maximum efficiency, Numerical problems

Hours-10

Course Outcomes:

1. Explain the construction & specification of various machine tools.
2. Describe various machining processes pertaining to relative motions between tool & work piece.
3. Discuss different cutting tool materials, tool nomenclature & surface finish.
4. Apply mechanics of machining process to evaluate machining time.
5. Analyze tool wear mechanisms and equations to enhance tool life and minimize machining cost.

Course	Statement	Knowledge

Outcome No		Level (KL)
CO1	Explain the construction & specification of various machine tools.	K_1
CO2	Describe various machining processes pertaining to relative motions between tool & work piece	K_1
CO3	Discuss different cutting tool materials, tool nomenclature & surface finish.	K_2
CO4	Apply mechanics of machining process to evaluate machining time.	K_2
CO5	Analyse tool wear mechanisms and equations to enhance tool life and minimize machining cost.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3			3							
CO2	2				3							
CO3	2	1			3			2				
CO4	3	2			3							
CO5	3				3							
CO Average)	2.6	2			3			2				

3 –High; 2 –Medium; 1 –Low

TEXT BOOKS:

1. Fundamentals of metal cutting and Machine Tools, B.L. Juneja, G.S. Sekhon and Nitin Seth, New Age International Publishers 2nd Edition, 2003
2. All about Machine Tools, Heinrich Gerling, New Age International Publishers revised 2nd Edition, 2006

MECHANICAL MEASUREMENTS AND METROLOGY

B. Tech IV Semester, Mechanical Engineering

Subject Code	BT4ME06	IA MARS	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. Understand metrology, its advancements & measuring instruments,
2. Acquire knowledge on different standards of length, calibration of End Bars, linear and angular measurements, Screw thread and gear measurement & comparators. 3.

Equip with knowledge of limits, fits, tolerances and gauging.

3. Acquire knowledge of measurement systems and methods with emphasis on different transducers, intermediate modifying and terminating devices.
4. Understand the measurement of Force, Torque, Pressure, Temperature and Strain.

Module- 1

MACHINE TOOLS

Introduction to Metrology: Definition, objectives and concept of metrology, Need of inspection., Principles, process, methods of measurement, Classification and selection of measuring instruments and systems. Accuracy, precision and errors in measurement.

System of measurement, Material Standard, Wavelength Standards, Subdivision of standards, Line and End standards, Classification of standards and Traceability, calibration of End bars (Numerical Problems), standardization.

Linear Measurement and angular measurements:

Slip gauges- Indian standards on slip gauge, method of selection of slip gauge, stack of slip gauge, adjustable slip gauge, wringing of slip gauge, care of slip gauge, slip gauge accessories, problems on building of slip gauges (M87, MI12).

Measurement of angles- sine bar, sine centre, angle gauges, optical instruments for angular measurements, Auto collimator-applications for measuring straightness and squareness.

Hours-10

Module- 2

System of Limits, Fits, Tolerance and Gauging:

Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963), geometric tolerance, position-tolerances. Classification of gauges, brief concept of design of gauges (Taylor's principles), Wear allowance on gauges, Types of gauges plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials.

Comparators:

Functional requirements, classification, mechanical- Johnson Mikrokator, sigma comparators, dial indicator, electrical- principles, , LVDT, Pneumatic- back pressure gauges, Solex comparators and optical comparators- Zeiss ltra-optimeter.

Hours-10

Module- 3

Measurement of screw thread and gear: Terminology of screw threads, measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3- wire methods, best size wire. Screw thread gauges, Tool maker's microscope. Gear tooth terminology, tooth thickness measurement using constant chord method,

addendum comparator method and base tangent method, measurement of pitch, concentricity, run out, and involute profile. Gear roll tester for composite error.
Advances in metrology:
Basic concepts of lasers, advantages of lasers, laser interferometers, types, applications. Basic concepts of Coordinate Measuring Machines-constructional features, applications.

Hours-10

Module- 4

Measurement systems and basic concepts of measurement methods:
Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy. precision, calibration, threshold, sensitivity, hysteresis, repeatability. linearity, loading effect, system response-time delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type transducers.
Intermediate modifying and terminating devices: Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast.
circuit, electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillography.

Hours-10

Module- 5

Force, Torque and Pressure Measurement:
Direct methods and indirect method, force measuring inst. Torque measuring inst., Types of dynamometers, Absorption dynamometer, Prony brake and rope brake dynamometer, and power me assuring instruments. Pressure measurement, principle, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge.
Measurement of strain and temperature:
Theory of strain gauges, types, electrical resistance strain gauge, preparation and mounting of strain gauges, gauge factor, methods of strain measurement. Temperature Compensation, Wheatstone bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors. Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, optical pyrometer.

Hours-10

Course Outcomes:

1. Understand the objectives of metrology, methods of measurement, selection of measuring instruments, standards of measurement and calibration of end bars.
2. Describe slip gauges, wringing of slip gauges and building of slip gauges, angle measurement using sine bar, sine center, angle gauges, optical instruments and straightness measurement using Autocollimator.
3. Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and

their design.

4. Understand the principle of Johnson Mikrokator, sigma comparator, dial indicator, LVDT, back pressure gauges, Solex comparators and Zeiss Ultra Optimeter
5. Describe measurement of major diameter, minor diameter. pitch, angle and effective diameter of screw threads by 2 - wire, 3 - wire methods, screw thread gauges and tool maker's microscope.
6. Explain measurement of tooth thickness using constant chord method, addendum comparator methods and base tangent method, composite error using gear roll tester and measurement of pitch, concentricity, run out and involute profile

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand the objectives of metrology, methods of measurement, selection of measuring instruments, standards of measurement and calibration of end bars.	K_2
CO2	Describe slip gauges, wringing of slip gauges and building of slip gauges, angle measurement using sine bar, sine centre, angle gauges, optical instruments and straightness measurement using Autocollimator.	K_1
CO3	Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design.	K_3
CO4	Understand the principle of Johnson Mikrokator, sigma comparator, dial indicator, LVDT, back pressure gauges, Solex comparators and Zeiss Ultra Optimeter.	K_2
CO5	Describe measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2 - wire, 3-wire methods, screw thread gauges and tool maker's microscope.	K_1
CO6	Explain measurement of tooth thickness using constant chord method, addendum comparator methods and base tangent method, composite error using gear roll tester and measurement of pitch, concentricity, run out and involute profile.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		2					3				
CO2	3		2									
CO3	3		3					2				
CO4	2		1					1				
CO5	3		1					2				
CO6	2		1					3				
CO Average)	2.83		1.66					2.2				

3 –High; 2 –Medium; 1 –Low

TEXT BOOKS:

1. Mechanical Measurements, Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006.
2. Engineering Metrology, R.K. Jain, Khanna Publishers, Delhi, 2009.

B.TECH -V SEMESTER, MECHANICAL ENGINEERING

Code No	Name of the Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT5ME01	Management and Engineering Economics	4	-	-	4	30	70	100
BT5ME02	Dynamics of Machines	4	-	-	4	30	70	100
BT5ME03	Turbo machines	4	-	-	4	30	70	100
BT5ME04	Design of Machine Elements-I	4	-	-	4	30	70	100
BT5ME05	Refrigeration and Air conditioning	4	-	-	4	30	70	100
BT5ME06	Elective-I	4	-	-	4	30	70	100
	Practical							
BT5ME07L	Fluids mechanics and Machinery Lab	-	-	3	2	15	35	50
BT5ME08L	Energy Lab	-	-	3	2	15	35	50
	TOTAL	**24**	**-**	**6**	**28**	**210**	**490**	**700**

Elective – I
Theory Of Elasticity
Human Resource Management
Non-Traditional Machine
Energy Environment

MANAGEMENT AND ENGINEERING ECONOMICS

B. TECH, V Semester, Mechanical Engineering

Subject Code	BT5ME01	IA MARS	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. Examine the meaning, importance, nature of management, its difference between management and administration and role of managers in management.
2. Examine the meaning characteristics principles and process of organizing.
3. Describe effective communication process, its importance, types and purpose for running an organization.
4. Explain the importance of engineering economics, Law of demand and supply in engineering decision making.
5. Describe various interest rate factors and implement the same for economic decision making.
6. Examine different economic analysis methods-NPW, EAW, IRR, FW for decision Making.

7. Discuss different component of costs and methods of cost estimation.
8. Explain depreciation, different methods of computing depreciation.
9. Discuss taxation concepts-income tax and corporate taxes.

Module -1

Management: Introduction - Meaning - nature and characteristics of Management, Scope, and Functional areas of management Management as a science, art of profession Management & Administration - Roles of Management, Levels of Management, Development of Management Thought- carly management approaches - Modern management approaches.

Planning: Nature, importance and purpose of planning process Objectives -Types of plans (Meaning Only) - Decision making Importance of planning -steps in planning & planning premises - Hierarchy of plans.

Hours-10

Module -2

Organizing And Staffing: Nature and purpose of organization Principles of organization Types of organization - Departmentation Committees- Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing--: Process of Selection & Recruitment (in brief).

Directing & Controlling: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief)

Hours-10

Module -3

Introduction: Engineering and economics, Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion, and problems

Hours-10

Module -4

Present, future and annual worth and rate of returns: Basic present worth comparisons, Present worth-equivalence, Assets with unequal lives and infinites lives, future worth

comparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons.

Asset life, Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Discussions, and problems

Hours-10

Module-5

Costing and depreciation: Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time.

Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems.

Course Outcomes:

1. Explain the development of management and the role it plays at different levels in an organization.
2. Comprehend the process and role of effective planning, organizing and staffing for the development of an organization.
3. Understand the necessity of good leadership, communication and coordination for establishing effective control in an organization.
4. Understand engineering economics demand supply and its importance in economics decision making and problem solving.
5. Calculate present worth, annual worth and IRR for different alternatives in economic decision making.

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	Explain the development of management and the role it plays at different levels in an organization	K_1
CO2	Comprehend the process and role of effective planning, organizing and staffing for the development of an organization	K_1
CO3	Understand the necessity of good leadership, communication and coordination for establishing effective control in an organization.	K_2
CO4	Understand engineering economics demand supply and its importance in economics decision making and problem solving.	K_2
CO5	Calculate present worth, annual worth and IRR for different alternatives in economic decision making.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	3	3		3			3		3		3	3
CO2	3	2					3		3		3	3
CO3	3	2	2	3	3		3		2		3	3
CO4	2	2	2				3		2		3	3
CO5	2		3	3			3		2		3	3
CO (Average)	2.6	1.75	2.33	3	3		3		2.4		3	3

CO & PO Mapping:

3 – High; 2 – Medium; 1 – Low

TEXT BOOK:

1. Economics and Management, Gurunath Waghale, D.R Dileep, M.Sonkamble, D.R Swati, Nirali Production.

DYNAMICS OF MACHINERY

Subject Code	**BT5ME02**	**IA MARS**	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. To gain the knowledge static and dynamic equilibrium conditions of mechanisms subjected forces and couple, with and without friction.
2. Analyze the mechanisms for static and dynamic equilibrium.
3. To understand the balancing principles of rotating and reciprocating masses, governs and gyroscopes.
4. Analyze the balancing of rotating and reciprocating masses, governors and gyroscopes.
5. To understand vibrations characteristics of single degree of freedom systems.
6. Characterize the single degree freedom systems subjected to free and forced vibrations with and without damping.

Module-1

Static force Analysis: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, Free body diagrams, Static force analysis of four bar mechanism and Slider-crank mechanism with and without friction.

Dynamic force Analysis: D 'Alembert's principle, Inertia force, Inertia torque. Dynamic force analysis of four-bar mechanism and Slider crank mechanism without friction, numerical problems.

Hours-10

Module -2

Balancing of Rotating Masses: Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.

Balancing of Reciprocating Masses: Inertia effect of crank and connecting rod, Single cylinder engine, balancing in multi cylinder-inline engine (primary and secondary forces), numerical problems.

Hours-10

Module-3

Governors: Types of governors, force analysis of Porter and Hartnell governors. Controlling force, Stability, Sensitiveness, Isochronism, Effort and Power.

Gyroscope: Vectoial representation of angular motion, Gyroscopic couple. Effect of gyroscopic couple on plane disc, aeroplane, ship, stability of two wheelers and four wheelers, numerical problems.

Hours-10

Module -4

Introduction & Undamped free Vibrations (Single Degree of Freedom)

Types of vibrations, Definitions, Simple Harmonic Motion (SHM), Work done by harmonic force, Principle of super position applied to SHM. Methods of analysis - (Newton's, Energy & Rayleigh's methods). Derivations for spring mass systems, Natural frequencies of simple systems, Springs in series and parallel, Torsional, and transverse vibrations, Effect of mass of spring and problems.

Hours-10

Module -5

Damped free Vibrations (Single Degree of Freedom)

Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement, and numerical problems.

Forced Vibrations (Single Degree of Freedom):

Analysis of forced vibration with constant harmonic excitation, Magnification factor (M.F.), Vibration isolation - Transmissibility ratio, Excitation of support (absolute and relative), Numerical problems.

Hours-10

Course Outcomes:

1. Determine the forces and couples for static and dynamic conditions of four bar and slider crank mechanisms to keep the system in equilibrium.

2. Determine magnitude and angular position of balancing masses under static and dynamic condition of rotating masses in same and different planes.
3. Determine unbalanced primary, secondary forces and couples in single and multi-cylinder engine.
4. Determine sensitiveness, isochronism, effort and power of porter and Hartnell Governors.
5. Determine gyroscopic couple and effects related to 2, 4-wheeler, plane disc, ship and aero planes.
6. Understand types of vibration, SHM and methods of finding natural frequencies of simple mechanical systems.
7. Determine equation of motion, natural frequency, damping factor, logarithmic decrement of damped free vibration (SDOF) systems.
8. Determine the natural frequency, force and motion transmissibility of single degree freedom systems.
9. Determine equation of motion of rotating and reciprocating unbalance systems, magnification factor, and transmissibility of forced vibration (SDOF) systems.

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	Determine the forces and couples for static and dynamic conditions of four bar and slider crank mechanisms to keep the system in equilibrium.	K_1
CO2	Determine magnitude and angular position of balancing masses under static and dynamic condition of rotating masses in same and different planes.	K_2
CO3	Determine unbalanced primary, secondary forces and couples in single and multi-cylinder engine.	K_2
CO4	Determine sensitiveness, isochronism, effort and power of porter and Hartnell governors.	K_2
CO5	Determine gyroscopic couple and effects related to 2, 4-wheeler, plane disc, ship and aero planes.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3			1		3				
CO2	3	3		3	1		1					
CO3		3		2		3			1			
CO4	3	2	3	2								
CO5	3	2	1	2		1		1				
CO (Average)	3	2.6	2.33	2.25	1	1.66	1	2	1			

3- High; 2- Medium; 1- Low

TEXT BOOK:

1. Kinematics and Dynamics of Machinery, Venkatachalam, R.J.Shruti, Blue Rose Publisher

TURBO MACHINES

B. TECH, V Semester, Mechanical Engineering

Subject Code	**BT5ME03**	**IA MARS**	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. The course aims at giving an overview of different types of turbomachinery used for energy transformation, such as pumps, fans, compressors, as well as hydraulic and steam turbines.
2. Explain the working principles of turbomachines and apply it to various types of machines.
3. It will focus on application of turbo machinery in power generation, power absorption and transportation sectors.

Module -1

Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Effect of Reynolds number, Unit and specific quantities, model studies. (Note: Since dimensional analysis is covered in Fluid Mechanics subject, questions on dimensional analysis may not be given. However, dimensional parameters and model studies may be given more weightage.)

Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, Incompressible fluids and perfect gases, overall isentropic efficiency, stage efficiency (their comparison) and polytrophic efficiency for both compression and expansion processes. Reheat factor for expansion process

Hours-10

Module-2

Energy exchange in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems.

General Analysis of Turbo machines: Radial flow compressors and pumps general analysis, Expression for degree of reaction, velocity triangles,

Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, Theoretical head - capacity relationship, General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Problems.

Hours-10

Module-3

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor.
Reaction turbine - Parsons's turbine, condition for maximum utilization factor, reaction staging. Problems.

Hours-10

Module -4

Hydraulic Turbines: Classification, various efficiencies. Pelton turbine – velocity triangles, design parameters, Maximum efficiency.
Francis's turbine - velocity triangles, design parameters, runner shapes for different blade speeds. Draft tubes- Types and functions. Kaplan and Propeller turbines - velocity triangles, design parameters. Problems.

Hours-10

Module -5

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems.

Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems. Axial flow Compressors: Expression for pressure ratio developed in a stage, work done factor, efficiencies and stalling. Problems.

Hours-10

Course Outcomes:

1. Able to give precise definition of turbomachinery.
2. Identify various types of turbo machinery.
3. Apply the Euler's equation for turbomachinery to analyse energy transfer in turbomachines.
4. Understand the principle of operation of pumps, fans, compressors, and turbines.
5. Preform the preliminary design of turbomachines (pumps, rotary compressors, and turbines)

Course	Statement	Knowledge

Outcome No		Level (KL)
CO1	Able to give precise definition of turbomachinery.	K_1
CO2	Identified the various types of turbo machinery.	K_1
CO3	Apply the Euler's equation for turbomachinery to analyse energy transfer in turbomachines.	K_3
CO4	Understand the principle of operation of pumps, fans, compressors, and turbines.	K_2
CO5	Perform the preliminary design of turbomachines (pumps, rotary compressors, and turbines)	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										
CO2	1											
CO3	1	2		2	1		1					
CO4	2	2		2	1							
CO5	2				1		1					
CO (Average)	1.8	2.33		2	1		1					

3- High; 2- Medium; 1- Low

TEXT BOOK:

1. Turbo Machines, B.K.Venkanna, PHI publications.

DESIGN OF MACHINE ELEMENTS –I

Subject Code	BT5ME04	IA MARS	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. Able to understand mechanical design procedure, materials, codes and use of standards
2. Able to design machine components for static, impact and fatigue strength.
3. Able to design fasteners, shafts, joints, couplings, keys, threaded fasteners riveted joints, welded joints and power screws

Module -1

Fundamentals of Mechanical Engineering Design

Mechanical engineering design, Phases of design process, Design considerations, Engineering Materials and their Mechanical properties, Standards and Codes, Factor of safety, Material selection.

Static Stresses: Static loads. Normal, Bending, Shear and Combined stress. Theories of failure. Stress concentration and determination of stress

Hours-10

Module -2

Design for Impact and Fatigue Loads

Impact stress due to Axial, Bending and Torsional loads.

Fatigue failure: Endurance limit, S-N Diagram, Low cycle fatigue, High cycle fatigue, modifying factors: size effect, surface effect. Stress concentration effects, Notch sensitivity, fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.

Hours-10

Module-3

Design of Shafts, Joints, Couplings and Keys

Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under combined loads. Design of Cotter and Knuckle joints, Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling. Design of keys-square, saddle, flat and father.

Hours-10

Module-4

Riveted Joints and Weld Joints

Rivet types, rivet materials, failures of riveted joints, Joint Efficiency, Boiler Joints, Lozanze Joints, Riveted Brackets, eccentrically loaded joints. Types of welded joints, Strength of butt and fillet welds, welded brackets with transverse and parallel fillet welds, eccentrically loaded welded joints.

Hours-10

Module -5

Threaded Fasteners and Power Screws

Stresses in threaded fasteners, Effect of initial tension, Design of threaded fasteners under static loads, Design of eccentrically loaded bolted joints. Types of power screws, efficiency and self-locking, Design of power screw, Design of screw jack: (Complete Design).

Course Outcomes:

1. Describe the design process, choose materials.
2. Apply the codes and standards in design process.
3. Analyze the behaviour of machine components under static, impact, fatigue loading

using failure theories.

4. Design shafts, joints, couplings.
5. Design of riveted and welded joints. Design of threaded fasteners and power screws.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Describe the design process, choose materials.	K_1
CO2	Apply the codes and standards in design process.	K_2
CO3	Analyze the behaviour of machine components under static, impact, fatigue loading using failure theories.	K_4,
CO4	Design shafts, joints, couplings.	K_5
CO5	Design of riveted and welded joints. Design of threaded fasteners and power screws.	K_5

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	3	3	3				3		
CO2	2	2	2	1	2	2			2			
CO3	2	2	1	1	3		1					
CO4	2	1		1	3							
CO5	2	1	1				3			3		
CO (Average)	2	1.6	1.75	1.5	2.75	2.5	2		2	3		

3- High; 2- Medium; 1- Low

REFRIGERATION AND AIR-CONDITIONING

Subject Code	**BT5ME05**	**IA MARS**	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. Study the basic definition, ASHRAE Nomenclature for refrigerating systems.
2. Understand the working principles and applications of different types of refrigeration systems.
3. Study the working of air conditioning systems and their applications.
4. Identify the performance parameters and their relations of an air conditioning system.

Module -1

Introduction to Refrigeration -Basic Definitions, Heat pump and Refrigerating Machine, Best Refrigeration Cycle: The Carnot Principle, Gas as a Refrigerant in Reversed Carnot Cycle, Limitations of Reversed Carnot Cycle, Reversed Brayton or Bell Coleman Cycle, Application to Aircraft Refrigeration, Simple Numerical problems.

Industrial Refrigeration-Chemical and process industries, Dairy plants, Petroleum refineries, Food processing units.

Hours-10

Module -2

Vapor Compression Refrigeration System (VCRS): Modifications in Reversed Carnot Cycle with Vapor as a refrigerant, Vapor Compression Cycle, Ewing's Construction, Actual Vapor Compression Cycle, Effect of Operating Conditions. Simple Numerical problems.

Multistage or Compound Compression, Multi-evaporator systems, Cascade Systems, Methods like Flash Gas removal, Flash inter cooling andwater Inter cooling.

Hours-10

Module-3

Vapor Absorption Refrigeration Systems: Simple Vapor- Absorption System, Maximum Coefficient of Performance of a Heat Operated Refrigerating Machine, Absorbent Refrigerant combinations, Water-Ammonia Systems, Practical problems, Lithium- Bromide System, Modifications to Simple Vapor-Absorption, Electrolux Refrigerator.

Other types of Refrigeration systems: (i) Steam-Jet refrigeration system and (ii) Thermoelectric refrigeration, (ii) pulse tube refrigeration, (iv) thermos acoustic refrigeration systems.

Hours-10

Module-4

Refrigerants: Primary and Secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants, Selection of a Refrigerant, Ozone Depletion Potential and Global Warming Potential of CFC Refrigerants. Thermodynamic requirements, Comparison between different refrigerants, Substitutes for CFC refrigerants, Secondary Refrigerants. Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.

Hours-10

Module-5

Air-Conditioning: Basic Processes in Conditioning of Air, Psychrometric Processes in Air-Conditioning Equipment, Simple Air-Conditioning/system and State and Mass Rate of Supply Air, Summer Air Conditioning, Winter Air Conditioning.

Loading Calculation and Applied Psychometrics: Preliminary Considerations, Internal Hear Gains, System Heat Gains, Break-up of Ventilation Load and Effective Sensible Heat Factor, Cooling Load Estimate. Psychrometric Calculations for Cooling, Selection of Air

Conditioning Apparatus for Cooling and Dehumidification, Building Requirements and Energy Conservation in Air-Conditioned Buildings.

Transport air conditioning Systems: Air conditioning systems for automobiles (cars, buses etc.), Air conditioning systems for trains, Air conditioning systems for ships.

Hours-10

Course Outcomes:

1. Illustrate the principles, nomenclature, and applications of refrigeration systems.
2. Explain vapor compression refrigeration system and identify methods for performance improvement.
3. Study the working principles of air, vapor absorption, thermoelectric and steam-jet and thermo-acoustic refrigeration systems
4. Estimate the performance of air-conditioning systems using the principles of psychometry.
5. Compute and Interpret cooling and heating loads in an air-conditioning system. Identify suitable refrigerant for various refrigerating systems.

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	Illustrate the principles, nomenclature, and applications of refrigeration systems.	K_1
CO2	Explain vapor compression refrigeration system and identify methods for performance improvement.	K_2
CO3	Study the working principles of air, vapor absorption, thermoelectric and steam-jet and thermo-acoustic refrigeration systems.	K_2
CO4	Estimate the performance of air-conditioning systems using the principles of psychometry.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3							
CO2	3	2	2	2								
CO3	1	2	3									
CO4	1	2	3									
CO (Average)	2.2	2	2.8	2.5	3							

3- High; 2- Medium; 1- Low

TEXT BOOK:

1. A text book of refrigeration and air conditioning, ANUP GOEL, H.J.SAWANT, TECHNICAL PUBLICATIONS.

THEORY OF ELASTICITY

B. TECH, V Semester, Mechanical Engineering

Subject Code	**BT5ME06L**	**IA MARS**	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. To gain knowledge of stresses and strains in 3D and their relations and thermal stresses.
2. To understand the 2D analysis of elastic structural members.
3. To gain knowledge of thermal stresses and stability of columns
4. To analysis elastic members for the stresses and strains induced under direct loading conditions.
5. To analyse the axisymmetric and torsional members.
6 To analyse the thermal stresses induced in disks and cylinders.
7. To analyse the stability of columns

Module -1

Analysis of Stress: Definition and notation of stress, equations of equilibrium in differential form, stress components on an arbitrary plane, equality of cross shear, stress invariants, principal stresses, octahedral stress, planes of maximum shear, stress transformation, plane state of stress, Numerical problems.

Hours-10

Module -2

Analysis of Strain: Displacement field, strains in term of displacement field, infinitesimal strain at a point, engineering shear strains, strain invariants, principal strains, octahedral strains, plane state of strain, compatibility equations, strain transformation, Numerical Problems.

Hours-10

Module -3

Two-Dimensional classical elasticity Problems: Cartesian co-ordinates - Relation between plane stress and plane strain, stress functions for plane stress and plane strain state, Airy's stress functions, Investigation of Airy's stress function for simple beams, bending of a narrow cantilever beam of rectangular cross section under edge load. Bending of simply supported beam under Outgeneral equations in polar coordinates, stress distribution symmetrical about an axis, thick wall cylinder subjected to internal and external pressures, Numerical Problems.

Hours-10

Module-4

Axisymmetric and Torsion problems: Stresses in rotating discs of uniform thickness and cylinders. Torsion of circular, elliptical and triangular bars, Prandtl's membrane analogy,

torsion of thin-walled thin tubes, torsion of thin-walled multiple cell closed sections. Numerical Problems

Hours-10

Module -5

Thermal stress and Elastic stability: Thermoelastic stress strain relations, equations of equilibrium, thermal stresses in thin circular discs and in long circular cylinders. Euler's column buckling load: clamped-free, clamped-hinged, clamped-clamped and pin-ended, Numerical Problem

Hours-10

Course Outcomes:

1. Describe the state of stress and strain in 2D and 3D elastic members subjected to direct loads and thermal loads.
2. Analyse the structural members: beam, rotating disks, columns.
3. Analyse the torsional rigidity of circular and non-circular sections.

Analyse the stability of columns.

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	Describe the state of stress and strain in 2D and 3D elastic members subjected to direct loads and thermal loads.	K_1
CO2	Analyse the structural members: beam, rotating disks, columns.	K_4
CO3	Analyse the torsional rigidity of circular and non-circular sections. Analyse the stability of columns.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		2							
CO2	3	3	2		3							
CO3	2	1			1							
CO Average)	2.66	2.33	2.5		2							

3 – High; 2 – Medium; 1 – Low

TEXT BOOK:

1. Theory of Elasticity by A.N. Shankar, Atlantic Publishers, and distributors.

HUMAN RESOURCE MANAGEMENT
B. TECH, V Semester, Mechanical Engineering

Subject Code	**BT5ME06L**	**IA MARS**	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. To develop a meaningful understanding of HRM theory, functions, and practices. To apply HRM concepts and skills across various types of organizations.

Module-1

Human Resource Management

Introduction, meaning, nature, scope of HRM. Importance and Evolution of the concept of HRM. Major functions of HRM, Principles of HRM, Organization of Personnel department, Role of HR Manager.

Job Analysis: Meaning, process of job analysis, methods of collecting job analysis data, Job Description and Specification, Role Analysis.

Hours-10

Module -2

Human Resource Planning: Objectives, Importance, and process of Human Resource planning, Effective HRP

Recruitment: Definition, Constraints and Challenges, Sources and Methods of Recruitment, New Approaches to recruitment.

Selection: Definition and Process of Selection.

Hours-10

Module-3

Placement: Meaning, Demotion and Employee Separation. Induction/Orientation, Internal Mobility, Transfer, Promotion,

Training and development: Training v/s development, Training v/s Education, Systematic Approach to Training, Training Methods, Executive Development, Methods and Development of Management Development, Career and Succession Planning.

Hours-10

Module -4

Performance Appraisal: Concept of Performance Appraisal, the Performance Appraisal process, Methods of Performance Appraisal, Essential Characteristic of an Effective Appraisal System.

Compensation: Objectives of Compensation Planning, Job Evaluation, Compensation Pay Structure in India, Wage and Salary Administration, Factors Influencing Compensation Levels, Executive Compensation.

Hours-10

Course Outcomes:

1. Understand the importance, functions and principles Human Resource Management and process of Job analysis.
2. Summarize the objectives of Human Resource planning, Recruitment, and selection process.
3. Understand the process involved in Placement, Training, and development activities.
4. Understand the characteristics of an effective appraisal system and compensation planning.
5. Understand the issues related to employee welfare, grievances, and discipline.

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	Understand the compare traditional and non-traditional machining process and recognize the need for Non-traditional machining process.	K_2
CO2	Understand the constructional features. performance parameters, process characteristics, applications, advantages, and limitations of USM, AJM and WJM.	K_2
CO3	Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages, and limitations.	K_3, K_2
CO4	Understand the constructional feature of the equipment, process parameters, process characteristics, applications, advantages, and limitations EDM& PAM.	K_2
CO5	Understand the LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages, and limitations LBM & EBM.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3		3	3		2				
CO2	3	2	2		2	3		2				
CO3	3	2	3		3	3	2	2				
CO4	3	2	2		2	3						
CO5	3	2	3		2	3						
CO (Average)	3	2	2.6		2.4	3	2	2				

3- High; 2- Medium; 1- Low

TEXTBOOK

1. C.B. MAMORIA, S.B. GANKAR, A textbook of human resource management, Himalaya publishing house.

NON-TRADITIONAL MACHINING

B.E, V Semester, Mechanical Engineering BTSME06L IA Marks

Subject Code	**BT5ME06L**	**IA MARS**	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Module -1

Introduction: Introduction to Non-traditional machining, Need for Non-traditional machining process. Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of

Non-traditional machining processes, Specific advantages, limitations, and applications of non-traditional machining processes.

Hours-10

Module -2

Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter. Effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.

Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.

Water Jet Machining (WJM): Equipment & process, Operation, applications, advantages and limitations of WJM.

Hours-10

Module -3

ELECTROCHEMICAL MA CHINING ECM)

Introduction, Principle of electro chemical machining: ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish.

Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials.

Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages, and application of ECG, ECH.

CHEMICAL MACHINING (CHM)

Elements of the process: Resists (maskants), Etchants. Types of chemical machining process chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations, and applications of chemical machining process.

Hours-10

Module –4

ELECTRICAL DISCHARGE MACHINING (EDM)

Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM.

PLASMA ARC MACHINING (PAM)

Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages, and limitations.

Hours-10

Module -5

LASER BEAM MACHINING (LBM)

Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.

ELECTRON BEAM MA CHINING (EBM)

Introduction, Principle, equipment and mechanism of metal removal, applications, advantages, and limitations.

Course Outcomes:

1. Understand the compare traditional and non-traditional machining process and 1ecognize the need for Non-traditional machining process.
2. Understand the constructional features, performance parameters, process characteristics, applications, advantages, and limitations of USM, AJM and WJM.
3. Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages, and limitations.
4. Understand the constructional feature of the equipment, process parameters, process characteristics, applications, advantages, and limitations EDM & PAM.
5. Understand the LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages, and limitations LBM & EBM.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand the compare traditional and non-traditional machining process and recognize the need for Non-traditional	K_2

	machining process.	
CO2	Understand the constructional features. performance parameters, process characteristics, applications, advantages, and limitations of USM, AJM and WJM.	K_2
CO3	Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages, and limitations.	K_3, K_2
CO4	Understand the constructional feature of the equipment, process parameters, process characteristics, applications, advantages, and limitations EDM& PAM.	K_2
CO5	Understand the LBM equipment, LBM parameters, and characteristics. EBM equipment and mechanism of metal removal, applications, advantages, and limitations LBM & EBM.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3		3	3		2				
CO2	3	2	2		2	3		2				
CO3	3	2	3		3	3	2	2				
CO4	3	2	2		2	3						
CO5	3	2	3		2	3						
CO (Average)	3	2	2.6		2.4	3	2	2				

3-High; 2-Medium; 1-Low

TEXTBOOK

1. DR. S. SENTHIL, NON-TRADITIONAL MACHINING PROCESS, SUCHITRA PUBLISHER.

ENERGY AND ENVIRONMENT

B.E, V Semester, Mechanical Engineering

Subject Code	**BT5ME06L**	**IA MARS**	30
Number of Lecture Hours/ Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objective:

1. Understand energy scenario, energy sources and their utilization.
2. Learn about methods of energy storage, energy management and economic analysis.
3. Have proper awareness about environment and eco system. Understand the environment

pollution along with social issues and acts.

Course Outcomes:

1. Summarize the basic concepts of energy, its distribution and general Scenario.
2. Explain different energy storage systems, energy management, audit, and economic analysis.
3. Summarize the environment eco system and its need for awareness.
4. Identify the various types of environment pollution and their effects. Discuss the social issues of the environment with associated acts.

Module -1

Basic Introduction to Energy: Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development: Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment.

Hours-10

Module-2

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems

Energy Management: Principles of Energy Management, Energy demand estimation, Energy pricing

Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries

Economic Analysis: Scope, Characterization of an Investment Project

Hours-10

Module -3

Environment: Introduction, Multidisciplinary nature of environmental studies- Definition, scope, and importance, Need for public awareness. Ecosystem: Concept, Energy flow, Structure, and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession.

Hours-10

Module -4

Environmental Pollution: Definition, Cause, effects, and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and nuclear hazards, Solid waste Management, Disaster management Role of an individual in prevention of pollution, pollution case of study.

Hours-10

Module-5

Social Issues and the Environment: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents, and holocaust. Case

Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation.

Hours-10

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3		3	3		2				
CO2	3	2	2		2	3		2				
CO3	3	2	3		3	3	2	2				
CO4	3	2	2		2	3						
CO (Average)	3	2	2.5		2.5	3	2	2				

TEXTBOOK

1. Smriti Srivastava, Energy Environment Ecology and Society, Katson Publisher.
2. V K Ahluwalia, Energy and Environment, TERI Press Publisher.

B. TECH, VI SEMESTER, MECHANICAL ENGINEERING

Code No.	Name of Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT6ME01	Finite Element Analysis	4	-	-	4	30	70	100
BT6ME02	Computer integrated Machine	4	-	-	4	30	70	100
BT6ME03	Heat Transfer	4	-	-	4	30	70	100
BT6ME04	Design Of Machine-II	4	-	-	4	30	70	100
BT6ME05	Total Quality Management	4	-	-	4	30	70	100
BT6ME06	Elective - II	4	-	-	4	30	70	100
	Practical							
BT6ME07L	Heat Transfer Lab		-	3	2	15	35	50
BT6ME08L	Modelling And Analysis Lab		-	3	2	15	35	50
Total		**24**	**-**	**6**	**28**	**210**	**490**	**700**

Elective -II
Computational Fluid Dynamics
Industrial Safety
Metal Forming
Automobile Engineering

FINITE ELEMENT ANALYSIS

B. Tech, VI Semester, Mechanical Engineering

Subject Code	BT6ME01	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lecture Hours	50	CREDITS	04

Course Objectives:

1. To learn basic principles of finite element analysis procedure.
2. To learn the theory and characteristics of finite elements that represent engineering structures.
3. To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses.

Hours-10

Module -1

Introduction to Finite Element Method: General description of the finite element method. Engineering applications of finite element method. Boundary conditions: homogeneous and nonhomogeneous for structural, heat transfer and fluid flow problems. Potential energy method, Rayleigh Ritz method, Galerkin's method, Displacement method of finite element formulation. Convergence criteria, Discretization process, Types of elements: ID, 2D and 3D, Node numbering, Location of nodes. Strain displacement relations, Stress strain relations, Plain stress and Plain strain conditions, temperature effects.

Interpolation models: Simplex, complex and multiplex elements, Linear interpolation polynomials in terms of global coordinates lD, 2D, 3D Simplex Elements.

Module-2

One-Dimensional Elements-Analysis of Bars and Trues, Linear interpolation polynomials in terms of local coordinate's for, lD, 2Delements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle, Four-Nodded Tetrahedral Element (TET 4), Eight-Nodded Hexahedral Element (HEXA8), 2D iso-parametric element, Lagrange interpolation functions, Numerical integration: Gaussian quadrature one point, two-point formulae, 2D integrals. Fore terms: Body force, traction force and point loads,

Numerical Problems: Solution for displacement, stress and strain in 1D straight bars, stepped bars and tapered bars using elimination approach and penalty approach, Analysis of trusses

Hours-10

Module -3

Beams and Shafts: Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler-Bernoulli bean theory, Examples on cantilever beams, propped cantilever beams, Numerical problems on simply supported, fixed straight and stepped beams using direct stiffness method with concentrated and uniformly distributed load.

Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts.

Hours-10

Module -4

Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, energy generated in solid, energy stored in solid, 1D finite element formulation using vibrational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.

Hours-10

Module -5

Axe-symmetric Solid Elements: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads, angular velocity, pressure vessels.

Dynamic Considerations: Formulation for point mass and distributed masses, Consistent element mass matrix of one-dimensional bar element, truss element, axisymmetric triangular element, quadrilateral element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.

Hours-10

Course Outcomes:

1. Understand the concepts behind formulation methods in FEM.
2. Identify the application and characteristics of FEA elements such as bars, beams, plane andiso-parametric elements.
3. Develop element characteristic equation and generation of global equation.
4. Able to apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axis symmetric and dynamic problems and solve them displacements, stress and strains induced.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand the concepts behind formulation methods in FEM.	K_2
CO2	Identify the application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.	K_2
CO3	Develop element characteristic equation and generation of	K_6

	global equation.	
CO4	Able to apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axis symmetric and dynamic problems and solve them displacements, stress and strains induced.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyse, K_5- Evaluate, K_6- Create

CO & PO Mapping:2

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1					2	2			
CO2	3	2			1			1	2			
CO3	1		3				2	3	2			
CO4	3	1						3	2			
CO5	2		3					3	2			
CO (Average)	2.2	1.33	2.33		1		2	2.4	2			

3- High; 2- Medium; 1- Low

TEXT BOOK:

1. P. SESHU, Textbook of finite element analysis, PHI Learning.
2. Nam-Ho Kim, Bhavani V. Sankar, Ashok V. Kumar, Introduction to Finite Element Analysis and Design, Wiley publisher.

Computer Integrated Manufacturing
B. Tech, VI Semester, Mechanical Engineering

Subject Code	**BT6ME02**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
2. To make students to understand the Computer Applications in Design and Manufacturing [CAD/CAM) leading to Computer integrated.
3. systems. Enable them to perform various transformations of entities on display devices.

4. To expose students to automated flow lines, assembly lines, Line Balancing Techniques, and Flexible Manufacturing Systems.
5. To expose students to computer aided process planning, material requirement planning, capacity planning etc.
6. To expose the students to CNC Machine Tools, CNC part programming, and industrial robots.
7. To introduce the students to concepts of Additive Manufacturing, Internet of Things, and Industry 4.0leading to Smart Factory.

Hours-10

Module-1

Introduction to CIM and Automation:
Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM.
Mathematical models and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-in- process, numerical problems.
Automated Production Lines and Assembly Systems: Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with storage buffer, fundamentals of automated assembly systems, numerical problems.

Hours-10

Module -2

CAD and Computer Graphics Software: The design process, applications of computers in design, software configuration, functions of graphics package, constructing the geometry. Transformations: 2D transformations, translation, rotation and scaling, homogeneous transformation matrix, concatenation, numerical problems on transformations.
Computerized Manufacture Planning and Control System: Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPC System, computer integrated production management system, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control.

Hours-10

Module-3

Flexible Manufacturing Systems: Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage

system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture.

Line Balancing: Line balancing algorithms, methods of line balancing, numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method.

Hours-10

Module -4

Computer Numerical Control: Introduction, components of CNC, CNC programming, manual part programming, G Codes, M Codes, programming of simple components in turning, drilling and milling systems, programming with canned cycles. Cutter radius compensations.

Robot Technology: Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics.

Robot programming methods: on-line and off-line methods.

Robot industrial applications: Material handling, processing and assembly and inspection.

Hours-10

Module -5

Additive Manufacturing Systems: Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies, Additive manufacturing processes: Photo polymerization, material jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct energy deposition techniques, applications of AM. Recent trends in manufacturing, Hybrid manufacturing.

Future of Automated Factory: Industry 4.0, functions, applications, and benefits. Components of Industry 4.0, Internet of Things (10T), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance,

industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems

Course Outcomes:

1. Able to define Automation, CIM, CAD, CAM and explain the differences between these concepts.
2. Solve simple problems of transformations of entities on computer screen.
3. Explain the basics of automated manufacturing industries through mathematical models and analyse different types of automated flow lines.
4. Analyse the automated flow lines to reduce time and enhance productivity.
5. Explain the use of different computer applications in manufacturing, and able to prepare part programs for simple jobs on CNC machine tools and robot programming.

Visualize and appreciate the modern trends in Manufacturing like additive manufacturing, Industry 4.0 and applications of Internet of Things lead into Smart Manufacturing.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Able to define Automation, CIM, CAD, CAM and explain the differences between these concepts.	K_1
CO2	Solve simple problems of transformations of entities on computer screen.	K_4
CO3	Explain the basics of automated manufacturing industries through mathematical models and analyse different types of automated flow lines.	K_2
CO4	Analyse the automated flow lines to reduce time and enhance productivity.	K_4
CO5	Explain the use of different computer applications in manufacturing, and able to prepare.	K_5

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		3	3		2				
CO2	3	3	3		3	3						
CO3	3	2	3		3	3	2	3	1			
CO4	3	2	3		3	3						
CO5	3	2	3		3	3	2		3			
CO (Average)	3	2.4	3		3	3	2	2.5	2			

3- High; 2- Medium; 1- Low

TEXT BOOK:

1. A. ALAVUDEEN, N. VENKATESHWARAN, computer integrated manufacturing, PHI Learning publisher.
2. Charles E. Wilson, Computer integrated machine design, Prentice Hall publisher.

Heat Transfer

B. Tech, VI Semester, Mechanical Engineering

Subject Code	BT6ME03	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70

Total Number of Lecture Hours	50	CREDITS	04

Course Objectives:

1. Study the modes of heat transfer.
2. Learn how to formulate and solve 1-D steady and unsteady heat conduction problems.
3. Apply empirical correlations for fully developed laminar, turbulent internal
1. flows and external boundary layer convective flow problems.
4. Study the basic principles of heat exchanger analysis and thermal design.
5. Understand the principles of boiling and condensation including radiation heat transfer related engineering problems.

Module -1

Introductory concepts and definitions: Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity; convective heat transfer coefficient; radiation heat transfer combined heat transfer mechanism, Types of boundary conditions. General Heat Conduction Equation: Derivation of the equation in (i) Cartesian, (ii) Polar and (iii) Spherical Co-ordinate Systems.

Steady-state one-dimensional heat conduction problems in Cartesian System: Steady-state one-dimensional heat conduction problems (i) with and without heat generation and (ii) with and without varying thermal conductivity - in Cartesian system with various possible boundary conditions, Thermal Resistances in Series and in Parallel.

Hours-10

Module-2

Critical Thickness of Insulation: Concept, Derivation, Extended Surfaces or Fins: Classification, Straight Rectangular and Circular Fins, Temperature Distribution and Heat Transfer Calculations, Fin Efficiency and Effectiveness, Applications

Transient [Unsteady-state] heat conduction: Definition, Different cases - Negligible internal thermal resistance, negligible surface resistance, comparable internal thermal and surface resistance, Lumped body, Numerical Problems, Heisler and Grober charts. Introduction to Numerical analysis of Heat conduction

Hours-10

Module-3

Forced Convection: Boundary Layer Theory, Velocity and Thermal Boundary Layers, Prandtl number, Governing Equations - Continuity, Navier- Stokes and Energy equations, Boundary layer assumptions, Integral and Analytical solutions to above equations, Turbulent flow, Various empirical solutions, forced convection flow over cylinders and spheres, Internal flows -laminar and turbulent flow solutions, Forced Convection Cooling of Electronic Devices.

Free convection: Laminar and Turbulent flows, Vertical Plates, Vertical Tubes and Horizontal Tubes, Empirical solutions.

Hours-10

Module -4

Thermal Radiation: Fundamental principles - Gray, White, Opaque, Transparent and Black bodies, Spectral emissive power, Wien's, Rayleigh-Jeans and Planck's laws, Hemispherical Emissive Power, Stefan-Boltzmann law for the total emissive power of a black body. Emissivity and Kirchhoff's
Laws, View factor, Net radiation exchange in a two-body enclosure, Typical examples for these enclosures, Radiation Shield.

Hours-10

Module -5

Heat Exchangers: Definition, Classification, applications, LMTD method, Effectiveness NTU method, Analytical Methods, Fouling Factors, Chart Solution Procedures for solving Heat Exchanger problems: Correction Factor Charts and Effectiveness-NTU Charts, compact heat exchangers.
Heat Transfer with Phase Change: Introduction to boiling, pool boiling, Bubble Growth Mechanisms, Nucleate Pool Boiling, Critical Heat Flux in Nucleate Pool Boiling, Pool Film Boiling, Critical Heat Flux, Heat Transfer beyond the Critical Point, film wise and dropwise Condensation, heat pipes, entrainment, wicking and boiling limitations.

Course Outcomes:

1. Understand the basic modes of heat transfer.
2. Compute temperature distribution in steady-state and unsteady- state heat conduction.
1. 3 Understand and interpret heat transfer through extended surfaces.
3. Interpret and compute forced and free convective heat transfer.
4. Explain the principles of radiation heat transfer and understand the numerical formula for heat conduction problems.
5. Design heat exchangers using LMTD and NTU methods.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand the basic modes of heat transfer.	K_2
CO2	Compute temperature distribution in steady-state and unsteady-state heat conduction.	K_3
CO3	Understand and interpret heat transfer through extended surfaces.	K_2
CO4	Interpret and compute forced and free convective heat transfer.	K_3
CO5	Explain the principles of radiation heat transfer and understand the numerical formula for heat conduction problems.	K_5

CO6	Design heat exchangers using LMTD and NTU methods.	K_6

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3		3					1		
CO2	3	2	3	3	2							
CO3	3	2	2		3	1	2					
CO4	3	2	2	2	3							
CO5	3	3	3		3							
CO6	3	3	2		3							
CO (Average)	3	2.33	2.5	2.5	2.8	1	2			1		

3- High; 2- Medium; 1- Low

TEXT BOOK:

1. R.K. Rajput, HEAT AND MASS TRANSFER, S.CHAND publisher.

2. FRANK KREITH, RAJ M.MANGLIK,MARK S.BHON, principles of heat transfer, seventh edition publisher.

DESIGN OF MACHINE ELEMENTS II

B. Tech, VI Semester, Mechanical Engineering

Subject Code	**BT6ME04**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. To understand various elements involved in a mechanical system.
2. To analyses various forces acting on the elements of a mechanical system and design them using appropriate techniques, codes, and standards.
3. To select transmission elements like gears, belts, pulleys, bearings from the manufacturers' catalogue.
4. To design completely a mechanical system integrating machine elements.
5. To produce assembly and working drawings of various mechanical systems involving machine elements like belts, pulleys, gears, springs, bearings, clutches and brakes.

Module-1

Curved Beams: Stresses in curved beams of standard cross sections used in crane hook, punching presses & clamps, closed rings and links.
Cylinders & Cylinder Heads: Review of Lame's equations; compound cylinders, stresses due to different types of fit on cylinders; cylinder heads and flats.

Hours-10

Module-2

Belts: Materials of construction of flat and V belts, power rating of belts, concept of slip and creep, initial tension, effect of centrifugal tension,
maximum power condition. Selection of flat and V belts-length & cross section from manufacturers' catalogues. Construction and application of timing belts.
Wire ropes: Construction of wire ropes, stresses in wire ropes, and selection of wire ropes. (Only theoretical treatment)
Chain drive: Types of power transmission chains, modes of failure for chain, and lubrication of chains (Only theoretical treatment)
Springs: Types of springs, spring materials, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, concentric springs; springs under fluctuating loads.
Leaf Springs: Stresses in leaf springs, equalized stresses, and nipping of leaf springs. Introduction to torsion and Belleville springs.

Hours-10

Module -3

Gear drives: Classification of gears, materials for gears, standard systems of gear tooth, gear tooth failure modes and lubrication of gears.
Spur Gears: Definitions, stresses in gear tooth: Lewis's equation and form factor, design for strength, dynamic load and wear.
Helical Gears: Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load, and wear.
Bevel Gears: Definitions, formative number of teeth, design based on strength, dynamic load, and wear.

Hours-10

Module-4

Worm Gears: Definitions, types of worm and worm gears, and materials for worm and worm wheel. Design based on strength, dynamic, wear loads and efficiency of worm gear drives.
Design of Clutches: Types of clutches and their applications, single plate, and multi-plate clutches. (Numerical examples only on single and multi-plate clutches)
Design of Brakes: Types of Brakes, Block and Band brakes, self-locking of brakes, and heat generation in brakes.

Hours-10

Module -5

Lubrication and Bearings: Lubricants and their properties, bearing materials and properties; mechanisms of lubrication, hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, and heat dissipated.
Numerical examples on hydro dynamic journal and thrust bearing design.
Anti-friction bearings: Types of rolling contact bearings and their applications, static and

dynamic load carrying capacities, equivalent bearing load, load life relationship; selection of deep grove ball bearings from the manufacturers' catalogue; selection of bearings subjected to cyclic loads and speeds; probability of survival.

Course Outcomes:

1. Apply engineering design tools to product design.
2. Design mechanical systems involving springs, belts and pulleys.
3. Design different types of gears and simple gear boxes for different applications.
4. Design brakes and clutches.
5. Design hydrodynamic bearings for different applications.
6. Select Anti friction bearings for different applications using the manufacturers, catalogue.
7. Develop proficiency to generate production drawings using CAD software.
8. Become good design engineers through learning the art of working in a team with morality and ethics.

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	Apply engineering design tools to product design.	K_3
CO2	Design mechanical systems involving springs, belts and pulleys.	K_5
CO3	Design different types of gears and simple gear boxes for different applications.	K_5
CO4	Design brakes and clutches.	K_5
CO5	Design hydrodynamic bearings for different applications.	K_2
CO6	Select Anti friction bearings for different applications using the manufacturers, catalogue.	K_1
CO7	Develop proficiency to generate production drawings using CAD software.	K_4
CO8	Become good design engineers through learning the art of working in a team with morality and ethics.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		3	2						
CO2	3	3	3		3	2						
CO3	3	3	3		3	2						
CO4	3	3	3		3	2						
CO5	3	3	3		3	2						
CO6	3	3	3		3	2						
CO7	3	3			3	2						
CO8	3	3	3		3	2						
CO (Average)	3	3	3		3	2						

3- High; 2- Medium; 1- Low

TEXT BOOK:

1. R.S.KHURMI, J.K.GUPTA, a text book of machine design, S.CHAND publisher.
2. RICHARD W HEING,CARL.R LOPER,R.SOSENTHAL, fundamental of machine design, TATA MCGRAW HILL publisher.

TOTAL QUALITY MANAGEMENT
B. Tech, VI Semester, Mechanical Engineering

Subject Code	**BT6ME05**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course objectives:

1. Understand various approaches to TQM.
2. Understand the characteristics of quality leader and his role.
3. Develop feedback and suggestion systems for quality management.
4. Enhance the knowledge in Tools and Techniques of quality management.

Module-1

Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM.
Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements

Hours-10

Module-2

Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making,

Hours-10

Module -3

Customer Satisfaction and Customer Involvement:
Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies.
Employee Involvement - Motivation, employee surveys, empowerment, teams, suggestion system, recognition, and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.

Hours-10

Module -4

Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, engineering, six sigma, case studies.

Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams. case studies

Hours-10

Module -5

Tools and Techniques: Benching marking, information technology, quality management systems, environmental management system, and quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance.

Course Outcomes:

1. Explain the various approaches of TQM.
2. Infer the customer perception of quality.
3. Analyse customer needs and perceptions to design feedback systems.
4. Apply statistical tools for continuous improvement of systems.
5. Apply the tools and technique for effective implementation of TQM.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Explain the various approaches of TQM.	K_2
CO2	Infer the customer perception of quality.	K_1
CO3	Analyse customer needs and perceptions to design feedback systems.	K_4
CO4	Apply statistical tools for continuous improvement of systems.	K_3
CO5	Apply the tools and technique for effective implementation of TQM.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1				1	3		3		3	3
CO2	3	3			2		3		3		3	3
CO3	3	2	3			1	3		3		3	3
CO4	3	2		1			3		3	2	3	3
CO5	3	2	3			3	3		3		3	3
CO (Average)	3	2	3	1	2	1.66	3		3	2	3	3

3- High; 2- Medium; 1- Low

TEXT BOOK:

1. P.SARAVANEAL,S.BALAKUMAR, total quality management, Margham Publications.
2. PROF.V.VIJAYAN,H RAMAKRISHNAN, total quality management, S.CHAND publisher**.**

Computational Fluid Dynamics
B. Tech, VI Semester, Mechanical

Subject Code	**BT6ME06A**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. Study the governing equations of fluid dynamics.
2. Learn how to formulate and solve Euler's equation of motion.
3. Become skilled at Representation of Functions on Computer
4. Solve computational problems related to fluid flows.

Module-1

Introduction to CFD and Governing Equations

Need of CFD as tool, role in R&D, continuum, material or substantial derivative or total derivative, gradient, divergence and cul operators, Linearity, Principle of Superposition. Derivation of Navier-Stokes equations in control volume (integral form) and partial differential form, Euler equations (governing inviscid equations). Mathematical classification of PDE (Hyperbolic, Parabolic, Elliptic). Method of characteristics, Introduction to Riemann Problem and Solution Techniques.

Hours-10

Module -2

One-dimensional Euler's equation

Conservative, non-conservative form, and primitive variable forms of Governing equations. Flux Jacobian Is there a systematic way to diagonalize Eigenvalues and Eigenvectors of Flux Jacobian. Decoupling of Governing equations, introduction of characteristic variables. Relation between the two non-conservative forms. Conditions for genuinely nonlinear characteristics of the flux Jacobian.

Introduction to Turbulence Modelling: Derivation of RANS equations and k-epsilon model.

Hours-10

Module-3

Representation of Functions on Computer

Need for representation of functions, Box Function, Hat Function, Representation of sin x using hat functions: Aliasing, high frequency, low frequency. Representation error as a global error. Derivatives of hat functions, Haar functions, Machine Epsilon. Using Taylor series for representation of Derivatives.

Hours-10

Module -4

Finite difference method- Applied to Linear Convection equation, Laplace Equations, Convection Diffusion equations, Burger's equations,

modified equations Explicit methods and Implicit methods -as applied to applied to linear Convection equation, Laplace equations, convection- diffusion equation。FTCS, FTFS, FTBS. CTCS。Jacobi Method, Gauss-Siedel, Successive Over Relaxation Method, TDMA. Vonn Aumann stability (linear stability) analysis. Upwind Method in Finite Difference method.

Hours-10

Module-5

Finite volume method

Finite volume method. Finding the flux at interface.

Central schemes - Lax-Friedrichs Method, Lax-Wendroff Method, Two-Step Lax-Wendroff Method, and Mac Cormack Method

Upwind Method in Finite Volume methods - Flux Splitting Method Steger and Warming, veneer, Roe's Method and finding Roe's Averages.

Course Outcomes:

1. Understand mathematical characteristics of partial differential equations.
2. Explain how to classify and computationally solve Euler and Navier-Stokes equations.
3. Make use of the concepts like accuracy, stability, consistency of numerical methods for the governing equations.
4. Identify and implement numerical techniques for space and time integration of partial differential equations.
5. Conduct numerical experiments and carry out data analysis.
6. Acquire basic skills on programming of numerical methods used to solve the Governing equations.

Hours-10

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand mathematical characteristics of partial differential equations.	K_2
CO2	Explain how to classify and computationally solve Euler and Navier-Stokes equations.	K_1

CO3	Make use of the concepts like accuracy, stability, consistency of numerical methods for the governing equations.	K_4
CO4	Identify and implement numerical techniques for space and time integration of partial differential equations.	K_3
CO5	Conduct numerical experiments and carry out data analysis.	K_3
CO6	Acquire basic skills on programming of numerical methods used to solve the Governing equations.	

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		3	2						
CO2	3	3	3		3	2						
CO3	3	3	3		3	2						
CO4	3	3	3		3	2						
CO5	3	3	3		3	2						
CO6	3	3	3		3	2						
CO (Average)	3	3	3		3	2						

3 -High; 2 -Medium; 1-Low

TEXT BOOK:

1. Anil W. Date, Introduction to Computational Fluid Dynamics**,** Cambridge University Press, 2005 publisher.

INDUSTRIAL SAFETY

B. Tech, VI Semester, Mechanical Engineering

Subject Code	**BT6ME06B**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. Students will be able to recognize and evaluate occupational safety and health hazards in the workplace, and to determine appropriate hazard controls following the hierarchy of controls.
2. Students will furthermore be able to analyses the effects of workplace exposures, injuries and illnesses, fatalities, and the methods to prevent incidents using the

hierarchy of controls, effective safety and health management systems and task-oriented training.

Module-1

Introduction to safety: Terms used, accident, safety, hazard, safe, safety devices, safety guard, security, precaution, caution, appliance, slip, trip, fall. Ladders and scaffolding. Unsafe acts, reason for accidents, MSDS (material safety data sheet), OSHA, WHO. Lockout and tag out procedures. Safe material handling and storage.

Hours-10

Module -2

Fire safety: Introduction, Class A, B, C, D and E fire. Fire triangle, Fire extinguishers, Tire hazard and analysis, prevention of fire. Tire protection and loss prevention, steps after occurrence of fire. Portable fire extinguishers. Fire detection, fire alarm and firefighting systems.

Safety sign boards, instruction on portable fire extinguishers.

Case studies: demonstration of fire extinguishers, visit to local firefighting stations. Visit to fire accident sites to analyses the cause of fire and its prevention for future.

Hours-10

Module -3

Mechanical Safety: PPE, safety guards, Safety while working with machine tools like lathe, drill press, power, and band saws, grinding machines. Safety during welding, forging, and pressing.

Safety while handling Material, compressed gas cylinders, corrosive substance, waste drum and containers.

Hours-10

Module -4

Electrical Safety: Introduction to electrical safety, Electric hazards, effect of electric current on human body, causes of electrical accidents, prevention of electric accidents, PPE used.

Electric shock. Primary and secondary electric shocks, AC and DC current shocks.

Safety precautions against shocks. Safety precautions in small and residential building installations. Safety procedures in electric plant.

Hours-10

Module -5

Chemical Safety and Other safety checks: Introduction to Chemical safety, Labeling of chemicals, acid hoods. Handling of acids, eye washers and showers. Safety thinking, accident investigation, safety policy of the company, safety, loss prevention and control, check list for LPG installations, safety precautions using CNG, fire prevention and safety audit, confined space entry, risk assessment.

Course Outcomes:

1. Understand the basic safety terms.
2. Identify the hazards around the work environment and industries.
3. Use the safe measures while performing work in and around the work area of the available laboratories.
4. Able to recognize the sign boards and its application.
5. Able to demonstrate the portable extinguishers used for different class of fires.
6. Able to write the case studies by sharing experience of the employees working in housekeeping, laboratories like workshops, electrical labs, machine shops, electronics, and computer laboratories.
7. Able to understand and report the case studies from various references (text books, news report, journals, visiting industries like power stations, manufacturing, and maintenance).

Hours-10

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	Understand the basic safety terms.	K_1
CO2	Identify the hazards around the work environment and industries.	K_2
CO3	Use the safe measures while performing work in and around the work area of the available laboratories.	K_3
CO4	Able to recognize the sign boards and its application.	K_4
CO5	Able to demonstrate the portable extinguishers used for different class of fires.	K_4
CO6	Able to write the case studies by sharing experience of the employees working in housekeeping, laboratories like workshops, electrical labs, machine shops, electronics, and computer laboratories.	K_5
CO7	Able to understand and report the case studies from various references (text books, news report, journals, visiting industries like power stations, manufacturing, and maintenance).	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6 - Create

CO & PO Mapping:

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

CO5	3	3	3		3	2						
CO6	3	3	3		3	2						
CO7	3	3			3	2						
CO (Average)	3	3	3		3	2						

3 -High; 2 -Medium; 1 –Low

METAL FORMING

B. Tech, VI Semester, Mechanical Engineering

Subject Code	**BT6ME06C**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. To acquaint with the basic knowledge on fundamentals of metal forming processes
2. To study various metal forming processes
3. Understanding plastic deformation during forming processes

Module-1

Introduction to Metal Forming: Classification of metal forming processes, advantages, and limitations, stress-strain relations in elastic and plastic deformation. Concepts of true stress, true strain, triaxial& biaxial stresses. Determination of flow stress, principal stresses, yield criteria and their significance, Tresca& Von-Mises yield criteria, concepts of plane stress & plane strain. Deformation mechanisms, Hot and Cold working processes and its effect on mechanical properties.

Hours-10

Module -2

Effects of Parameters: Metallurgical aspects of metal forming, slip, twinning mechanics of plastic deformation, Effects of Temperature, strain rate, friction and lubrication, hydrostatic pressure in metalworking, Deformation zone geometry, workability of materials, Residual stresses in wrought products.

Forging: Classification of forging processes. Forging machines equipment. Expressions for forging pressures& load in open die forging and closed die forging by slab analysis, concepts of friction hill and factors affecting it. Die-design parameters. Material flow lines in forging, forging defects, residual stresses in forging. Simple problems.

Hours-10

Module -3

Rolling: Classification of rolling processes. Types of rolling mills, expression for rolling load.

Roll separating force. Frictional losses in bearing, power required in rolling, effects of front & back tensions, friction, friction hill. Maximum possible reduction. Defects in rolled products. Rolling variables. Simple problems.

Drawing: Drawing equipment& dies, expression for drawing load by slab analysis, power requirement. Redundant work and its estimation, optimal cone angle & dead zone formation, drawing variables, Tube drawing, classification of tube drawing. Simple problems.

Hours-10

Module -4

Extrusion: Types of extrusion processes, extrusion equipment & dies, deformation, lubrication & defects in extrusion. Extrusion dies, extrusion of seamless tubes. Extrusion variables. Simple problems.

Sheet Metal Forming: Forming methods, dies & punches, progressive die, compound die, combination die. Rubber forming. Open back inclinable press (OBI press), piercing, blanking. bending, deep drawing, LDR in drawing, forming limit criterion, defects of drawn products, stretch forming. Roll bending & contouring. Simple problems

Hours-10

Module-5

High Energy Rate Forming Methods &Powder Metallurgy: High Energy Rate Forming Methods: Principles, advantages and applications, explosive forming, electrohydraulic forming, Electromagnetic forming.

Powder Metallurgy: Basic steps in Powder metallurgy brief description of methods of production of metal powders, conditioning and blending powders, compaction and sintering application of powder metallurgy components, advantages and limitations.

Course Outcomes:

1. Able to understand the concept of different metal forming process.
2. Able to approach metal forming processes both analytically and numerically.
3. Able to design metal forming processes.
4. Able to develop approaches and solutions to analyses metal forming processes and the associated problems and flaws.

Hours-10

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Able to understand the concept of different metal forming process.	K_2
CO2	Able to approach metal forming processes both analytically and numerically.	K_3
CO3	Able to design metal forming processes.	K_4

CO4	Able to develop approaches and solutions to analyses metal forming processes and the associated problems and flaws.	K_6

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1									3	3
CO2	2	1			2							1
CO3	1						2	1				2
CO4		1		2		2				2		
CO (Average)	2	1		2	2	2	2	1		2	2.5	2

3 -High; 2 -Medium; 1 –Low

TEXT BOOK:

1. Fundamentals of metal forming process, B. L. Juneja, New Age Publications.

AUTOMOBILE ENGINEERING

B. Tech, VI Semester, Mechanical Engineering

Subject Code	**BT6ME06D**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. The layout and arrangement of principal parts of an automobile
2. The working of transmission and brake systems
3. The operation and working of steering and suspension systems.
4. To know the Injection system and its advancements
5. To know the automobile emissions and its effects on environment

Module -1

ENGINE COMPONENTS AND IT'S PRINCIPLE PARTS: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S. IL Engine and C.I.Engines, methods of a

Swirl generation, choice of materials for different engine components, engine positioning. Concept of HCCI engines, hybrid engines, twin spark engine, electric car.

COOLING AND LUBRICATION: cooling requirements, types of cooling- thermos siphon system, forced circulation water cooling system, water pump, Radiator, thermostat valves. Significance of lubrication, splash and forced feed system.

Hours-10

Module -2

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

BRAKES: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock -Braking systems, purpose and operation of antilock braking system, ABS Hydraulic Unit, Rear-wheel antilock & Numerical

Hours-10

Module-3

STEERING AND SUSPENSION SYSTEMS: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension System.

IGNITION SYSTEM: Battery Ignition system, Magneto Ignition system, electronic Ignition system.

Hours-10

Module -4

SUPERCHARGERS AND TURBOCHARGERS: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger. construction and operation, Intercooler, Turbocharger lag.

FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES: Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers, Fuel mixture requirements for SI engines, types of carburettors, C.D.& C.C. carburettors, multi point and single point fuel injection systems, fuel transfer pumps, Fuel filters, fuel injection pumps and injectors. Electronic Injection system, Common Rail Direct Injection
System.

Hours-10

Module-5

AUTOMOTIVE EMISSION CONTROL SYSTEMS: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, controlling crankcase emissions, controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air

fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter.

EMISSION STANDARDS: Euro I, I, III and IV norms, Bharat Stage I, II, IV norms. Motor Vehicle Act.

Hours-10

Course Outcomes:

1. To identify the different parts of an automobile and it's working.
2. To understand the working of transmission and braking systems
3. To comprehend the working of steering and suspension systems
4. To learn various types of fuels and injection systems
5. To know the cause of automobile emissions, its effects on environment and methods to reduce the emissions.

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	To identify the different parts of an automobile and it's working.	K_2
CO2	To understand the working of transmission and braking systems	K_2
CO3	To comprehend the working of steering and suspension systems	K_3
CO4	To learn various types of fuels and injection systems	K_2
CO5	To know the cause of automobile emissions, its effects on environment and methods to reduce the emissions.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3				3		3	3	2	2	
CO2	3	3			2	3		3	3	2	2	
CO3	3	3				3	2	2	3	2	2	
CO4	3	3		2		3		2	3	2	2	
CO5	3	3				3		2	3	2	2	
CO (Average)	3	3		2	2	3	2	2.4	3	2	2	

3 -High; 2 -Medium; 1 -Low

TEXT BOOK:

1. Automobile engineering, R.B.Gupta, Satya prakshan, Tech India Publication.

B.Tech, VII Semester, Mechanical Engineering

Code No.	Name of Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT7ME01	Energy Engineering	4	-	-	4	30	70	100
BT7ME02	Control Engineering	4	-	-	4	30	70	100
BT7ME03	Advance Vibration	4	-	-	4	30	70	100
BT7ME04	Total Quality Management	4	-	-	4	30	70	100
BT7ME05	Elective -III	3	1	-	4	30	70	100
	Practical							
BT7ME06L	Internship/ Professional Practice			3	2	30	70	100
BT7ME07L	Design Lab			3	2	15	35	50
BT7ME08L	CIM Lab			3	2	15	35	50
Total		**19**	**1**	**9**	**26**	**210**	**490**	**700**

ENERGY ENGINEERING (BT-301)

Subject Code	BT7ME01	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lecture Hours	50	CREDITS	04

Course Objectives:

1. Understand energy scenario, energy sources and their utilization.
2. Learn about energy conversion methods and their analysis.
3. Study the principles of renewable energy conversion systems. 4. Understand the concept of green energy and zero energy.

Module-1

Thermal Energy conversion system: Review of energy scenario in India, General Philosophy and need of Energy, Different Types of Fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types, Oil burners, Advantages and Disadvantages of using pulverized fuel, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace, Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures. Chimneys: Natural, forced, induced and balanced draft, Calculations and numerical

involving height of chimney to produce a given draft. Cooling towers and Ponds. Accessories for the Steam generators such as Superheaters, De-superheater, control of superheaters, Economizers, Air preheaters and reheaters.

Hours- 10

Module -2

Diesel Engine Power System: Applications of Diesel Engines in Power field. Method of starting Diesel engines. Auxiliaries like cooling and lubrication system, filters, centrifuges, Oil heaters, intake and exhaust system, Layout of diesel power plant.
Hydro-Electric Energy: Hydrographs, flow duration and mass curves, unit hydrograph and numerical. Storage and pondage, pumped storage plants, low, medium, and high head plants, Penstock, water hammer, surge tanks, gates, and valves. General layout of hydel power plants.

Hours-10

Module -3

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data, Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning: Thermal energy storage systems, Solar Photovoltaic systems: Introduction: Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal Systems

Hours-10

Module-4

Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis windmills, coefficient of performance of a wind mill rotor (Numerical Examples).
Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, Limitations.

Hours-10

Module -5

Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energyconversion; Biomass gasification. Green Energy: Introduction: Fuel cells: Overview; Classification of fuel cells; Operating principles; Fuel cell thermodynamics Nuclear, ocean,

MHD, thermoelectric and geothermal energy applications; Origin and their types; Working principles, Zero energy Concepts.

Hours-10

Course Outcomes:

1. Summarize the basic concepts of thermal energy systems.
2. Identify renewable energy sources and their utilization.
3. Understand the basic concepts of solar radiation and analyze the working of solar PV and thermal systems.
4. Understand principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, biogas.
5. Understand the concepts and applications of fuel cells, thermoelectric convertor and MHD generator.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Summarize the basic concepts of thermal energy systems,	K_1
CO2	Identify renewable energy sources and their utilization.	K_1
CO3	Understand the basic concepts of solar radiation and analyse the working of solar PV and thermal systems.	K_2
CO4	Understand principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, biogas.	K_2
CO5	Understand the concept and application of fuel cells, thermoelectric convertor and MHD generator.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3						3	3	3	
CO2	3	2	3						3	3	3	
CO3	3	2	3						3	3	3	
CO4	3	2	3					3	3	3	3	
CO5	3	2	3						3	3	3	
CO (Average)	3	2.2	3					3	3	3	3	

3 -High; 2 -Medium; 1 –Low

TEXT BOOK:

1. Engineering Technology, S.Rao & Dr.BB Parulekar, Khana Publisher.

CONTROL ENGINEERING

B.Tech, VII Semester, Mechanical Engineering

Subject Code	BT7ME02	IA Marks	30
Number of	04	Term End	70

Lecture Hours/Week		Exam Marks	
Total Number of Lecture Hours	50	CREDITS	04

Course Objectives:

1. Modeling of mechanical, hydraulic, pneumatic, and electrical systems.
2. Representation of system elements by blocks and its reduction
3. Transient and steady state response analysis of a system.
4. Frequency response analysis using polar plot.
5. Frequency response analysis using bode plot.
6. Analysis of system using root locus plots.
7. Different system compensators and variable characteristics of linear systems.

Module-1

Introduction: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers-Proportional, Integral, Differential, Proportional & Integral, Proportional Differential and Proportional Integral Differential controllers.

Hours-10

Module-2

Modeling of Physical Systems: Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic and Pneumatic Systems.

Analogous Systems: Direct and inverse analogs for mechanical, thermal, and fluid systems.

Block diagram Algebra: General representation of a feedback control system, transfer functions, rules of block diagram algebra, reduction of block dia. obtain closed loop transfer function.

Signal flow graphs: Mason's gain formula.

Hours-10

Module-3

Steady state operation: Steady state analysis for general block dia. for a control system, steady state characteristics, equilibrium in a system.

Transient Response: Transient response and steady state analysis of unit, step input, general operational representation for a differential equation of control system, distinct, repeated, and complex conjugate zeros, general form of transient response, Routh's stability criterion for a control system.

Root Locus Plots: Root locus method: Significance of Root locus, angle and magnitude conditions, breakaway points, angles of departure and arrival, construction of Root locus using general rules and steps, Lead and Lag compensation.

Hours-10

Module-4

Frequency Domain Analysis: Relationship between time and frequency response, Polar plot, Bode's Plot, Nyquist plot and Nyquist stability criterion, Relative Stability, Phase and Gain Margins.

Hours-10

Module-5

System Compensation and State Variable Characteristics of Linear Systems: Series and feedback compensation, Introduction to state concepts, state equation of linear continuous data system. Matrix representation of state equations, controllability, and observability, Kalman and Gilberts test.

Hours-10

Course Outcomes:

1. Recognize control system and its types, control actions.
2. Determine the system governing equations for physical models (Electrical, Thermal, Mechanical, Electromechanical)
3. Calculate the gain of the system using block diagram and signal flow graph.
4. Illustrate the response of 1st and 2nd order systems.
5. Determine the stability of transfer functions in complex domain and frequency domain.
6. Employ state equations to study the controllability and observability.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Recognize control system and its types, control actions.	K_2
CO2	Determine the system governing equations for physical models (Electrical, Thermal, Mechanical, Electromechanical)	K_2
CO3	Calculate the gain of the system using block diagram and signal flow graph.	K_4
CO4	Illustrate the response of 1Ist and 2nd order systems.	K_4
CO5	Determine the stability of transfer functions in complex domain and frequency domain.	K_3
CO6	Employ state equations to study the controllability and observability.	K_5

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										
CO2	3	2						2		2		

CO3	3	2										
CO4	3	2			3	3						
CO5	3	1										
CO6	3	3										3
CO (Average)	3	2.1			3	3		2		2		3

3 -High; 2 -Medium; 1 –Low

TEXT BOOK:

1. Control engineering: theory and practice, BANDYOPADHYAY, M. N., PHI Learning Pvt. Ltd.

ADVANCE VIBRATION

B.Tech, VII Semester, Mechanical Engineering

Subject Code	**BT7ME03**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objective:

1. To enable the students to understand the theoretical principles of vibration and vibration analysis techniques for the practical solution of vibration problems.
2. To enable the students to understand the importance of vibrations in mechanical design of machine parts subject to vibrations.

Module -1

Forced Vibrations (1DOF): Introduction, analysis of forced vibration with constant harmonic excitation, ME, rotating and reciprocating, unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility, energy dissipated due to damping and numerical problems.

Hours-10

Module -2

Systems with 2DOF: Principal modes of vibrations, normal mode and natural frequencies of systems (Damping is not included), simple spring- mass systems, masses on tightly stretched strings, double pendulum, tensional systems, combined rectilinear and angular systems, geared systems and numerical problems.

Hours-10

Module -3

Numerical methods for multi DOF systems: Maxwell's reciprocal theorem, influence coefficients, Rayleigh's method, Dunkerley's method, Stodola method, orthogonality principle, method of matrix iteration and numerical.

Hours-10

Module-4

Vibration measuring instruments and whirling of shafts: seismic instruments, vibrometers, accelerometer, frequency measuring instruments and numerical. Whirling of shafts with and without damping.

Vibration Control: Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation, Dynamic vibration absorbers and Vibration dampers.

Hours-10

Module -5

Transient Vibration of single Degree-of freedom systems: Impulse excitation, arbitrary excitation, Laplace transforms formulation, Pulse excitation and rise time, Shock response spectrum, Shock isolation.

Random Vibrations: Random phenomena Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms and response.

Hours-10

Course Outcomes:

1. On completion of this subject, students will be able to:
2. Understand and characterize the single and multi- degrees of freedom systems subjected to free and forced vibrations with and without damping.
3. Understand the method of vibration measurements and its controlling.
4. Understand the concept of dynamic vibrations of a continuous system.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand and characterize the single and multi-degrees of freedom systems subjected to free and forced vibrations with and without damping.	K_2
CO2	Understand the method of vibration measurements and its controlling.	K_2
CO3	Understand the concept of dynamic vibrations of a continuous system	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										
CO3	3	2										
CO (Average)	3	2										

3 -High; 2 -Medium; 1 -Low

TEXT BOOK:

1. Advanced vibration, DR. F.B. SAYAAD, TECH KNOWLEDGE.

OPTIMIZATION TECHNIQUE

B.Tech, VII Semester, Mechanical Engineering

Subject Code	**BT7ME04**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objective:

The general objectives of the course is to:

1. Introduce the fundamental concepts of Optimization Techniques;
2. Make the learners aware of the importance of optimizations in real scenarios;
3. Provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.

Module-1

Introduction to Classical Optimization Techniques

Statement of an Optimization problem - design vector- design constraints – constraint surface objective function - objective function surfaces classification of Optimization problems.

Classical Optimization Techniques

Single variable Optimization, Multi variable Optimization with and without constraints,Multivariable Optimization with equality constraints - solution by method of Lagrange multipliers, Multivariable Optimization with inequality constraints - Kuhn -Tucker conditions.

Hours-10

Module -2

Linear Programming

Various definitions, statements of basic theorems and properties, Advantages, Limitations and Application areas of Linear Programming, Graphical method of Linear Programming problem.

Simplex Method Phase I and Phase II of the Simplex Method, The Revised Simplex method, Primal and Dual Simplex Method, Big -M method.

Hours-10

Module -3

Transportation Problem

Finding initial basic feasible solution by north – west corner ule, least cost method and Vogel's approximation method - testing for optimality of balanced transportation problems. (Including assignment and travelling salesman problems) (No degeneracy problems)

Queuing

Queuing Models : Essential features of queuing systems, operating characteristics of queuing system, probability distribution in queuing systems, classification of queuing models, solution of queuing M/M/1: D FCFS,M/M/1 : NFCFS, MIM/C: DFCFS, M/M/C: NFCFS

Hours-10

Module -4

Dynamic Programming

Dynamic programming multistage decision processes - types - Concept of sub optimization and the principle of optimality computational procedure in dynamic programming

examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

Integer Programming

Pure and mixed integer programming problems, Solution of Integer programming problems Gomory's all integer cutting plane method and mixed integer method, branch and bound method, Zero-one programming.

Hours-10

Module -5

Simulation Modeling

Introduction, Definition and types, Limitations, Various phases of modeling, Monte Carlo method, Applications, advantages and limitations of simulation.

Hours-10

Course Outcomes:

1. Understand the overview of optimization techniques, concepts of design space, constraint surfaces and objective function.
2. Review differential calculus in finding the maxima and minima of functions of several variables.
3. Formulate real-life problems with Linear Programming.
4. Solve the Linear Programming models using graphical and simplex methods.

5. Formulate real-life transportation, assignment and travelling salesman problems to find the optimum solution using transportation algorithms
6. Analyze the Queuing model for effective customer satisfaction.
7. Apply dynamic programming to optimize multi stage decision problems.
8. Determine the level of inventory that a business must maintain to ensure smooth operation.
9. Construct precedence diagram for series of activities in a huge project to find out probability of expected completion time using PERT-CPM networks. Also reduce the duration of project by method of crashing.

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	Understand the overview of optimization techniques, concepts of design space, constraint surfaces and objective function.	K_2
CO2	Review differential calculus in finding the maxima and minima of functions of several variables.	K_4
CO3	Formulate real-life problems with Linear Programming.	K_5
CO4	Solve the Linear Programming models using graphical and simplex methods.	K_4
CO5	Formulate real-life transportation, assignment and travelling salesman problems to find the optimum solution using transportation algorithms.	K_4
CO6	Analyse the Queuing model for effective customer satisfaction.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2					3		2		3	1
CO2	3	2					3		2		3	1
CO3	3	2					3	3	2		3	
CO4	3	2					3	3	2		3	
CO5	3	2					3		2		3	3
CO6	3	2					3		2		3	3
CO (Average)	3	2					3	3	2		3	2

3 -High; 2 -Medium; 1 -Low

TEXT BOOK:

1. OPTIMIZATION TECHNIQUES, A.K.MALLICK, S.R. AND S.K.YADAV, KINLE EDITION

FINANCIAL MANAGEMENT

B.Tech, VII Semester, Mechanical Engineering

Subject Code	BT7ME05A	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lecture Hours	50	CREDITS	04

Subject Overview: Finance is the lifeblood of any enterprise. Financial Management is imperative for efficient utilization and generation of monetary resources and funds. The subject deals with fundamental books and records of accounts with financial analysis. The subject imparts expose to statutory levies to strengthen the understanding of government taxed and duties including the general sales tax structure. The subject includes concepts of market risks and returns to efficiently manage the cash and circumvent liquidity problems both at the individual and organizational levels. In the new CBCS scheme, topics on investment decisions and asset management decisions besides the financing decisions. The curriculum also includes costing and budgeting to enable budding engineers to make a comparative study of finance and economics and evaluate costs and revenues of engineering operations.

Module -1

INTRODUCTION: Bookkeeping systems of book keeping, journal and ledger posting. Financial Statement, Preparation of Trial balance, profit and Loss Account, Balance Sheet with adjustments.

STATUTORY LEVIES: Forms of organization, direct and indirect taxes. Statutory Registration- excise Duty, central sales tax, VAT, service tax, central and state general Sales tax, international fund availability.

Hours-10

Module -2

WORKING CAPITAL MANA GEMENT: Definition, need, and factors influencing the working capital requirement. Determination of operating cycle, cash cycle and operating cycle analysis. Calculation of gross working capital and net working capital requirement.

LONG TERM FINANCING: Raising of finance from primary and secondary markets. Valuation of securities features of convertible securities and warrants. Features of debt, types of debt instruments, return on investment (ROI) and credit rating of units. Shares, debentures.

Hours-10

Module -3

INVESTMENT DECISIONS: Inventory investment, Strategic investment, Ownership investments, lending investment, cash equivalent investment, factors affecting investment decisions, Capital Budgeting, disinvestment methods public offer, sale of equity, cross holding.

ASSET MANAGEMENT DECISIONS: Current Asset Management, Fixed Asset Management, Wealth management, engineering asset management (EAM) - asset maintenance technologies, asset reliability management, project management

Hours-10

Module-4

RISK AND REQUIRED RETURN: Risk and return relationship, methods of measuring the risk, Business risk, financial risk, calculation of expected rate of return to the portfolio, financial theories - portfolio theory, capital asset pricing model, arbitage pricing theory numerical problems.

RATIO ANALYSIS / ACCOUNTING RATIO: Liquidity ratio Current ratio, quick ratio, turnover ratio, capital structure ratio- Debt - equity ratio, Coverage ratio, Profitability ratio, Profit margin, Return on assets, Activity ratios - Inventory turnover ratio, Debtors Turnover ratio.

Preparation of the balance sheet from various ratios. Analysis of any one published balanced sheet.

Hours-10

Module-5

COSTING: Classification of costs, preparation of cost sheet, absorption and variable costing, standard costing, job costing, process costing. Classification of the variances analysis - material., labor and overhead variances.

BUDGETING: Types of budgets - Flexible budgets, preparation of cash budgets, purchase and production budgets and master budget, Budgetary control, advantages & limitations of budgeting.

Hours-10

Course Outcomes:

1. Measure the returns from engineering projects of differing risks and present a risk return tradeoff relationship (PO 4, 12)
2. Determine the financial ratios and profitability margins of projects to evaluate economic viability to accept or reject the project. (PO 11)
3. Evaluate cost break ups of engineering projects and processes to determine and control the prohibitive cost components (PO 11)
4. Apply a Engineering Asset Management techniques to evaluate the economic value of physical assets. (PO 1, 11, 12)

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Measure the returns from engineering projects of differing risks and present a risk return tradeoff relationship (PO 4, 12)	K_2
CO2	Determine the financial ratios and profitability margins of projects to evaluate economic viability to accept or reject the project. (PO 11)	K_2
CO3	Evaluate cost break ups of engineering projects and processes to determine and control the prohibitive cost components (PO 11)	K_3

CO4	Apply a Engineering Asset Management techniques to evaluate the economic value of physical assets. (PO 1, 11, 12)	K_2

1. KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
2. K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1									3	3
CO2	2	1			2							1
CO3	1						2	1				2
CO4	2			2		2				2	2	
CO (Average)	2	1		2	2	2	2	1		2	2.5	2

3 -High; 2 -Medium; 1 –Low

TEXT BOOK:

1. Fundamentals Of Financial management, Prasanna Chandra, MCGRAW HILL PUBLICATIONS.

DESIGN for MANUFACTURING

B.Tech, VII Semester, Mechanical Engineering

Subject Code	**BT7ME05B**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objective:

1. To educate students on factors to be considered in designing parts and components with focus on manufacturability.
2. To expose the students to dimensional tolerances, geometric tolerances and true position tolerance techniques in manufacture.
3. To impart the knowledge on design considerations for designing components produced using various machining operations like turning, drilling, milling, grinding etc.
4. To educate the students on design rules and recommendations for processes like casting, welding, forgings powder metallurgy and injection moulding.

Module-1

Major phases of design, effect of material properties on design, effect of manufacturing processes on design. Material selection process- cost per unit property, weighted properties, and limits on properties methods. Guidelines for design for manufacturability.
Review of relationship between attainable tolerance grades and different machining processes. Process capability, mean, variance, skewness, kurtosis, process capability indices Cp, and Cpk.
Cumulative effect of tolerance- Sure fit law and truncated normal law, problems.

Hours-10

Module -2

Selective Assembly: Interchangeable part manufacture and selective assembly. Deciding the number of groups -model-1: group tolerance of mating parts equal, model- 2: total and group tolerances of shaft equal. Control of axial play- introducing secondary machining operations, and laminated shims; examples.
True positional theory: Comparison between coordinate and true position method offeature location. True position tolerance- virtual size concept, floating and fixed fasteners, projected tolerance zone and functional gages. Concept of Zero true position tolerance. Simple problems on true position tolerancing.

Hours-10

Module -3

Datum Features: Functional datum, datum for manufacturing, changing the datum; examples.
Component Design: Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clamp ability, Design for accessibility. Design for assembly.

Hours-10

Module -4

Design of components with casting considerations: Pattern, mould, and parting line. Cored holes and machined holes. Identifying the possible and probable parting lines. Castings requiring special sand cores. Designing to obviates and cores.
Welding considerations: requirements and rules, redesign of components for welding; case studies.

Hours-10

Module -5

Forging considerations -requirements and rules-redesign of components for forging and case studies. Design of components for powder metallurgy- requirements and rules-case studies. Design of components for injection moulding- requirements and rules-case studies.

Hours-10

Course Outcomes:

1. Describe the different types of manufacturing systems and compare their suitability for economic production of various components and products.
2. Identify factors and causing mechanisms of the defects likely to occur with different manufacturing processes in producing mechanical products and the relevant design approaches to rectify them.
3. Select proper materials and manufacturing processes for designing products/components by applying the relevant principles for ease and economic production.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Describe the different types of manufacturing systems and compare their suitability for economic production of various components and products.	K_3
CO2	Identify factors and causing mechanisms of the defects likely to occur with different manufacturing processes in producing mechanical products and the relevant design approaches to rectify them.	K_1
CO3	Select proper materials and manufacturing processes for designing products/components by applying the relevant principles for ease and economic production.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3		3	2						
CO2	3	2	3		3	3						
CO3	3	3	3		3	2						
CO (Average)	3	2.3	3		3	2.3						

3 -High; 2 -Medium; 1 -Low

TEXT BOOK:

1. Design For Manufacturing A Structural Approach, C.poli, Butterworth Heineman.

SMART MATERIALS and MEMS

B.Tech, VII Semester, Mechanical Engineering

Subject Code	BT7ME05C	IA Marks	30
Number of Lecture	04	Term End Exam Marks	70

Hours/Week			
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objective:

1. This course provides a detailed overview to smart materials, piezoelectric materials structures and its characteristics.
1. 2 The study of Smart structures and modelling helps in Vibration control using smart materials in various applications.
2. Helps to understand the principles and concepts of using MEMS, ER & MR Fluids for various applications.

Module -1

Introduction: Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Inchworm Linear motor, Shape memory alloys, Shape memory effect-Application, Processing, and characteristics.

Shape Memory Alloys: Introduction, Phenomenology, Influence of stress on characteristic temperatures, Modelling of shape memory effect. Vibration control through shape memory alloys. Design considerations, multiplexing embedded NiTiNOL actuators.

Hours-10

Module-2

Electro rheological and Magneto rheological Fluids: Mechanisms and Properties, Characteristics, Fluid composition and behaviour, Discovery and Early developments, Summary of material properties. Applications of ER and MR fluids (Clutches, Dampers, others).

Fibre Optics: Introduction, Physical Phenomenon, Characteristics, Fibre optic strain sensors, Twisted and Braided Fibre Optic sensors, Optical fibres as load bearing elements, Crack detection applications, Integration of Fibre optic sensors and shape memory elements.

Hours-10

Module-3

Vibration Absorbers: Introduction, Parallel Damped Vibration Absorber, Analysis, Gyroscopic Vibration absorbers, analysis & experimental set up and observations, Active Vibration absorbers. Control of Structures: Introduction, Structures as control plants, Modelling structures for control, Control strategies and Limitations.

Biomimetics: Characteristics of Natural structures. Fibre reinforced: organic matrix natural composites, Natural creamers, Mollusks. Biomimetic sensing, Challenges, and opportunities.

Hours-10

Module-4

MEMS: History of MEMS, Intrinsic Characteristics, Devices: Sensors and Actuators. Microfabrication: Photolithography, Thermal oxidation, Thin film deposition, etching types, Doping, Dicing. Bonding. Microelectronics fabrication process flow, Silicon based, Process selection and design.

Piezoelectric Sensing and Actuation: Introduction, Cantilever Piezoelectric actuator model, Properties of Piezoelectric materials, Applications. Magnetic Actuation: Concepts and Principles, Magnetization and Nomenclatures, Fabrication and case studies, Comparison of major sensing and actuation methods.

Hours-10

Module -5

Polymer MEMS & Microfluidics: Introduction, Polymers in MEMS (Polyimide, SU-8, LCP, PDMS, PMMA, Parylene, Others) Applications (Acceleration, Pressure, Flow, Tactile sensors). Motivation for micro fluidics, Biological Concepts, Design and Fabrication of Selective components. Channels and Valves.

Case Studies: MEMS Magnetic actuators, BP sensors, Microphone, Acceleration sensors, Gyro, MEMS Product development: Performance, Accuracy, Repeatability, Reliability, Managing cost, Market uncertainties, Investment, and competition.

Hours-10

Course Outcomes:

1. Describe the methods of controlling vibration using smart systems and fabrication methods of MEMS.
2. Explain the principle concepts of Smart materials, structures, Fibre optics, ER & MR Fluids, Biomimetics and MEMS with principles of working.
3. Analyze the properties of smart structures, MEMS, with the applications and select suitable procedure for fabrication.
4. Summarize the methods and uses of Micro fabrications, Biomimetics, types of polymers used in MEMS, Fibre optics, piezoelectric sensing and actuation.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Describe the methods of controlling vibration using smart systems and fabrication methods of MEMS.	K_2
CO2	Explain the principle concepts of Smart materials, structures, Fibre optics, ER & MR Fluids, Biomimetics and MEMS with principles of working.	K_2
CO3	Analyze the properties of smart structures, MEMS, with the applications and select suitable procedure for fabrication.	K_3
CO4	Summarize the methods and uses of Micro fabrications, Biomimetics, types of polymers used in MEMS, Fibre optics, piezoelectric sensing and actuation.	K_2

3. KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
4. K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	3	1									3	3
CO2	2	1			2							1
CO3	1						2	1				2
CO4		1		2		2				2		
CO (Average)	2	1		2	2	2	2	1		2	2.5	2

3 -High; 2 -Medium; 1 –Low

TEXT BOOK:

1. Smart Material Systems & Mems, Vijay K Varadan , K J. Vinoy & S. Gopalakrishnan,Wiley.

HUMAN RESOURCE MANAGEMENT

B.Tech, VII Semester, Mechanical Engineering

Subject Code	**BT7ME05D**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objective:

1. To understand the HRM concepts and theory
2. To gain overview of analysis of job, Recruitment and selection process
3. To obtain an overview of various HRM functions and practices and training.
4. To understand different concepts of employee welfare, grievances handling and employee discipline.
5. To gain an insight into the various statutory provisions.

Module-1

Human Resource Management:
Introduction, nature, scope of HRM, Importance and Evolution of the concept of HRM - Major functions of HRM, influencing factors for future of HRM, Business ethics in HRM Job Analysis: Meaning, process of Job Analysis, methods of collecting job analysis data, Job Description and Job Specification, Role Analysis.

Hours-10

Module-2

Human Resource Planning: Objectives, Importance, and process of Human Resource Planning, Efective HRP. Recruitment: Definition, Constraints and Challenges, Sources and Methods of Recruitment, New Approaches to recruitment. Selection: Definition and Process of Selection.

Placement: Meaning, Induction/Orientation, Internal Mobility, Transfer, Promotion, Demotion and Employee Separation.

Hours-10

Module -3

Training and development: Training v/s development, Training v/s Education, Systematic Approach to Training, Training Methods.
Performance Appraisal: Concept of Perfomance Appraisal, the Performance Appraisal Process, Methods of Performance Appraisal
Compensation: Objectives of Compensation Planning, Job Evaluation, Compensation Pay Structure in India.

Hours-10

Module -4

Employee Welfare: Introduction, Types of Welfare Facilities and Statutory Provisions. Employee Grievances: Employee Grievance procedure, Grievances Management in Indian Industry.
Discipline: Meaning, approaches to discipline, essential of a good disciplinary system, managing difficult employees.

Hours-10

Module- 5

Industrial Relations and labour laws: Importance, approaches, settlement of industrial disputes, industrial disputes act 1947, payment of wages act, factories act, employee's compensation act, minimum wages act 1948, payment of bonus act 1948, ESI act 1948, payment of gratuity act 1972, trade union movement in India
e-HRM: Nature of e-HRM, e-HR activities, e- Recruitment, e-selection, e-performance management, e-learning, e-compensation

Hours-10

TEXT BOOK:

1. Human Resource Management, K Aswathappa & Sadhna Das, MCGRAW HILL PUBLICATIONS.

B. Tech, VIII Semester, Mechanical Engineering

Code No.	Name of Subjects	Periods			Credits	Marks		
		L	T	P		IA	TE	TM
BT8ME01	Operation Research	4	-	-	4	30	70	100
BT8ME02	Additive Manufacturing	4	-	-	4	30	70	100
BT8ME03	Fluid Power System	4	-	-	4	30	70	100
BT8ME04	Professional Elective -V	3	1	-	4	30	70	100
BT8ME05	Final project Viva Voce	-	-	-	8	100	100	200
BT8ME06L	Seminar	-	-	-	2	-	50	50
Total		**15**	**1**	**-**	**26**	**220**	**430**	**650**

Elective- V
Experiment Stress Analysis
Theory Of Plasticity
Green Manufacturing
Product Life Cycle Management

OPERATION RESEARCH

B. Tech, VIII semester, Mechanical Engineering

Subject Code	BT8ME01	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lecture Hours	50	CREDITS	04

Course Objectives:

1. To enable the students, understand the scientific methods of providing various departments of an organization with a quantitative basis of decision making.
2. To enable the students to understand the importance of various tools and techniques in finding optimal solutions to problems involving limited resources in the form of Men, Materials, and machinery.

Module -1

Introduction: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear

Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables).

Hours-10

Module -2

LPP: Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and Two-Phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method.

Hours-10

Module -3

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner nule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. Unbalanced T.P. Maximization TP.
Degeneracy in transportation problems, application of transportation problem.

Hours-10

Module-4

Network analysis: Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Crashing of networks- Problems.

Queuing Theory: Queuing systems and their characteristics, Pure -birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models - Numerical on M/M/1 and M/M/C Queuing models.

Hours-10

Module-5

Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games.
Sequencing: Basic assumptions, Johnson's algorithm, sequencing n’jobs on single machine using priority rules, sequencing using Johnson's
rule- 'n’jobs on 2machines, n'jobs on3machines, n'jobs on 'm’machines. Sequencing of 2 jobs on ‘m' machines using graphical method.

Course Outcomes:

1. Understand the meaning, definitions, scope, need, phases, and techniques of operations research.

2. Formulate as L.P.P and derive optimal solutions to linear programming problems by graphical method, Simplex method, Big-M method, and Dual Simplex method.
3. Formulate as Transportation and Assignment problems and derive optimum solutions for transportation, Assignment and travelling salesman problems.
4. Solve problems on game theory for pure and mixed strategy under competitive environment.
5. Solve waiting line problems for M/M/1 and M/M/K queuing models.
6. Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks.
7. Determine minimum processing times for sequencing of n jobs-2 machines, n jobs-3machines, n jobs-m machines and 2 jobs-n machines using Johnson's algorithm.

Hours-10

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	Understand the meaning, definitions, scope, need, phases, and techniques of operations research.	K_2
CO2	Formulate as L.P.P and derive optimal solutions to linear programming problems by graphical method, Simplex method, Big-M method, and Dual Simplex method.	K_2
CO3	Formulate as Transportation and Assignment problems and derive optimum solutions for transportation, Assignment and travelling salesman problems.	K_3
CO4	Solve problems on game theory for pure and mixed strategy under competitive environment.	K_2
CO5	Solve waiting line problems for M/M/l and M/MK queuing models.	K_4
CO6	Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks.	

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			2	1		2				3
CO2	2	2						2				3
CO3	2	2						2				3
CO4	3	2						2				3
CO5	3	2						2				3
CO6	3	2						2				3
CO (Average)	2.6	2			2	1		2				3

3 -High; 2 -Medium; 1 –Low

TEXT BOOK:

1. Operations Research, Prem Kumar Gupta & D S Hira, S Chand Publisher.

ADDITIVE MANUFACTURING

B. Tech, VIII Semester, Mechanical Engineering

Subject Code	BT8ME01	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lecture Hours	50	CREDITS	04

Course Objectives:

1. Understand the additive manufacturing process, polymerization and powder metallurgy process.
2. Understand characterization techniques in additive manufacturing.
3. Acquire knowledge on CNC and Automation.

Module -1

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM, AM process chain: Conceptualization, CAD, Conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build, removal and clean up, post processing.
Classification of AM processes: Liquid polymer system, Discrete particle system, Molten material systems and Solid sheet systems.
Post processing of AM parts: Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.
Guidelines for process selection: Introduction, selection methods for a part, challenges of selection
AM Applications: Functional models, Pattern for investment and vacuum casting, medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defence, automobile, Bio-medical and general engineering industries.

Hours-10

Module -2

System Drives and devices: Hydraulic and pneumatic motors and their features, Electrical motors AC/DC and their features.
Actuators: Electrical Actuators; Solenoids, Relays, Diodes, Thyristors, and Triacs. Hydraulic and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys.

Hours-10

Module-3

POLYMERS & POWDER METALLURGY

Basic Concepts: Introduction to Polymers used for additive manufacturing: polyamide, PF resin, polyesters etc. Classification of polymers, Concept of functionality, Polydispersity and Molecular weight [MW], Molecular Weight Distribution [MWD] Polymer Processing: Methods of spinning for additive manufacturing: Wet spinning, Dry spinning. Biopolymers, Compatibility issues with polymers. Moulding and casting of polymers, Polymer processing techniques

General Concepts: Introduction and History of Powder Metallurgy (PM), Present and Future Trends of PM

Powder Production Techniques: Different Mechanical and Chemical methods, Atomisation of Powder, other emerging processes.

Characterization Techniques: Particle Size & Shape Distribution, Electron Microscopy of Powder, Interparticle Friction, Compression ability, Powder Structure, Chemical Characterization

Microstructure Control in Powder: Importance of Microstructure Study, Microstructures of Powder by Different techniques. Powder Shaping: Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process Variables, Pre ssure & Density Distribution during Compaction, Isotactic Pressing, Injection Moulding, Powder Extrusion, Slip Casting, Tape Casting.

Sintering: Theory of Sintering, Sintering of Single & Mixed Phase Powder, Liquid Phase Sintering Modern Sintering Techniques, Physical & Mechanical Properties Evaluation, Structure-Property Correlation Study, Modern Sintering techniques, Defects Analysis of Sintered Components

Application of Powder Metallurgy: Filters, Tungsten Filaments, Self-Lubricating Bearings, Porous Materials, Biomaterials etc.

Hours-10

Module -4

NANO MATERIALS & CHARACTERIZATION TECHNIOUES:

Introduction: Importance of Nanotechnology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology

Nano-materials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding: Wet Chemical Synthesis of Nano materials- sol-gel process; Gas Phase synthesis of Nano-materials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing (GPC), Chemical Vapour Condensation (CVC).

Optical Microscopy - principles, Imaging Modes, Applications, Limitations.

Scanning Electron Microscopy (SEM) principles, Imaging Modes, Applications, Limitations. **Transmission Electron Microscopy (TEM)** - principles, Imaging Modes, Applications, Limitations**. X- Ray Diffraction (XRD)** principles, Imaging Modes, Applications, Limitations. **Scanning Probe Microscopy (SPM)** - principles, Imaging Modes, Applications, Limitations. **Atomic Force Microscopy (AFM)** basic principles, instrumentation, operational modes,

Applications, Limitations. **Electron Probe Micro Analyzer (EPMA)** - Introduction, Sample preparation, Working procedure, Applications, Limitations.

Hours-10

Module -5

MANUFACTURING CONTROL AND AUTOMATION

CNC technology An overview: Introduction to NC/CNC/DNC machine tools, Classification of NC /CNC machine tools, Advantage, disadvantages of NC /CNC machine tools, Application of NC/CNC.

Part programming: CNC programming and introduction, Manual part programming: Basic (Drilling, milling, turning etc.), Special part programming, Advanced part programming, Computer aided part programming (APT)

Introduction: Automation in production system principles and strategies of automation, basic Elements of an automated system. Advanced Automation functions. Levels of Automations, introduction to automation productivity

Control Technologies in Automation: Industrial control system. Process industry vs discrete manufacturing industries. Continuous vs discrete control. Continuous process and its forms. Other control system components.

Course Outcomes:

1. Understand the different process of Additive Manufacturing. using Polymer, Powder and Nano materials manufacturing.
2. Analyse the different characterization techniques.
3. Describe the various NC, CNC machine programming and Automation techniques.

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	Understand the different process of Additive Manufacturing. using Polymer, Powder and Nano materials manufacturing.	K_2
CO2	Analyse the different characterization techniques.	K_2
CO3	Describe the various NC, CNC machine programming and Automation techniques.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2			3						
CO2	3	3	2		2	3						
CO3	2	3	1		3	3						
CO (Average)	2.33	3	1.66		2.5	3						

3 -High; 2 -Medium; 1 -Low

TEXT BOOK:

1. Additive Manufacturing, Dr. R.B. Choudhary, Khanna Publishers.

FLUID POWER SYSTEMS

B. Tech, VIII Semester, Mechanical Engineering

Subject Code	BT8ME03	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lecture Hours	50	CREDITS	04

Course Objectives:

1. To provide an insight into the capabilities of hydraulic and pneumatic fluid power. 2. To understand concepts and relationships surrounding force, pressure, energy and power in fluid power systems.
2. To examine concepts centring on sources of hydraulic power, rotary and linear actuators, distribution systems, hydraulic flow in pipes, and control components in fluid power systems.
3. Exposure to build and interpret hydraulic and pneumatic circuits related to industrial applications.
4. To familiarize with logic controls and trouble shooting

Module-1

Introduction to fluid power systems: Fluid power system: components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications. Fluids for hydraulic system: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Types of pipes, hoses, and quick acting couplings. Pressure drop in hoses/pipes. Fluid conditioning through filters, strainers; sources of contamination and contamination control; heat exchangers.

Hours-10

Module - 2

Pumps and actuators

Pumps: Classification of pumps, pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump selection factors, problems on pumps.

Accumulators: Types, selection/ design procedure, applications of accumulators. Types of Intensifiers, Pressure switches /sensor, Temperature switches/sensor, Level sensor.

Actuators: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders.

Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power, flowrate, and hydraulic

motor performance; numerical problems. Symbolic representation of hydraulic actuators (cylinders and motors).

Hours-10

Module-3

Components and hydraulic circuit design

Components: Classification of control valves, Directional Control Valves-symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, and check valves.

Pressure control valves - types, direct operated types, and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

Hydraulic Circuit Design: Control of single and Double -acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counterbalance valve application, hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylinder- metering in, metering out and bleed off circuits. Pilot pressure operated circuits. Hydraulic circuit examples with accumulator.

Hours-10

Module -4

Pneumatic power systems: Introduction to Pneumatic systems: Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit.

Pneumatic Actuators: Linear cylinder -types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders- types, construction and application, symbols.

Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols.

Hours-10

Module -5

Pneumatic control circuits

Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling.

Signal Processing Elements: Use of Logic gates OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates.

Multi- Cylinder Application: Coordinated and sequential motion control, motion and control diagrams. Signal elimination methods, Cascading method- principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves).

Electro- Pneumatic Control: Principles signal input and output, pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple signal cylinder application.

Course Outcomes:

1. Identify and analyse the functional requirements of a fluid power transmission system for a given application.
2. Visualize how a hydraulic/pneumatic circuit will work to accomplish the function.

3. Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro-pneumatics for a given application.
4. Select and size the different components of the circuit.
5. Develop a comprehensive circuit diagram by integrating the components selected for the given application.

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	Identify and analyse the functional requirements of a fluid power transmission system for a given application.	K_2
CO2	Visualize how a hydraulic/pneumatic circuit will work to accomplish the function.	K_2
CO3	Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro-pneumatics for a given application.	K_3
CO4	Select and size the different components of the circuit.	K_2
CO5	Develop a comprehensive circuit diagram by integrating the components selected for the given application.	K_4

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2	2				2							
CO3	2	3	3			3						
CO4				1		2						
CO5						1						
CO (Average)	2.33	3	3	1	1	2						

3 -High; 2 -Medium; 1 -Low

TEXT BOOK:

1. Fluid Power Engineering, Venkatesh Naik, Sunstar Publisher.

EXPERMENTAL STRESS ANALYSIS
B. Tech, VIII Semester, Mechanical Engineering

Subject Code	**BT8ME04A**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. To understand the measurement of stain using electrical strain gauges.
2. To analyse stress and strains induced mechanical systems using electrical strain gauges.
3. To understand the photo elastic techniques to characterize the elastic behavior of solids
4. To understand elastic behavior of solid bodies using coating techniques.
5. To apply the holography methods to measure stress and strains.

Module-1

Introduction: Definition of terms, Calibration, Standards, Dimension, and units generalized measurement system. Basic concepts in dynamic measurements, system response, distortion, impedance matching, Analysis of experimental data, cause, and types of experimental errors. General consideration in data analysis.

Electrical Resistance Strain Gages: Strain sensitivity in metallic alloys, Gage construction, adhesives and mounting techniques, Gage sensitivity and gage factor, Performance Characteristics, Environmental effects, Strain Gage circuits. Potentiometer, Wheatstone's bridges, Constant current circuits.

Hours-1O

Module-2

Strain Analysis Methods: Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, Stress intensity factor gage

Force, Torque and strain measurements: Mass balance measurement, Elastic element for force measurements, torque measurement.

Hours-10

Module -3

Photoelasticity: Nature of light, Wave theory of light optical interference. Stress optic law - effect of stressed model in plane and circular polariscopes, Isoclinic & Isochromatic, Fringe order determination Fringe multiplication techniques, Calibration photo elastic model materials.

Two-Dimensional Photoelasticity: Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photo elastic model materials, Materials for 2D photoelasticity.

Hours-10

Module -4

Three-Dimensional Photo elasticity: Stress freezing method, scattered light photoelasticity, Scattered light as an interior analyser and polarizer, Scattered light polariscope and stress data Analyses.

Photo elastic (Birefringent) Coatings: Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poisson’s Stress separation techniques: Oblique incidence.

Hours-10

Module -5

Brittle Coatings: Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings and its applications.
Moire Methods: Moire fringes produced by mechanical interference. Geometrical approach, Displacement field approach to Moire fringe analysis, Out of plane displacement measurements, Out of plane slope measurements. Applications and advantages

Hours-10

Course Outcomes:

1. Explain and the elastic behavior of solid bodies.
2. Describe stress strain analysis of mechanical systems using electrical resistance strain gauges.
3. Understand the experimental methods of determining stresses and strains induced.
4. Apply the coating techniques to determine the stresses and strains.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Explain and the elastic behavior of solid bodies.	K_2
CO2	Describe stress strain analysis of mechanical systems using electrical resistance strain gauges.	K_2
CO3	Understand the experimental methods of determining stresses and strains induced.	K_3
CO4	Apply the coating techniques to determine the stresses and strains.	K_2

5. KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
6. K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1									3	3
CO2	2	1			2							1
CO3	1						2	1				2
CO4		1		2		2				2		
CO (Average)	2	1		2	2	2	2	1		2	2.5	2

3 -High; 2 -Medium; 1 -Low

TEXT BOOK:

1. Experimental stress analysis, Dr. Sadhu Singh, Khanna Publishers.

THEORY OF PLASTICITY

B. Tech, VIII Semester, Mechanical Engineering

Subject Code	BT8ME04B	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of	50	CREDITS	04

Lecture Hours			

Course Objectives:

1. To introduce the concepts of Plasticity and mechanism of plastic deformation in metals.
2. To expose the students to elasto-plastic problems involving plastic deformation of beams and bars.
3. To introduce the concepts of slip line field theory.

Module -1

Brief review of fundamentals of elasticity: Concept of stress, stress invariants, principal Stresses, octahedral normal and shear stresses, spherical and deviatoric stress, stress transformation; concept of strain, engineering and natural strains, octahedral strain, deviator and spherical strain tensors, strain rate and strain rate tensor, cubical dilation, generalized Hooke's law, numerical problems.

Hours-10

Module -2

Plastic Deformation of Metals: Crystalline structure in metals, mechanism of plastic deformation, factors affecting plastic deformation, strain hardening, recovery, recrystallization and grain growth, flow figures or Luder's cubes.
Yield Criteria: Introduction, yield or plasticity conditions, Von Mises and Tresca criterion, geometrical representation, yield surface, yield locus (two-dimensional stress space), experimental evidence for yield criteria, problems.

Hours-10

Module -3

Stress Strain Relations: Idealised stress-strain diagrams for different material models, empirical equations, Levy-VonMises equation, Prandtl-Reuss and Saint Venant theory, experimental verification of Saint Venant's theory of plastic flow. Concept of plastic potential, maximum work hypothesis, mechanical work for deforming a plastic substance.

Hours-10

Module -4

Bending of Beams: Stages of plastic yielding, analysis of stresses, linear and nonlinear stress strain curve, problems.
Torsion of Bars: Introduction, plastic torsion of a circular bar, elastic perfectly plastic material, elastic work hardening of material, problems.

Hours-10

Module -5

Slip Line Field Theory: Introduction, basic equations for incompressible two-dimensional flows, continuity equations, stresses in conditions of plain strain, convention for slip lines, geometry of slip line field, properties of the slip lines, construction of slip line nets.

Hours-10

Course Outcomes:

1. Understand stress, strain, deformations, relation between stress and strain and plastic deformation in solids.
2. Understand plastic stress-strain relations and associated flow rules.
3. Perform stress analysis in beams and bars including Material nonlinearity.
4. Analyse the yielding of a material according to different yield theory for a given state of stress.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Understand stress, strain, deformations, relation between stress and strain and plastic deformation in solids.	K_2
CO2	Understand plastic stress-strain relations and associated flow rules.	K_2
CO3	Perform stress analysis in beams and bars including Material nonlinearity.	K_3
CO4	Analyse the yielding of a material according to different yield theory for a given state of stress.	K_2

7. KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)
8. K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1									3	3
CO2	2	1			2							1
CO3	1						2	1				2
CO4		1		2		2				2		
CO (Average)	2	1		2	2	2	2	1		2	2.5	2

3 -High; 2 -Medium; 1 –Low

TEXT BOOK:

1. Theory of plasticity, J. Chakrabarty, Butterworth-Heinemann Ltd.

Green Manufacturing

B. Tech, VII Semester, Mechanical Engineering

Subject Code	BT8ME04C	IA Marks	30
Number of Lecture Hours/Week	04	Term End Exam Marks	70
Total Number of Lecture Hours	50	CREDITS	04

Course Objectives:

1. Acquire a broad understanding of sustainable manufacturing, green product, and process.
2. Understand the analytical tools, techniques in green manufacturing.
3. Understand the structures of sustainable manufacturing, environmental and management practice.

Module -1

Introduction to Green Manufacturing
Why Green Manufacturing, Motivations and Barriers to Green Manufacturing. Environmental Impact of Manufacturing, Strategies for Green Manufacturing.
The Social, Business, and Policy Environment for Green Manufacturing
Introduction, The Social Environment- Present Atmosphere and Challenges for Green Manufacturing, The Business Environment: Present Atmosphere and Challenges, The Policy Environment- Present Atmosphere and Challenges for Green Manufacturing.

Hours-10

Module -2

Metrics for Green Manufacturing: Introduction, Overview of Currently Used Metrics, Overview of LCA Methodologies, Metrics Development Methodologies, Outlook, and Research Needs.
Green Supply Chain: Motivation and Introduction, Definition, Issues in Green Supply Chains (GSC), Techniques/Methods of Green Supply Chain, Future of Green Supply Chain.

Hours-10

Module-3

Closed-Loop Production Systems
Life Cycle of Production Systems, Economic and Ecological Benefits of Closed a Loop Systems, Machine Tools and Energy Consumption, LCA of Machine Tools, Process Parameter Optimization, Dry Machining and Minimum Quantity Lubrication, Remanufacturing, Reuse, Approaches for Sustainable Factory Design.
Semiconductor Manufacturing
Overview of Semiconductor Fabrication, Micro fabrication Processes, Facility Systems, Green Manufacturing in the Semiconductor Industry: Concepts and Challenges, Use-Phase Issues with Semiconductors, Example of Analysis of Semiconductor Manufacturing.

Hours-10

Module-4

Environmental Implications of Nano-manufacturing
Introduction, Nano-manufacturing Technologies, Conventional Environmental Impact of Nano-manufacturing, Unconventional Environmental Impacts of Nano-manufacturing, Life Cycle Assessment (LCA) of Nanotechnologies.
Green Manufacturing Through Clean Energy Supply
Introduction, Clean Energy Technologies, Application Potential of Clean Energy Supplying Green Manufacturing

Hours-10

Module -5

Packaging and the Supply Chain: A Look at Transportation Introduction, Background, Recommended Method to Determine Opportunities for Improved Pallet Utilization, Discussion.

Enabling Technologies for Assuring Green Manufacturing

Motivation, Process Monitoring System, Applying Sensor Flows in Decision Making: Automated Monitoring, Case Study.

Concluding Remarks and Observations about the Future

Introduction, Evolution of Manufacturing, Leveraging Manufacturing, Energy of Labor.

Hours-10

Course Outcomes:

1. Understand the basic design concepts, methods, tools, the key technologies and the1. operation of sustainable green manufacturing.
2. Apply the principles, techniques, and methods to customize the learned generic concepts to meet the needs of a particular industry/enterprise.
3. Identify the strategies for the purpose of satisfying a set of given sustainable green manufacturing requirements.
4. Design the rules and processes to meet the market need and the green manufacturing requirements by selecting and evaluating suitable technical, managerial / project management and supply chain management scheme.

Course Outcome No	**Statement**	**Knowledge Level (KL)**
CO1	Understand the basic design concepts, methods, tools, the key technologies and the operation of sustainable green manufacturing.	K_2
CO2	Apply the principles, techniques, and methods to customize the learned generic concepts to meet the needs of a particular industry/enterprise.	K_2
CO3	Identify the strategies for the purpose of satisfying a set of given sustainable green manufacturing requirements	K_3
CO4	Design the rules and processes to meet the market need and the green manufacturing requirements by selecting and evaluating suitable technical, managerial / project management and supply chain management scheme.	K_2

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1									3	3
CO2	2	1			2							1
CO3	1						2	1				2
CO4		1		2		2				2		
CO (Average)	2	1		2	2	2	2	1		2	2.5	2

3 -High; 2 -Medium; 1 –Low

TEXT BOOK:

1. Green Manufacturing and Materials Processing Methods, Sarbjeet Kaushal, Sandeep Bansal, Chander Prakash, CRC Press.

PRODUCT LIFE CYCLE MANAGEMENT
B. Tech, VIII Semester, Mechanical Engineering

Subject Code	**BT8ME04D**	**IA Marks**	30
Number of Lecture Hours/Week	04	**Term End Exam Marks**	70
Total Number of Lecture Hours	50	**CREDITS**	04

Course Objectives:

1. Familiarize with various strategies of PLM
2. Understand the concept of product design and simulation.
3. Develop New product development, product structure and supporting systems
4. Interpret the technology forecasting and product innovation and development in business processes.
5. Understand product building and Product Configuration.

Module-1

INTRODUCTION TO PLM AND PDM

Introduction to PLM need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation. Product Data Management, implementation of PDM systems.

Hours-1O

Module-2

PRODUCT DESIGN

Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modelling and simulation in product

Hours-10

Module -3

PRODUCT DEVELOPMENT

New Product Development, structuring new product development, building decision support system, estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product.

Hours-10

Module -4

TECHNOLOGY FORECASTING

Technological change, methods of technology forecasting, relevance trees, morphological methods, flow diagram and combining forecast of technologies Integration of technological product innovation and product development in business processes within enterprises, methods and tools in the innovation process according to the situation, methods and tools in the innovation process according to the situation

Hours-10

Module -5

PRODUCT BUILDING AND STRUCTURES

Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis, production (process) planning, and product data technology, Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items.

Hours-10

Course Outcomes:

1. Explain the various strategies of PLM and Product Data Management.
2. Describe decomposition of product design and model simulation.
3. Apply the concept of New Product Development and its structuring.
4. Analyse the technological forecasting and the tools in the innovation.
5. Apply the virtual product development and model analysis.

Course Outcome No	Statement	Knowledge Level (KL)
CO1	Explain the various strategies of PLM and Product Data Management.	K_2
CO2	Describe decomposition of product design and model simulation.	K_2
CO3	Apply the concept of New Product Development and its structuring.	K_3
CO4	Analyse the technological forecasting and the tools in the innovation.	K_4
CO5	Apply the virtual product development and model analysis.	K_3

KL- Bloom's Knowledge Level (K_1, K_2, K_3, K_4, K_5, K_6)

K_1-Remember, K_2- Understand, K_3- Apply, K_4- Analyze, K_5- Evaluate, K_6- Create

CO & PO Mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			3					2	1		
CO2	2				1		1		3	3		
CO3	3		2	3					1	1		
CO4												
CO5												
CO Average	2.66		2	3			1		2	1.66		

3 -High; 2 -Medium; 1 –Low

TEXT BOOK:

1. Product Lifecycle Management: Driving the Next Generation of Lean Thinking, Michael Grieves, McGraw-Hill Education, 2006.

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