Mechanical Engineering Department

Third Semester (Syllabus)

THIRD SEMESTER

CODE	SUBJECT NAME	L-T-P	CREDIT
UME03B07	Basic Engineering Thermodynamics	**3-0-0**	**03**
UME03B08	Engineering Materials	**3-0-0**	**03**
UME03B09	Fluid Mechanics-I	**3-0-0**	**03**
UME03C14	Mathematics-III	**3-0-0**	**03**
UME03C15	Applied Electrical and Electronics Engineering	**3-0-0**	**03**
UME03B10	Strength of Materials	**3-0-0**	**03**
LABORATORIES			
UME03P14	M.E Lab-I(Applied Mechanics Lab)	**0-0-2**	**01**
UME03P15	M.E Lab-I(Strength of Materials Lab)	**0-0-2**	**01**
UME03P19	Applied Electrical &Electronics lab	**0-0-2**	**01**
UME03P16	M.E Lab-II(Machine Drawing Lab)	**0-0-2**	**01**
UME03P17	M.E Lab-II(Material Science Lab)	**0-0-2**	**01**
UME03P20	Professional Ethics	**0-0-2**	**01**
	TOTAL CREDIT	**18-0-12**	**24**

BASIC ENGINEERING THERMODYNAMICS:

Course		Credit-03			Marks(Weightage)		
Name	Basic Engineering Thermodynamics	L	T	P	Mid	End	Internal
Code	**UME03B07**	3	0	0	30	50	20

Unit 1: Basic Concepts and First Law of Thermodynamics
Macroscopic and Microscopic Approach; Continuum Theory; Thermodynamic System, Control Volume; Properties, State and Equilibrium, Processes, Cycles, Path Function and Point Function; Temperature and Zeroth Law of Thermodynamics; Forms of Energy, Energy Transfer Mechanism; First Law of Thermodynamics; Energy Balance of Closed and Open System; Work Transfer; Boundary work; Free expansion; Conservation of Mass; Flow Work; Energy Analysis of Steady-Flow Systems and Devices – Nozzle, Diffuser, Compressor, Pump, Turbine, Throttling
Valve, Mixing Chamber, Heat Exchanger; Energy Analysis of Unsteady-Flow Systems; Internal Energy, Enthalpy, and Specific Heats of Ideal Gases; Specific Heat Relations of Ideal Gases; Internal Energy, Enthalpy, and Specific Heat of Solids and Liquids; Internal Energy Changes; Enthalpy Changes; PMM1; Limitations of First Law of Thermodynamics.

Unit 2: Second Law of Thermodynamics
Thermal Energy Reservoirs; Reversible and irreversible processes; Heat engine and Kelvin– Planck Statement; Refrigerator and Heat Pumps and Clausius Statement; Carnot Cycle; Carnot Theorem and Corollaries; Thermodynamic Temperature Scale; Carnot Heat Engine, Carnot Refrigerator, and Carnot Heat Pump; Quality of energy, PMM-II.

Unit 3: Entropy
Clausius' Theorem; Inequality of Clausius; Principle of increase of entropy and its application; Entropy and its significance; Tds relations; Entropy change in solid, liquid, and gases; Reversible
Steady flow work; Isentropic efficiencies; Compressor work; Statement of the Third law of Thermodynamics.

Unit 4: Exergy
Exergy, Reversible work and irreversibility; Second Law Efficiency; Flow and non-flow exergy; Exergy Transfer; Decrease of Exergy Principle and Exergy Destruction; Exergy Balance.

Unit 5: Properties of Pure Substances and Their Relations
Pure substances; Phase Change States and Processes; Triple point, Critical point; Property Diagrams; Steam Tables; Charts and Tables of Thermodynamic Properties; Dryness Fraction of liquid-vapor mixtures; Behavior of Ideal and Real gases; Compressibility Factor; Maxwell Relations; Clapeyron Equation; Internal Energy, Entropy, Enthalpy, Specific Heat Changes; Mayer Relation; Joule-Thomson Coefficient.

Text Books:

1. *P.K. Nag, Engineering Thermodynamics, Tata McGraw-Hill.*
2. *Y.A. Cengal, and M.A. Boles, Thermodynamics: An Engineering Approach, McGraw Hill.*

Reference Books:

1. *C. Borgnakke & R.E. Sonntag, Fundamentals of Thermodynamics, Wiley.*
2. *M.J. Moran, H.N. Shapiro, D.D. Boettner, M.B. Bailey, Fundamentals of Engineering Thermodynamics,Wileyces:*

Course outcome (*Basic Engineering Thermodynamics*)

CO-No.	**Course outcome**
UME03B07.1	Understand the basic principles of first law of thermodynamics and know how energy transfer takes place
UME03B07.2	Understand the basic principles of second law of thermodynamics and quality of energy
UME03B07.3	Explain the concepts of entropy and its presence in processes and cycles
UME03B07.4	Gain the knowledge to use exergy in real-world engineering applications
UME03B07.5	Explain the phase change processes and calculate the properties of pure substances
UME03B07.6	Understand the interrelation between the thermodynamics functions and properties

Mapping of Course outcomes

POs	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	PSO-1	PSO-2
UME03B07	**Basic Engineering Thermodynamics**													
UME03B07.1	3	2	2	2	--	--	--	--	--	--	--	--	3	2
UME03B07.2	3	2	2	2	--	--	--	--	--	--	--	--	3	2
UME03B07.3	3	2	2	2	--	--	--	--	--	--	--	--	3	2
UME03B07.4	3	2	2	2	--	--	--	--	--	--	--	--	3	2
UME03B07.5	3	2	2	2	--	--	--	--	--	--	--	--	3	2
UME03B07.6	3	2	2	2	--	--	--	--	--	--	--	--	3	2

ENGINEERING MATERIALS

Course		Credit-03			Marks(Weightage)		
Name	Engineering Materials	L	T	P	Mid	End	Internal
Code	**UME03B08**	3	0	0	30	50	20

Structure of Materials: Crystalline structure of solids; Concept of unit cell and space lattice; Miller indices; Crystal structure determination by X-ray diffraction, optical method, Crystal structure of ferrous and non-ferrous metals; Crystal imperfection

Plastic Deformation: Mechanism of plastic deformation; Role of dislocation; Slip and Twinning; Strain hardening and re crystallization; Elementary cause and treatment of creep fatigue and fracture

Phase Diagram: Phase and Phase equilibrium; solidification of pure metals and alloys; Phase diagrams; Eutectic, eutectoid; Peritectic and peritectoid systems; Allotropy of iron and Fe-C diagrams.

Heat Treatment Introduction and purpose of heat treatment; T-T-T curve and micro constituents in steel heat treatment process like hardening, tempering, normalizing, annealing; Electrical, magnetic and optical properties of materials; Surface treatment processes.

Engineering Materials: Ferrous ;Pig iron ,Blast furnace, Cast iron, Cupola, steel, steel making process, Carbon and alloy steel and their coding; Nonferrous; Aluminum; Copper Nickel; Chromium; Zinc; Lead; Tin; Tungsten etc. and their alloys .Classification; Structure; General properties and application of polymers, Ceramics and composites.

Text Book:

1. *W. D. Callister, Jr: Materials Science and Engineering- An Introduction, John Wiley and Sons,N.Y, 1985.*

Reference Books:

1. *V. Raghavan, Materials Science and Engineering 4ed., Prentice Hall, 1999*
2. *G. E. Dieter, Mechanical Metallurgy, Mc-Graw Hill, 1987*
3. *William F. Smith, Materials Science and Engineering, Tata Mc-Graw Hill*
4. *S. H. Avner, Introduction of Physical Metallurgy, Mc-Graw Hill, 1987*

Course outcome (*Engineering Materials*)

CO-No.	Course outcome
UME03B08.1	Illustrate the various methods of determining crystal structure in ferrous and non ferrous metals
UME03B08.2	Enumerate the principles of deformation and fracture mechanisms.
UME03B08.3	Construct the phase diagrams for the Iron- Carbon system and also for any given alloy systems, interpret the various micro constituents of iron and its alloys.
UME03B08.4	Appraise various methods of Heat treatment process and also illustrate the effects of cooling on phase transformation in iron based alloy systems.
UME03B08.5	Analyze the effects of alloying elements on the properties of ferrous Materials. and nonferrous metallic materials.
UME03B08.6	Compare the properties of metallic, nonmetallic and composite materials and also recommend suitable materials for a particular engineering application by doing adequate literature survey.

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME03B08	**Engineering Materials**													
UME03B08.1	3	3	2	2	1	1	1	2	1	1	1	--	3	2
UME03B08.2	3	3	2	2	1	1	1	2	3	1	1	--	3	2
UME03B08.3	3	3	2	2	1	1	1	2	3	1	1	--	3	2
UME03B08.4	3	3	2	2	1	2	1	1	1	1	1	--	3	2
UME03B08.5	3	3	2	2	1	2	1	1	1	3	3	--	3	2
UME03B08.6	3	3	2	2	1	2	1	1	1	1	1	1	3	2

FLUID MECHANICS-I

Course		Credit-03			Marks(Weightage)		
Name	Fluid Mechanics-I	L	T	P	Mid	End	Internal
Code	**UME03B09**	3	0	0	30	50	20

Properties of fluid, pressure and it's measurement: Mass and weight density, specific gravity, specific volume, viscosity and Newton's law of viscosity, Compressibility, Types of fluid, surface tension and capillarity. Fluid pressure at a point and Pascal's law, absolute, gauge and vacuum pressures, pressure variation in a fluid at rest, pressure measurement-Manometers and Mechanical Gauges

Hydrostatics, buoyancy and flotation: Total pressure and centre of pressure for horizontal, vertical, inclined plane surfaces and curved surfaces submerged in liquid. Total pressure and center of pressure on lock gates. Buoyancy, center of buoyancy, Meta centre and metacentric height and equilibrium of floating bodies, period of oscillation

Kinematics of flow: Kinematics of flow: Types of fluid flow, continuity equation in three dimensions, velocity potential function and stream function, forced and free vortex flow

Dynamics of flow: Euler's equation and Bernoulli's equation, application of Bernoulli's equation Venturimeter, orifice-meter and Pitot tube.

Orifice and notches: Flow through orifices, hydraulic coefficients, time of emptying hemispherical and horizontal cylindrical tank through an orifice at its bottom. Discharge over rectangular, triangular and trapezoidal notches, velocity of approach

Laminar flow and turbulent flow: Flow of viscous fluid through circular pipe-velocity distribution and average velocity, Hagen-Poiseiulle formula, Kinetic energy correction and Momentum Correction factors, Navier-Stokes equation of motion. Reynold's experiment, Loss of head due to friction in pipes, Reynold's expression and Prandtl mixing length theory for turbulent shear stress.

Text Books:

1. *Bansal, R. K., "Fluid Mechanics & Hydraulic Machines", Laxmi Publications.*
2. *Cengel, Y. A., "Fluid Mechanics: Fundamentals & Applications (SI Units)", Tata McGraw- Hill Publications.*
3. *Jain, A. K., "Fluid Mechanics", Khanna Publishers.*
4. *Rajput, R. K., "Fluid Mechanics & Hydraulic Machines, S. Chand Publications.*

Reference Books:

1. *S. K. Som, G. Biswas, S. Chakraborty, "Introduction to Fluid Mechanics and FluidMachines"*
2. *Streeter, V. L. ,Wylie, E. Benjamin , Fluid Mechanics, McGraw-Hill, London, 199*
3. *Shames, I. H., Mecahnics of Fluids, McGraw Hill, New York, 1992*

Course outcome (*Fluid Mechanics-I)*

CO-No.	Course outcome
UME03B09.1	Understand the basic principles of fluid mechanics and its applications.
UME03B09.2	Develop methods and techniques for describing and specifying the fluids in rest as well as in motion.
UME03B09.3	Know about different kinds of flows and governing equation.
UME03B09.4	Know the relation between thermodynamics and fluid mechanics.
UME03B09.5	Gain the knowledge to use such relationship to solve the real-world engineering problems.
UME03B09.6	Understand the most complex problems, formulate them and interpret the results.

Mapping of course outcomes

POs	PO -1	PO - 2	PO - 3	PO - 4	PO - 5	PO - 6	PO - 7	PO - 8	PO - 9	PO - 10	PO - 11	PO - 12	PSO - 1	PSO - 2
UME03B09	**Fluid Mechanics-I**													
UME03B09.1	3	2	3	-	-	-	-	-	-	-	-	-	2	3
UME03B09.2	-	3	3	-	-	-	-	-	-	-	2	-	3	2
UME03B09.3	3	-	3	-	-	-	-	-	-	-	-	-	-	2
UME03B09.4	3	2	3	-	-	-	-	-	2	-	2	-	2	2
UME03B09.5	-	3	2	3	-	-	2	-	-	-	-	-	2	3
UME03B09.6	3	3	3	3	-	-	-	-	-	-	-	-	2	3

MATHEMATICS III

Course		Credit-03			Marks(Weightage)		
Name	Mathematics-III	L	T	P	Mid	End	Internal
Code	**UME03C14**	3	0	0	30	50	20

Probability and Random Variable: Axioms of probability, Conditional probability, Independent events, Baye's Theorem, Random variables, Probability mass function, Probability density function - properties, Moments, Moment generating functions and their properties

Standard Distributions: Binomial, Poisson Normal distribution and their properties, function of random variables.

Two-dimensional random variables: Joint distribution, Marginal and conditional distribution, covariance, correlation and regression, Transformation of random variables, Central limit theorem.

Testing of hypothesis: Sampling distribution, Testing of hypothesis of mean, variance, proportion and differences using Normal, t and Chi-square.

Fourier series: Periodic functions, Fourier series, Dirichlet's conditions, function defined in two or more sub-ranges, discontinuous functions, even function, odd function, half range series, change of interval.

Partial Differential Equations: Order, Method of forming Partial Differential Equations, Solution of Equation by Direct Integration, Lagrange's Linear equation, Method of Multipliers, Partial Differential equations non-linear in p,q, Charpits Method, Linear Homogeneous Partial Differential equation, Non-Homogeneous Linear Equations, Method of Separation of variables, Equation of vibrating string, Solution of wave equation by D Alembert's method, One dimensional heat flow, Two dimensional Heat flow.

Course outcome (*Mathematics-III*)

CO-No.	**Course outcome**
UME03C14.1	Understand the basic concepts of probability, random variables, probability distribution, and moments and moment generating functions.
UME03C14.2	Define the basic discrete and continuous distributions such as normal, binomial, Poisson, and make be able to apply them and simulate them in simple cases.
UME03C14.3	Explain the concepts of two dimensional random variable, independence, jointly distributed random variables and conditional distributions, and use generating functions to establish the distribution of linear combinations of independent random variables. Also State the central limit theorem, and apply it.
UME03C14.4	Explain the concepts of random sampling, statistical inference and sampling distribution, and state and use basic sampling distributions. Hypothesis testing and its application in real life problems.
UME03C14.5	Find the Fourier series representation of a function of one variable, and find the solution of the wave, diffusion and Laplace equations using the Fourier series.
UME03C14.6	Students familiarize with the fundamental concepts of Partial Differential Equations (PDE) which will be used as background knowledge for the understanding of specialized courses in Engineering. Students will master how solutions of PDEs are determined by conditions at the boundary of the spatial domain and initial conditions at time zero

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME03C14	**Mathematics-III**													
UME03C14.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
UME03C14.2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
UME03C14.3	-	-	2	-	-	-	-	-	-	-	-	-	3	-
UME03C14.4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
UME03C14.5	-	2	-	-	-	-	-	-	-	-	-	-	-	-
UME03C14.6	-	3	-	-	-	-	-	-	-	2	-	2	-	-

APPLIED ELECTRICAL AND ELECTRONICS ENGINEERING

Course		Credit-03			Marks(Weightage)		
Name	Applied Electrical and Electronics Engineering	L	T	P	Mid	End	Internal
Code	**UME03C15**	3	0	0	30	50	20

Asynchronous Machines: Three phase induction motor-Principle of operation Cage and Slip ring rotors. Torque-Slip Characteristics-Equivalent circuit-Starting and speed control. Single phase induction motor Types-Applications-Universal Motor.

Selection of Drives: Electric drives-Individual and group drives- Factors governing selection of drives Motors for domestic uses. Cranes, Lifts, General Factory, Textile Mill, Paper Mill, Mining Work, Cement Mill, Machine tools, Belt Conveyors, Ships, Refrigeration and Air conditioning. Amplifier Circuits-RC Coupled, Transformer coupled; direct coupled; Differential Amplifiers Inverting and Non-inverting amplifiers; Differentiator- Multiplier-Divider, Comparator; VI and IV converter.

Digital Circuits : D/A and A/D-Types; Sample and Hold Circuit-Multiplexers, De multiplexers, Decoder and Encoders. Practice on RC Coupled amplifier, OP Amp, Multiplexers and De-multiplexers, SCR and Applications, Power supply and regulator.

Text Books:

- *Digital Design by Morris Mano*
- *Electronic Principles -Albert Malvino and David Bates*
- *Electric Machinery Fundamentals by Stephen Chapman.*
- *Fundamentals of Electrical Drives by G. K. Dubey,*

Reference Books:

- *Modern Digital Fundamentals by Floyd*
- *Digital Electronics, By R. P. Jain*
- *Microelectronics Ckt - Sedra & Smith*
- *Electric Drives N.K. De and P.K. Sen.*
- *Electric Drives: Concepts And Applications by Vedam Subrahmanyam*
- *Electrical Machine Design by A.K. Sawhney*

Course outcome (*Applied Electrical and Electronics Engineering)*

CO-No.	**Course outcome**
UME03C15.1	To equip the students with the knowledge of the construction, principle, types, applications and performance characteristics of Single Phase and Three Phase Induction motor. Construction and application of Universal Motor.
UME03C15.2	To learn how to select of various types of Drives and their application in industries.
UME03C15.3	To understand various types of amplifier and there characteristics and applications.
UME03C15.4	To analyse Converter circuits, operational amplifier basics and design of various circuits by using op amp.
UME03C15.5	Introduction of MUX, DMUX, Encoder, Decoder circuits and various implementations and design by using these circuits To develop an understanding for analysis and design of various combinational circuits.
UME03C15.6	Introduction to SCR and its application in power supply and regulators

-Mapping of course outcomes

POs	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
UME03C15	**Applied Electrical and Electronics Engineering**													
UME03C15.1	3	3	3	2	-	-	-	-	-	-	-	2	3	3
UME03C15.2	3	3	3	3	-	-	-	-	-	-	-	2	3	3
UME03C15.3	3	3	2	1	-	-	-	-	-	-	-	-	1	2
UME03C15.4	3	3	3	1	-	-	-	-	-	-	-	1	2	3
UME03C15.5	3	3	2	1	-	-	-	-	-	-	-	-	1	1
UME03C15.6	3	3	2	1	-	-	-	-	-	-	-	1	2	2

STRENGTH OF MATERIALS

Course		Credit-03			Marks(Weightage)		
Name	Strength of Materials	L	T	P	Mid	End	Internal
Code	**UME03B10**	3	0	0	30	50	20

Simple stresses and strains : Stress, strain, types of stresses, elastic limit, Hook's law, Analysis of bars of varying sections, law of superposition, composite bar, thermal stress, thermal stresses in composite bars, elongation of bar due to its own weight, stress-strain diagram. Concept of strain, normal and shear strain, two dimensional states of strain, Poisson's ratio, volumetric strain, strain circle. Relation between various elastic constants.

Mechanical Properties : Uniaxial tension test to determine yield and ultimate strength of materials, stress-strain diagram, proof stress, ductile and brittle materials, hardness and impact strength; Conditions affecting mechanical behavior of engineering materials.

Principle stresses and strain: Introduction, Principle planes and principle stresses, methods for determining stresses on oblique section, Analytical method, Graphical method, Mohr's circle, Use of Mohr's circle to find Principle stresses.

Shear force and bending moment: Introduction, different types of beams and loads, S.F & BM diagram for a cantilever, uniformly distributed load, simply supported beam for various types of loading, relation between load, shear force and bending moment diagram.

Theory of pure bending: Expression of Bending stress, Neutral Axis and Moment of Resistance, Bending stress in symmetrical sections, Section modulus.

Deflection of Beam: Deflection of beams-- Moment-Area methods, Macaulay's method, Double Integral method.

Torsion of shafts: Introduction, Basic assumptions, Derivation of shear stress produced in a circular shaft subjected to torsion, Max. Torque transmitted by a circular and hollow circular shaft. Polar modulus, strength of a shaft and torsional rigidity, composite shafts, combined bending and torsion. Strength of a shaft of varying cross section.

Column and Struts: Introduction, Failure of columns, Euler's column theory, End conditions of columns, crippling load.

Thin and Thick cylinder: Introduction, Thin cylindrical vessel subjected to internal pressure, expression for circumferential and longitudinal stress in thin cylinder, stresses in thick cylindrical shells, stresses in compound thick cylinder.

Text Books:

- *A text book of Strength of materials- Dr R. K Bansal, Laxmi Publications Private Limited.*

Reference Books:

- *Timoshenko and Gere, Mechanics of Materials, CBS Publishers, 2011*
- *J. Case and A.H. Chilver, Strength of Materials and Structures,Edward Arnold, 1980*
- *L.S. Srinath, Advanced Mechanics of Solids (2nd edition), TataMcGraw Hill, 2003.*

S. H. Crandall, N. C. Dahl

Course outcome (*Strength of Materials*)

CO-No.	**Course outcome**
UME03B10.1	Apply fundamental concepts and compute simple stresses and deformations in structural members
UME03B10.2	Construct shear force and bending moment diagrams for statically determinate beams and determine stress distribution.
UME03B10.3	Compute slope and deflection in statically determinate beams
UME03B10.4	Examine the buckling failure in columns and calculate strain energy under varying load conditions.
UME03B10.5	Solve problems on shafts and springs subjected to twisting moment.
UME03B10.6	Apply the concepts of complex stress system in 2D systems and in thin walled containers.

Mapping of course outcomes

POs	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
UME03B10	**Strength of Materials**													
UME03B10.1	3	2	3	-	-	-	-	-	-	-	-	-	2	3
UME03B10.2	2	3	3	-	-	-	-	-	-	-	2	-	3	2
UME03B10.3	3	2	3	-	-	-	-	-	-	-	-	-	-	2
UME03B10.4	3	2	3	-	-	-	-	-	2	-	2	-	2	2
UME03B10.5	-	3	2	3	-	-	2	-	-	-	-	-	2	3
UME03B10.6	3	3	3	3	-	-	-	-	-	-	-	-	2	3

M.E LAB-I (APPLIED MECHANICS LAB)

Course		Credit- **01**			Marks(Weightage)		
Name	Applied Mechanics Lab	L	T	P	Mid	End	Internal
Code	UME03P14	0	0	2	00	100	00

Course contents:

Exp 1: To prove that the time period of a simple pendulum is independent of mass.
Exp 2: To determine the radius of gyration K of given bar (compound pendulum)
Exp 3: To determine the moment of inertia of a given bar by using Bi-Flier suspension
Exp 4: To determine the moment of inertia of a given circular bar by using tri-Flier suspension
Exp 5: To determine the torque on a two arm lever apparatus.
Exp 6: To find out velocity ratio, mechanical advantage and efficiency of equilibrium of moments on pulleys apparatus.
Exp 7: To study the Hooke's law & find spring constant.

Course outcomes:

No of course outcome	Name of the course outcome
UME03P14.1	Students will learn how the time period of a simple pendulum is independent of mass.
UME03P14.2	Students will be able to determine the radius of gyration K of given bar(compound pendulum)
UME03P14.3	Students will be able to determine the moment of inertia of a given bar by using Bi-filar/Tri filar suspension method.
UME03P14.4	Students will be able to determine the torque on a two arm lever apparatus.
UME03P14.5	Students will be able to find velocity ratio, mechanical advantage and efficiency of equilibrium of moments on pulleys apparatus.
UME03P14.6	Students will understand the Hooke's law & will be able to find spring constant.

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME03P14	**Applied Mechanics lab**													
UME03P14.1	-	3	-	3	-	-	-	-	3	-	-	-	-	3
UME03P14.2	3	3	-	3	-	-	-	-	3	-	-	-	-	3
UME03P14.3	-	3	-	3	-	-	-	-	3	-	-	-	-	3
UME03P14.4	3	3	-	3	-	-	-	-	3	-	-	-	-	3
UME03P14.5	-	3	-	3	-	-	-	-	3	-	-	-	-	3
UME03P14.6	3	3		3					3					3
Average	3	3	-	3	-	-	-	-	3	-	-	-	-	3

Text Books: 1. *Engineering mechanics, author:. Stephen Timoshenko.*
2. Engineering mechanics, author: R.S Khurmi.
Reference: *Lab Manual.*

M.E LAB-I (STRENGTH OF MATERIALS LAB)

Course		Credit 01			Marks(Weightage)		
Name	Strength of Materials Lab	L	T	P	Mid	End	Internal
Code	UME03P15	0	0	2	00	100	00

Universal Testing Machine:

Exp-1: To study the universal testing machine and perform the tensile test for various metals. (Mild steel, TMT bar, copper etc.)

Exp-2: To perform compression test of various metals on UTM.

Exp-3: To perform bend test on Universal Testing Machine for rectangular bar. (Mild steel etc.)Exp-4: To perform bend test of a circular specimen on Universal Testing Machine.

Exp-5: To perform shear test of various metal on UTM.

Impact Testing Machine:

Exp-6: To study the impact testing machine and determine the impact test of steel (Izod test). Exp-7: To study the impact testing machine and determine the impact test of steel (Charpy test). **Unit 3: Torsion Testing Machine:**

Exp-8: To study the torsion testing Machine and perform torsion test.

Unit 4:Semi Vickers Hardness Tester

Exp-9: To study the Vickers hardness testing Machine and perform Vickers Hardness test.

Unit 5: Electronics Rockwell Hardness Tester

Exp-10: To study the Rockwell hardness testing Machine and perform Rockwell Hardness test.

Course outcomes:

No of course	Name of the course outcome
UME03P15.1	Evaluate Properties of material by hardness test.
UME03P15.2	Evaluate Properties of material by tensile test.
UME03P15.3	Determine Compressive & Flexural Strength of materials.
UME03P15.4	Reproduce the basic knowledge of mathematics and engineering in finding the strength in tension, compression, shear and torsion.
UME03P15.5	Identify, formulate and solve engineering problems of structural elements subjected to flexure
UME03P15.6	Evaluate the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures due to unsuitable materials.

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME03P15	**Strength of Materials Lab**													
UME03P15.1	-	3	-	3	-	-	-	-	3	-	-	-	-	3
UME03P15.2	3	3	-	3	-	-	-	-	3	-	-	-	-	3
UME03P15.3	-	3	-	3	-	-	-	-	3	-	-	-	-	3
UME03P15.4	3	3	-	3	-	-	-	-	3	-	-	-	-	3
UME03P15.5	-	3	-	3	-	-	-	-	3	-	-	-	-	3
Average	3	3	-	3	-	-	-	-	3	-	-	-	-	3

Text Books:

i. *Strength of Material Lab Manual, ME Deptt, NIT Agartala*

Reference Books:

- *Fenner, "Mechanical Testing of Materials", George Newnes Ltd. London.*
- *Holes K A, "Experimental Strength of Materials", English Universities Press Ltd. London*
- *Davis, Troxell and Hawk, "Testing of Engineering Materials", International Student Edition – McGraw Hill Book Co. New Delhi*
- *Kukreja C B, Kishore K. and Ravi Chawla "Material Testing Laboratory Manual", Standard Publishers & Distributors 1996*

APPLIED ELECTRICAL & ELECTRONICS LAB

Course		Credit-01			Marks(Weightage)		
Name	Applied Electrical &Electronics lab	L	T	P	Mid	End	Internal
Code	**UME03C19**	0	0	2	00	100	00

Exp 1: Familiarization with Logic Gates (AND, OR, NOT, XOR).
Exp 2: Design and implementation of Encoder
Exp 3: Design and implementation of Decoder
Exp 4: Design and implementation of Multiplexer
Exp: 5: Design and implementation of Demultiplexer
Exp: 6: To sketch and analyse the following basic op-amp circuits and explain the operation of each Unity gain amplifier (With DC and AC Power supply), Inverting amplifier (With DC and AC Power supply), and non-Inverting amplifier (With DC and AC Power supply)
Exp: 7: To sketch and analyse the basic summing amplifier circuits and explain the operation of summing amplifier circuits
Exp: 8: To sketch and analyse the basic difference amplifier circuits and explain the operation of difference amplifier circuits
Exp: 9: Study the starting of three phase Induction Motor.
Exp: 10: Study the speed control of three phase Induction Motor.

No of course	Name of the course outcome
UME03P19.1	Explain the basic logic operations of NOT, AND, OR, NAND, NOR, and XORwith truth table.
UME03P19.2	Understand various ccombinational Logic Design.
UME03P19.3	Design op-amp circuits to perform arithmetic operations and analyze and design linear and non-linear applications using op-amps.
UME03P19.4	Develop the basic experimental and modelling skills for handling problems associated with Induction Motor

***Mapping of course outcomes**:*

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME03P19	**Applied Electrical &Electronics lab**													
UME03P19.1	3	3	3	3					2			1	3	1
UME03P19.2	3	3	3	3					2			1	3	1
UME03P19.3	3	3	3	3					2			2	3	2
UME03P19.4	3	3	3	3					2			1	3	1
UME03P19.5	3	3	3	3					2			1	3	1
UME03P19.6	3	3	3	3					2			2	3	2

Text Books:

- *Digital Design by Morris Mano*
- *Electronic Principles -Albert Malvino and David Bates*
- *Electric Machinery Fundamentals by Stephen Chapman.*

***Reference Books*:**

- *Modern Digital Electronics, By R. P. Jain.*
- *Digital Fundamentals by Floyd*
- *Microelectronics Ckt - Sedra & Smith & Electrical Machine Design by A.K. Sawhney*

M.E LAB-II (MACHINE DRAWING LAB)

Course		Credit-01			Marks(Weightage)		
Name	M.E Lab-I(Machine Drawing Lab)	L	T	P	Mid	End	Internal
Code	**UME03P16**	0	0	2	00	100	00

Intersection & Development of Surfaces: Draw the development of surfaces for Prisms, cylinders, pyramids and Cones. Intersection of prism and pyramid, intersection of prism and cylinder, intersection of cylinder and cone.

Representation of elements of machine drawing: Engineering Materials, Surface finishes, tolerances, sectional views, Screw threads.

Component Drawings: Bolts and Nuts, Locking devices, Bearings.

Pipes and Pipe joint: General discussions, Types of Pipe Joints, Piping Layout and Conventions

Assembly Drawing Practice: Introduction, Types of Assembly, Assembly procedures, Draw the assembly drawings of Stuffing Box, Pedestal Bearing using the component drawings

Course outcomes:

No of course	Name of the course outcome
UME03P16.1	Develop the surfaces for constructing the sheet metal components.
UME03P16.2	Construct the Orthographic Views of Intersected Solids.
UME03P16.3	Represent engineering materials, surface finish, limits, tolerances and sectional views in Machine Drawing as per standards.
UME03P16.4	Develop/Construct a piping layout for a given piping system.
UME03P16.5	Construct and represent various machine parts through component and assembly drawings.

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME03P16	**Machine Drawing Lab**													
UME03P16.1	3	-	2	-	-	-	-	-	-	-	-	-	2	-
UME03P16.2	-	-	2	-	-	-	-	-	-	-	-	-	2	-
UME03P16.3	3	-	-	-	-	2	-	-	-	3	-	-	3	-
UME03P16.4	-	-	3	-	-	-	-	-	-	-	-	-	2	-
UME03P16.5	-	-	-	-	-	-	-	-	-	3	-	2	3	-

Reference Books:

1. *N.D. Bhatt, Machine Drawing, Charotar Book Stall, Anand, 1996.*
2. *P.S.Gill, A Textbook of Machine Drawing,S.K. Kataria&Sons .*
3. *N. Sidheswar, P. Kanniah and V.V.S. Sastry, Machine Drawing, Tata McGraw Hill, 1983*
4. *SP 46: 1988 Engineering Drawing Practice for School & Colleges. Bureau of Indian Standards*

M.E LAB-II (MATERIAL SCIENCE LAB)

Course		Credit			Marks(Weightage)		
Name	Material Science lab	L	T	P	Mid	End	Internal
Code	**UME03P17**	0	0	2	00	100	00

Expt 1: Sample preparation (sectioning, mounting, polishing and etching) for metallographic examination
Expt 2: Quantitative and qualitative analysis of microstructure using optical microscopy
Expt 3: Micro-hardness test.
Expt 4: Annealing and its effect on the mechanical properties of mild steel and medium carbon steel.
Expt 5: Hardening/ quenching and its effect on the mechanical properties of mild steel medium carbon steel.
Expt 6: Comparative study on effects of heat treatment with reference to experiment 4 and 5.

Course outcome

No of course	Name of the course outcome
UME03P17.1	Preparation of samples for metallurgical study.
UME03P17.2	Microstructural Analysis using optical microscopy
UME03P17.3	To conduct heat treatment of steel.
UME03P17.4	To conduct surface hardening using induction heating.
UME03P17.5	Estimate the effects of heat treatment on mechanical properties of engineering materials.
UME03P17.6	Ability to select material based on its properties for a particular application.

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME03P17	**Material Science Lab**													
UME03P17.1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
UME03P17.2	3	2	-	-	1	-	-	-	-	-	-	-	-	2
UME03P17.3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
UME03P17.4	3	-	-	-	-	-	-	-	-	-	-	-	2	-
UME03P17.5	3	2	-	2	-	-	-	-	-	-	-	-	-	2
UME03P17.6	3	2	-	2	-	-	-	-	-	-	-	-	-	2

Text Books:

1. *William F. Smith, Material science and engineering, Mc Graw Hill Education.*

Reference Books:

1. *W. D. Callister, Material science and engineering an introduction, Wiley*

PROFESSIONAL ETHICS

Course		Credit			Marks(Weightage)		
Name	Professional Ethics	L	T	P	Mid	End	Internal
Code	**UME03C20**	0	0	2	00	100	00

Organizational Communication: Professional Ethics and basic concepts of process of ethical communication; Silence and its interpretation, Features of Successful Professional Communication; Importance of Communication; Purpose of Professional Communication; Different Forms of Communication; Communication Network in an Organization; Barriers to communication.

Listening Skills: Listening is an art ; Listening vs. Hearing; Poor Listening vs. Effective Listening ; Important facts about listening; Advantages of Good Listening; Process of Listening ; Types of Listening; Intensive vs. Extensive Listening; Barriers to Effective Listening; Techniques for Effective Listening; Listening and Note Taking.

Effective Presentation Strategies: Introduction; Defining Purpose; Analyzing Audience and Locale; Organizing Contents; Preparing an Outline; Kinesics; Proxemics; Paralinguistic.

Oral Communication: Communication/ Public Speaking Skill, Features of Effective Speech-verbal; Group Discussion-principle and practice (the context of a GD, positive and negative roles played in a GD, different stages in a GD etc. and practice sessions), Interview skills and Non –verbal Communication using Audio-Visual aids, Studying Body Language, Distance and Positioning, Body Orientation, Pronunciation and Vocabulary extension.

Writing Skills: The Basics of Writing, The Process of Writing, Mind Mapping

Mechanics of Reading & Writing: Fundamentals of Grammar, One Word Substitution

Models of Technical Writing: Notice Writing, Formal Letters, Email Writings, Job Applications, Reports, Essays, CV, Passages for Comprehension and Advertisements.

No. of Course Outcome (CO)	Course Outcome
UME03P20.1	Handle all aspects of that experience with a professional demeanor; interacting with team members responsibly, meeting deadlines, preparing and presenting effectively.
UME03P20.2	Display competence in oral, written, and visual communication.
UME03P20.3	Possess skills to effectively deliver formal and informal oral presentations
UME03P20.4	Respond effectively to cultural communication differences.
UME03P20.5	Overcoming communication barriers, understanding the nuances of organizational set up by acting positively through group communication.
UME03P21.6	Ability to use ethical communication skills.

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME03P20	**Professional Ethics**													
UME03P20.1	--	2	--	--	--	--	2	1	3	3	2	2	--	--
UME03P20.2	--	2	--	--	--	--	2	1	3	2	3	3	--	1
UME03P20.3	--	2	1	--	--	--	2	--	3	3	2	2	--	1
UME03P20.4	--	3	--	--	--	--	2	--	3	2	2	3	--	--
UME03P20.5	--	--	1	--	--	--	2	2	2	2	2	2	--	--
UME03P21.6	--	--	1	--	--	--	2	2	2	2	3	2	--	--

References:

Mishra Sunita and Murali Krishna C. Communication Skills for Engineers, (2nd Edition), Thane: Pearson India Education Services Pvt. Ltd., 2019.

Mitra, Barun. Personality Development and Soft Skills.Oxford University Press, 2012.

Raymond Murphy. Intermediate English Grammer. (II Edition) Cambridge University Press, 2011.

Rizvi Ashrf M. Effective Technical Communication, (II Edition), Chennai: Mc Graw Hill Education, 2018.

Raman Meenakshi and Sangeeta Sharma. Technical Communication; Principles and Practice, (II Edition), Oxford University Press, 2011.& Sharma RC and Mohan Krishna. Business Correspondence and Report Writing :Practical Approach to Business and Technical Communication, (V Edition), Chennai: Mc Graw Hill Education, 2018.

Mechanical Engineering Department

Fourth Semester (Syllabus)

FOURTH SEMESTER

CODE	SUBJECT NAME	L-T-P	CREDIT
UME04C07	Applied Thermodynamics	**3-0-0**	**03**
UME04C08	Kinematics of Machine	**3-0-0**	**03**
UME04C09	Fluid Mechanics - II	**3-0-0**	**03**
UME04C10	Manufacturing Technology - I	**3-0-0**	**03**
UME04B15	Numerical Methods & Computer Programming	**3-0-0**	**03**
UME04C11	Design of Machine Elements - I	**3-0-0**	**03**
LABORATORIES			
UME04P18	ME Lab - III (Primary Manufacturing Processes Laboratory)	**0-0-2**	**01**
UME04P19	ME Lab - III (Computer programming Laboratory)	**0-0-2**	**01**
UME04P20	ME Lab - IV (Fluid Mechanics Laboratory)	**0-0-2**	**01**
UME04P21	ME Lab - IV (Design of Machine Elements Laboratory)	**0-0-2**	**01**
UME04P22	Soft Skill Development	**0-0-2**	**01**
	TOTAL CREDIT	**18-0-10**	**23**

APPLIED THERMODYNAMICS

Course		Credit-03			Marks(Weightage)		
Name	Applied Thermodynamics	L	T	P	Mid	End	Internal
Code	**UME04C07**	3	0	0	30	50	20

Unit 1: Gas Power Cycles: Air standard cycles, Carnot, Otto, Diesel, Dual and Stirling cycles, Gas turbine (Brayton)cycle, Regenerative gas turbine cycle. Inter-cooling and reheating in gas turbine cycles.

Unit 2: Vapour Power Cycles: Simple Rankine cycle, Actual vapour power cycles, Ideal and practical regenerative Rankine cycles, Reheat Rankine cycle.

Unit 3: Refrigeration Cycles and Psychrometry: Refrigeration: Vapour compression refrigeration system, Refrigerants and their desirable properties, Air cycle refrigeration, Vapour absorption refrigeration system

Unit 4: Ideal Gas Mixtures: Dalton's law of additive pressures, Amagat's law of additive volumes, evaluation of properties. Analysis of various processes.

Unit 5: Psychrometry: Atmospheric air and Psychometric properties, Construction and use of psychrometric chart, Analysis of various processes - heating, cooling, dehumidifying and humidifying, Adiabatic mixing of stream of moist air.

Unit 6: Combustion Thermodynamics: Theoretical (Stoichiometric) air for combustion of fuels. Excess air, mass balance, Exhaust gas analysis, A/F ratio. Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion. Combustion efficiency. Dissociation and equilibrium, emissions.

Unit 7: Reciprocating Compressors: Single stage and multi-stage reciprocating compressors, Volumetric efficiency, Adiabatic, isothermal and mechanical efficiencies.

Text Books:

- *P.K. Nag, Engineering Thermodynamic, Tata McGraw-Hill.*
- *Y.A. Cengal and M.A. Boles, Thermodynamics: An Engineering Approach, McGraw Hill.*

Reference Books:

- *Claus Borgnakke and Richard E Sonntag, Fundamentals of Thermodynamics, Wiley.*
- *Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey,*
- *Fundamentals Of Engineering Thermodynamics, Wiley*

Course Outcome *(Applied Thermodynamics)*

CO	**Course outcome**
CO1	Evaluate the performance of gas power cycles and perform the second law analysis
CO2	Evaluate the performance of vapour power cycles, analyze the combined power cycles and perform the second law analysis
CO3	Evaluate the performance of refrigeration systems
CO4	Understand the concept of basic psychrometry
CO5	Understand the overview of fuels and combustion processes
CO6	Know the basic concepts of reciprocating compressors

Mapping of course outcomes

POs	**PO -1**	**PO - 2**	**PO - 3**	**PO - 4**	**PO - 5**	**PO - 6**	**PO - 7**	**PO - 8**	**PO - 9**	**PO - 10**	**PO - 11**	**PO - 12**	**PSO - 1**	**PSO - 2**
UME04C07	**Applied Thermodynamics**													
UME04C07.1	3	2	3	-	-	-	-	-	-	-	-	-	2	3
UME04C07.2	2	3	3	-	2	-	-	-	-	-	2	-	3	2
UME04C07.3	3	-	3	-	-	-	-	-	-	2	-	-	-	2
UME04C07.4	3	2	3	-	-	-	-	-	2	2	2	-	2	2
UME04C07.5	2	3	2	3	-	2	2	-	-	-	-	-	2	3
UME04C07.6	3	3	3	3	-	-	-	2	-	-	-	-	2	3

KINEMATICS OF MACHINE

Course		Credit-03			Marks(Weightage)		
Name	Kinematics of Machine	L	T	P	Mid	End	Internal
Code	**UME04C08**	3	0	0	30	50	20

Machine and mechanism: Definition, Mechanism and Machine, Link, Kinematic Pair, Degrees of freedom, Kinematic chain, Various types of joints, Degrees of freedom for plain Mechanism, Inversion, Different types of kinematic chain and their inversions, Mobility and range of movement - Kutzbach and Grubler‟s criterion, Grashof‟s criterion.

Velocity and acceleration analysis of planar mechanisms: Instantaneous Center Method, Properties of the Instantaneous Centre, Types of Instantaneous Centres, Aronhold Kennedy Theorem, Method of Locating Instantaneous Centres in a Mechanism. Relative velocity method; Motion of a Link, Rubbing Velocity at a Pin Joint
Acceleration Diagram for a Link, Acceleration of a Point on a Link, Acceleration in the Slider Crank Mechanism, Corioli‟s Acceleration Component.

Belt, Rope and Chain drive: Types of Belt Drives, Velocity Ratio of Belt Drive, Power Transmitted by a Belt, Analysis of Belt Tensions, Maximum Tension in the Belt, Length of an Open and Cross Belt Drive, V-belt Construction, Types of Rope in Rope Drive, Ratio of Driving Tensions for Fibre Rope, Classification of Chains Used in Chain Drive, Construction of Roller Chain, Geometrical Relationships in Chain Drive, Polygonal Effect in Chain Drives

Clutches and Dynamometers: Types of Clutches, Mechanical lockup clutches, Friction clutches, Multi disk friction Clutch, Cone clutches, Centrifugal clutches, Dynamometer, Absorption and transmission Dynamometer.

Gears and Gear Train: Gear classification and Terminology, Law of Gearing, Velocity of sliding, Forms of teeth, length of Arc & path of contact, Interference, Minimum number of teeth required to avoid interference, Types of Gear Train, Velocity ratio in different Gear train arrangement, Epicyclic Gear train, and compound Epicyclic Gear train

Cams: Types of followers; Cam profile Nomenclature; various types of motion of the follower Uniform motion, Simple Harmonic, Uniform Acceleration and Retardation, Cycloidal; Cam profile construction for various types of followers.

Text Books:

i.Theory of Mechanism and Machine; A Ghosh and AK Malik, East West Press (Pvt.) Ltd., New Delhi.
ii.Theory of Machines; SS Rattan: Tata McGraw Hill, New Delhi.
iii.Theory of Machines by RS Khurmi and JK Gupta; S.Chand and Company Ltd., New Delhi.

Reference Books:

i. Shigley, J.E., Vicker Jr., J.J., Theory of Machines and Mechanisms, McGraw-Hill.
ii. Rao, J.S. and Dukkipati, R.Y., Mechanism and Machine Theory, 2nd ed., Wiley Eastern Ltd
iii. Kinematic Synthesis of Linkages by Hartenberg and Denavitt

Course outcomes (*Kinematics of Machine)*

No of course outcome	Course Outcome
CO1	Understand fundamentals and categorize mechanisms used in real life.
CO2	Analyze mechanisms for displacement, velocity and acceleration
CO3	Evaluate friction and its effect on machine elements like Belt, rope and chain drive
CO4	Evaluate friction and its effect on machine elements like Clutches and Dynamometers.
CO5	Perform kinematic analysis of gears and gear trains.
CO6	Develop CAM profile for various followers and follower motions and perform its kinematic analysis

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME04C08	**Kinematics of Machine**													
UME04C08.1	3	2	-	-	-	-	-	-	-	-	-	1	2	3
UME04C08.2	3	3	-	-	-	-	-	-	-	-	-	1	3	2
UME04C08.3	3	3	2	-	-	-	-	-	-	-	-	3	-	2
UME04C08.4	3	3	2	-	-	-	-	-	-	-	-	3	2	2
UME04C08.5	3	3	3	-	-	-	-	-	-	-	-	3	2	3
UME04C08.6	3	3	3	-	-	-	-	-	-	-	-	3	2	3

FLUID MECHANICS - II

Course		Credit-03			Marks(Weightage)		
Name	Fluid Mechanics - II	L	T	P	Mid	End	Internal
Code	**UME04C09**	3	0	0	30	50	20

Dimensional and Model Analysis: Dimensions of fundamental and derived quantities, Dimensional Homogeneity, Reyleigh‟s method and Buckingham‟s of pie-theorem, Simlitude, dimensionless, Model Laws, classification of models.

Flow through Pipes : Major and minor losses of energies in pipes, Hydraulic gradient and total energy lines, flow through pipes in series, equivalent pipe, Flow through parallel pipes, Power transmission through pipes and nozzles, water hammer.

Flow in open channel: Uniform flow through open channels, Chezy‟s formula, Most economical sections of channel. Non-uniform flow-specific energy and specific energy curve, critical depth and critical velocity, minimum specific energy, hydraulic jump.

Boundary Layer Theory: Laminar and Turbulent boundary Layer thickness, Vonkarman‟s momentum equation, Total drag due to Laminar and turbulent layers on flat plate, separation of boundary layer and it‟s control.

Forces on submerged bodies: Drag and lift on a stationary body by flowing fluid, expression for drag and lift and dimensional analysis, stream lined and Bluff bodies, Drag on a sphere and cylinder, Terminal velocity of a body, lift on a airfoil.

Compressible flow of Gas dynamics : Thermodynamic relations, continuity equation, Bernoulli‟s equation and momentum equation, velocity of sound in fluid, Mach no. propagation of pressure waves in a compressible fluid-Mach angle, zone of action and silence, stagnation properties, Area-velocity relationship for compressible flow, flow of compressible fluid through nozzles-maximum mass flow rate and it‟s variation, mass flow rate of compressible fluid through venturimeter, pito-static tube. Normal and oblique shock waves.

Text Books:

i. *Rajput, R.K., "Fluid Mechanics & Hydraulic Machines, S. Chand Publications.*

ii. *Bansal, R. K., "Fluid Mechanics & Hydraulic Machines", Laxmi Publications.*

iii. *Cengel, Y. A., "Fluid Mechanics: Fundamentals & Applications (SI Units)", Tata McGraw-Hill Publications.*

iv. *Jain, A. K., "Fluid Mechanics", Khanna Publishers.*

Reference Books:

i. *S.K. Som, G. Biswas, S. Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines".*

ii. *Shames, I. H., Mecahnics of Fluids, McGraw Hill, New York, 1992*

iii. *Streeter, V. L. ,Wylie, E. Benjamin , Fluid Mechanics, McGraw-Hill, London, 199*

Course outcome (*Fluid Mechanics – II)*

No. of course Outcome	Name of the course outcome
UME04C09.1	Understand the advanced fluid mechanics and its applications.
UME04C09.2	Develop the methods and techniques for analyzing and specifying the model and prototype.
UME04C09.3	Know about different kinds of hydrostatics forces on submerges bodies.
UME04C09.4	Know the relation between thermodynamics and advanced fluid mechanics.
UME04C09.5	Gain the engineering knowledge to solve the real-world problems.
UME04C09.6	Understand the most complex problems at various flow and fluid properties.

Mapping of course outcomes:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
UME04C09	**Fluid Mechanics-II**													
UME04C09.1	3	-	2	-	3	-	-	-	-	-	-	-	2	3
UME04C09.2	-	3	2	-	-	-	-	-	-	-	-	-	3	3
UME04C09.3	-	2	-	-	-	-	-	-	-	-	-	-	-	2
UME04C09.4	3	-	-	-	-	-	2	-	2	-	-	-	2	2
UME04C09.5	-	3	3	3	-	-	-	-	-	-	3	2	-	3
UME04C09.6	-	-	3	3	-	-	-	-	-	-	-	3	2	2
Average	3	2.7	2.5	3	3	-	2	-	2	-	3	2.5	2.3	2.5

MANUFACTURING TECHNOLOGY - I

Course		Credit-03			Marks(Weightage)		
Name	Manufacturing Technology - I	L	T	P	Mid	End	Internal
Code	**UME04B16**	3	0	0	30	50	20

Types of production & production processes, product configuration & Manufacturing requirements. Casting of ferrous & Non-ferrous metals including Die Casting, Loam moulding, Investment casting, Centrifugal casting, Continuous casting.

Pattern Making & Moulding: - Types of pattern, Pattern material, Pattern making tools and allowances, Moulding sands and their properties, Sand Testing.

Joining Methods : - Welding, Brazing & Soldering, welding processes like fusion welding, electric arc welding, gas welding, Resistance welding, TIG, MIG, Submerged arc welding, friction welding,, Newer welding methods.

Mechanical working of metals:- Hot working, Hot rolling, Piercing or seamless tubing, Drawing, Deep drawing, Hot spinning, Extrusion. Cold working, cold rolling, cold drawing, cold bending, cold spinning, cold extrusion, squeezing, peening, sizing, coining and hobbing, Electro hydraulic forming, Metallurgical aspects.

Smithing and Forging :- Heating devices, forging temperatures, hand tools and appliances, smith forging operations, forging process, hand forging, power forging, impression die forging, drop hammers, press forging, machine or upset forging, high energy rate forging (HERF), Fibrous structure of forging: grain flow, defects in forging, advantages & limitations.

Powder Metallurgy :- Process description, manufacture of metal powders, Blending of powders, compacting, pre-sintering, sintering, secondary operations, isostatic pressing, metal injection moulding, products of powder metallurgy, advantages of the process, disadvantages & limitations.

Other Methods :- Explosive fabrication, magnetic pulse forming, electroforming, hard facing, sheet metal work, computers in metal forming technology, CAD/CAM technology.

Text Books:

- *Materials and processes in manufacturing by E. Paul, De Garmo*
- *Manufacturing Technology, Volume-1, by P. N. Rao*

Reference Books:

- *Mechanical Metallurgy by Dieter, George E.*
- *A Ghosh and A K Mallik, Manufacturing Science, Wiley Eastern, 1986.*
- *Production Technology by Jain, R.K.*

Course outcome (*Manufacturing Technology – I)*

No of CO	Name of the course outcome
UME04B16.1	Acquire knowledge about the various tools, equipment, machinery and operations required for these basic manufacturing processes.
UME04B16.2	Know the various basic Manufacturing processes used in industry for converting raw materials into finished products.
UME04B16.3	Know the principles and science of various basic manufacturing processes
UME04B16.4	Select appropriate Manufacturing Processing to manufacture any component.
UME04B16.5	Interpret foundry practices like pattern making, mold making, Core making and Inspection of defects.
UME04B16.6	Select appropriate Joining Processes to join Work piece. Implement the Knowledge of gained subject in Industry.

Mapping of course outcomes:

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME04B16	**Manufacturing Technology - I**													
UME04B16.1	**3**	**2**	**2**	**-**	**-**	**-**	**1**	**-**	**3**	**2**	**-**	**3**	3	-
UME04B16.2	**3**	**2**	**2**	**-**	**1**	**-**	**1**	**-**	**3**	**2**	**-**	**3**	3	-
UME04B16.3	**3**	**2**	**2**	**-**	**1**	**-**	**1**	**-**	**3**	**2**	**-**	**3**	3	2
UME04B16.4	**3**	**2**	**2**	**-**	**-**	**-**	**1**	**-**	**3**	**2**	**-**	**3**	3	-
UME04B16.5	**3**	**2**	**2**	**-**	**1**	**-**	**1**	**-**	**3**	**2**	**-**	**3**	3	-
UME04B16.6	**3**	**2**	**2**	**-**	**1**	**-**	**1**	**-**	**3**	**2**	**-**	**3**	3	3

NUMERICAL METHODS & COMPUTER PROGRAMMING

Course		Credit-03			Marks(Weightage)		
Name	Numerical Methods & Computer Programming	L	T	P	Mid	End	Internal
Code	**UME04B15**	3	0	0	30	50	20

Unit-1: Approximation and round off errors; Truncation errors and Taylor series.
Determination of roots of polynomials and transcendental equations by Newton- Raphson, Secant and Barstow‟s method.
Unit-2: Solution of linear simultaneous algebraic equations by Gauss elimination and Gauss-Siedel iteration methods.
Unit-3: Curve fitting; Linear and non-linear regression analysis.
Finite Difference Method: Backward; Forward and central difference relations and their uses in numerical differentiation and integration; Application of different relations in the solution of partial differential equations, Introduction of Finite Element Method.
Unit-4: Numerical solution of ordinary differential equations by Euler; modified Euler, Runge-Kutta and predictor-corrector method.
Unit-5: Introduction to computer programming in C and C++ languages: Arithmetic expressions; Simple programs
Example of some C programs; Dissection of the program line by line; Concept of variables; Program statement and function calls from the library.
Unit-6: C data types: int, char, float etc.
C expressions, arithmetic operations, relational and logic operations.
Unit-7: C assignment statements, extension of assignment to the operation; C primitive input output using getchar and putchar; exposure to the scanf and printf function. C statements; conditional execution using if, else etc.(Optionally switch and break statements should be mentioned)
Unit-8: Concepts of loop; Example of loops in C using for-while and do-while(Optionally continue may be mentioned) One dimensional arrays and example of iterative programs using arrays; 2-d arrays; Use in matrix computations.
Unit-9: Concept of sub-programming; Functions; Example of functions; Argument passing mainly for the simple variables. Pointers, relationship between arrays and pointers; Argument passing using pointers.
Array of pointer; Passing arrays as arguments. Strings and C string library.
Unit-10: Structure and unions; Defining C structure; Passing structure as arguments (Program examples) File I/O; Use of fopen, fsanf and fprintf routines.

Text Book:

Mollah S.A, "Numerical Analysis and Computational Procedure" , Books and Allied (P) ltd., Kolkata, 1 st print, 1996

References Book:

Kandasamy, P., Thilagavathy, K., and Gunavathy, S., "Numerical Methods", S.Chand

Course Outcome (NACP)

No. of Course Outcome	Course outcome
UME04B15.1	To attain ability to apply knowledge of mathematics, science, and engineering.
UME04B15.2	To attain an ability to design and conduct experiments, as well as to analyze and interpret data.
UME04B15.3	To attain an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
UME04B15.4	To attain an ability to identify, formulate, and solve engineering problems
UME04B15.5	To attain an understanding of professional and ethical responsibility
UME04B15.6	To attain an ability to use the techniques, skills, and modern Engineering tools necessary for engineering practice.

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME04B15	**Numerical Methods & Computer Programming**													
UME04B15.1	3	2	2	2	-	2	2	2	-	3	-	2	-	-
UME04B15.2	2	2	2	2	-	2	2	2	-	2	2	2	2	1
UME04B15.3	2	2	3	2	-	2	2	2	-	2	-	2	3	1
UME04B15.4	3	3	2	3	-	3	2	3	-	3	-	3	1	2
UME04B15.5	2	2	3	2	-	2	3	2	-	2	2	2	2	2
UME04B15.6	2	2	2	2	-	3	2	2	-	3	2	2	3	2

DESIGN OF MACHINE ELEMENTS - I

Course		Credit-03			Marks(Weightage)		
Name	Design of Machine Elements - I	L	T	P	Mid	End	Internal
Code	**UME04B17**	3	0	0	30	50	20

Steady Stresses in Machine Members

Fundamentals of Machine Design – Design philosophy, various considerations in machine design .Design Procedure, Common engineering materials, I.S.I. specification on steels.
Stresses in machine elements: Types of Simple stresses, Stress strain relationship, Factor of safety.
Design for Strength: Design for static loading, Theories of failures, Stress Concentration Factors.

Design of Shafts

Shaft and its design based on strength, Design of shaft for variable load and based on stiffness, combined bending and twisting moment.

Design of Fasteners and Couplings

Fasteners: Types of fasteners, Design of Cotter and knuckle joint, Design of Key.
Coupling: Types, use**,** Design procedure, working principle of rigid and flexible rubber-bushed couplings.

Design of Permanent Joints

Rivets, types and use of rivet joint, types and efficiency, design procedure, welded joint. Bolted joint.

Design of Power Screws and springs

Power Screws: Power Screw, drives and their efficiency, Design of power screws
Springs: Introduction to Design of Helical Springs

Text Books:

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

Reference Books:

iv. *Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill Book Co. (Schaum's Outline), 2010*
v. *P.C. Gope, "Machine Design – Fundamental and Application", PHI learning private ltd, New Delhi, 2012*
vi. *R.B. Patel, "Design of Machine Elements", MacMillan Publishers India P Ltd., Tech -Max Educational resources, 2011.*
vii. *Khurmi, R.S., Gupta, J.K., "A Text Book of Machine Design" S. Chand Publishing, 2010*

Course outcome *(Design of Machine Elements – I)*

CO-No.	**Course outcome**
UME04B17.1	Analyze the strength of the components using failure theories based on fundamentals of design.
UME04B17.2	Design shaft under static loading and variable loading conditions.
UME04B17.3	Formulate and design several fasteners and couplings
UME04B17.4	Design mechanical permanent joints.
UME04B17.5	Design different transmission and mechanical energy storage systems.
UME04B17.6	Solve real life problems related to aspects of design and analyses of various mechanical equipment and systems.

Mapping of course outcomes:

POs	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
UME04B17	**Design of Machine Elements - I**													
UME04B17.1	-	3	-	-	-	-	-	-	-	-	-	-	-	3
UME04B17.2	-	-	3	-	-	-	-	-	-	-	-	-	-	3
UME04B17.3	-	-	3	-	-	-	-	-	-	-	-	-	-	3
UME04B17.4	-	-	3	-	-	-	-	-	-	-	-	-	-	3
UME04B17.5	-	-	3	-	-	-	-	-	-	-	-	-	-	3
UME04B17.6	-	3	3	-	-	-	-	-	-	-	-	-	-	3

PRIMARY MANUFACTURING PROCESSES LABORATORY

Course		Credit-01			Marks(Weightage)		
Name	Primary Manufacturing Processes Laboratory	L	T	P	Mid	End	Internal
Code	**UME04P18**	0	0	2	00	100	00

1) **MACHINE SHOP:**
   1. Introduction to the machine tools (lathe, shaper, planer, drilling, etc.)
   2. Introduction to cutting tool, properties of different materials used in cutting Tool, Method of metal cutting.
2) **FITTING SHOP:**
   1. Introduction, use of precision tools & jobs
   2. To make a fitting as per the job assigned.
3) **SHEET METAL SHOP:**
   1. Introduction, sheet metal tools
   2. Sheet metal operation - cutting, notching Soldering, brazing
   3. Job: (a) To make a square tin
      i. (b) To make a round tin with lid
      ii. (c) To make "T" pipe joint/ waste paper basket/measuring jar etc.
4) **FORGING SHOP**:
   1. Introduction, tools & equipment
   2. Hand forging & machine forging
   3. Forging operation -
   4. Defects in forgings.
5) **MOULDING SHOP:**
   1. Introduction of moulding tools & equipment
   2. Moulding making
   3. Melting of metals -
   4. Advantages of casting & casting defects
   5. Casting techniques
   6. Job: (a) to prepare a sand mould, using the single piece pattern
      i. (b) Spilt pattern/ loose piece pattern/pattern with core etc.
6) **WELDING SHOP:**
   1. Introduction of welding equipment and safety measures
   2. Different joint of welding& their use
   3. Welding process
   4. Different types of electrode, fluxes & their uses.
   5. Practice on setting welding equipment, gas welding
   6. & cutting practice, preparation of simple structures

Text Books:

i. *Materials and processes in manufacturing by E. Paul, De Garmo*
ii. *Manufacturing Technology, Volume-1, by P. N. Rao*

Reference Books:

i. *A Ghosh and A K Mallik, Manufacturing Science, Wiley Eastern, 1986.*
ii. *Production Technology by Jain, R.K.*

Course outcome (*Primary Manufacturing Processes Laboratory)*

No. of Course Outcome	Name of the Course outcome
UME03P11.1	Distinguish between tools of various trades such as carpentry, fitting, sheet metal, welding, foundry and machine tools.
UME03P11.2	Comprehend the safety measures required to be taken while using the tools.
UME03P11.3	Select the appropriate tools required for specific operation.
UME03P11.4	To describe the use of carpentry & fitting joints sheet metal models & manufacturing processes.
UME03P11.5	Preparation of different types of welding joints.
UME03P11.6	Study and practice on machine tools and their operations.

Mapping of course outcomes:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
UME03P11	**Primary Manufacturing Processes Lab**													
UME03P11.1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
UME03P11.2	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**
UME03P11.3	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
UME03P11.4	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**
UME03P11.5	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**-**
UME03P11.6	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**2**	**-**
Average	**3**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**-**

COMPUTER PROGRAMMING LABORATORY

Course		Credit-01			Marks(Weightage)		
Name	Computer programming Laboratory	L	T	P	Mid	End	Internal
Code	**UME04P19**	0	0	2	00	100	00

Experiment-1: Revision and Dissection of a „C" program.

Experiment-2: Programming on Arrays, Loops and Matrixes.

Experiment-3: Programming for different Root Finding Methods.

Experiment-4: Programming on Curve Fitting (Function and Approximation.)

Experiment-5: Programming on Numerical Interpolation.

Experiment-6: Numerical Programming using Differentiation and Integration.

Text Books:

i. *Kandasamy, P. Thilagavathy, K., and Gunavathy, S., **"Numerical Methods"**, S. Chand Publications.*

Reference Books:

viii. *NACP Laboratory Manual of ME Department, NIT Agartala*

ix. *Other Online/ Offline Resources available.*

Course outcome (*Computer programming Laboratory)*

No. of COs	Name of the Course outcome
UME04P19.1	Implement the knowledge of coding to solve practical problems using numerical methods with the help of computer.
UME04P19.2	Solve an algebraic or transcendental equation using an appropriate numerical method with C codes
UME04P19.3	Approximate a function using an appropriate numerical method with C codes
UME04P19.4	Solve a linear system of equations &ANY differential equation using an appropriate numerical method using C codes
UME04P19.5	Evaluate a derivative at a value using an appropriate numerical method using C codes.
UME04P19.6	Solve numerical root finding methods, calculate a definite integral and solve curve fitting problems using an appropriate numerical method using C codes.

Mapping of course outcomes:

POs	**PO -1**	**PO -2**	**PO -3**	**PO -4**	**PO -5**	**PO -6**	**PO -7**	**PO -8**	**PO -9**	**PO -10**	**PO -11**	**PO -12**	**PSO-1**	**PSO -2**
UME04P19	**Computer programming Laboratory**													
UME04P19.1	3	3	-	-	3	-	-	-	-	-	-	-	-	-
UME04P19.2	-	3	3	-	-	-	-	-	-	-	-	-	-	2
UME04P19.3	-	3	3	-	3	-	-	-	-	-	-	-	-	-
UME04P19.4	-	3	3	-	3	-	-	-	-	-	-	-	-	2
UME04P19.5	3	3	3	-	-	-	-	-	-	-	-	-	-	-
UME04P19.6	-	-	3	3	3	-	-	-	-	-	-	-	-	2
Avg.	1	2.5	2.5	0.5	2	-	-	-	-	-	-	-	-	1

FLUID MECHANICS LABORATORY

Course		Credit-01			Marks(Weightage)		
Name	Fluid Mechanics Laboratory	L	T	P	Mid	End	Internal
Code	**UME04P20**	0	0	2	00	100	00

Experiment-1: To study and verify the Bernoulli‟s equation.

Experiment-2: To determine the co efficient of friction in pipes.

Experiment-3: To determine minor losses due to sudden contraction.

Experiment-4: To determine minor losses due to sudden enlargement.

Experiment-5: To determine minor losses due to bend in pipes.

Experiment-6: To determine the co efficient of discharge through rectangular notch.

Experiment-7: To determine co-efficient of discharge through triangular notch.

Experiment-8: To determine co-efficient of discharge through trapezoidal notch.

Text Books:

iii. *Cengel, Y.A., "Fluid Mechanics: Fundamentals & Applications (SI Units)", Tata McGraw-Hill Publications.*

iv. *Bansal, R.K., "Fluid Mechanics & Hydraulic Machines", Laxmi Publications.*

Reference:

x. *Laboratory Manual from ME Department, NIT Agartala*

xi. *S.K. Som, G. Biswas, S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines.*

Course outcome *(Fluid Mechanics Laboratory)*

No. of COs	Name of the course outcome
UME04P20.1	To understand the basic measurement units and different principles and governing equation of fluid flow.
UME04P20.2	To know about various fluid flow measuring devices like venturimeter, pitot tube and notches or weir etc.
UME04P20.3	Student will be able to gain basic knowledge from Fluid Dynamics experimentation.
UME04P20.4	To understand about various components of hydro-electric power station.
UME04P20.5	To know the various flow pattern and study their characteristics.
UME04P20.6	To design flow measuring device of various components.

Mapping of course outcomes:

POs	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO -1	PSO -2
UME04P20	**Fluid Mechanics Laboratory**													
UME04P20.1	2	3	-	-	-	-	-	-	-	-	-	-	-	2
UME04P20.2	-	3	-	-	-	-	-	-	-	-	-	-	2	3
UME04P20.3	3	-	-	-	-	-	-	-	-	-	-	-	3	2
UME04P20.4	-	-	-	-	-	2	-	-	-	-	3	-	-	2
UME04P20.5	-	2	-	-	-	-	-	-		-	-	-	2	2
UME04P20.6	-	2	-	-	-	-	-	-	-	-	-	-	2	-
Avg.	2.5	2.5	-	-	-	2	-	-	-	-	3	-	2.3	2.2

DESIGN OF MACHINE ELEMENTS LABORATORY

Course		Credit-01			Marks(Weightage)		
Name	Design of Machine Elements Laboratory	L	T	P	Mid	End	Internal
Code	**UME04P21**	0	0	2	00	100	00

1. Introduction of the Course:

Students can build up skills to utilize the Sophisticated Tools and Technologies to manage and solve the real-world problems of Design, Analysis and Manufacturing.

2. Course Objectives:

1. To impart students with the necessary skills for Modeling and Assembling of machine components using CAD tool (Solidworks) along-with theoretical calculations.
2. To impart students with the necessary skills for drafting of Model and Assemblies of machine components using CAD tool (Solidworks).

(The emphasis should be more on conceptual application and calculation rather than the modeling itself. The Solidworks CAD/CAM/CAE software is being chosen mainly because of the availability of license.)

3. Course Contents:

Ex. 1: Introduction to CAD/CAM/CAE/User Interfaces and contemporary Industrial Standards. Concept of Parametric and Non- Parametric Modeling.

Ex.2: Concept and importance of Fully Constrained Modeling approach and 2D Sketch.

Ex. 3: Development of 3D parametric models using basic Feature Commands.
Ex. 4: Utilization of Advanced Features for building up Complex shapes of modeling.
Ex. 5: Concept of Assembly and utilization of Bottom-up Assembly Method.
Ex. 6: Initiate Drafting and prepare sheet as per ISO and BIS standards.
Ex. 7. Placing of Standard and Projected views of Models and Assemblies.
Ex. 8. Apply required Annotations in the views.

Text Books:

1. "Solidworks for Engineers and Designers" – By Prof. Sham Tickoo.
2. "A Textbook of Machine Design" - By R.S. Khurmi.

Reference Books:

i. DOME Laboratory Manual of ME Department, NIT Agartala
ii. Other Online/ Offline Resources available.

Course Outcome (*Design of Machine Elements Laboratory)*

No. of COs	Name of the Course Outcome
CO1	Ability to interpret ISO and BIS standards for Design and Drafting.
CO2	Ability to construct accurate 2D geometry as well as complex 3D shapes by Solid and Surface modeling techniques.
CO3	Ability to produce assembly of models and sub- assemblies in industry standard form.
CO4	Ability to recognize standard drawing/ drafting requirements for distribution at different facilities.
CO5	Ability to create 2D representations of 3D objects as plain view, elevations and sections.
CO6	Ability to create assembly drawing/ plans in industry standard form and produce plotted hardcopies ready for distribution.

Mapping of course outcomes:

POs	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO 1	3	3	2	-	2	2	2	2	2	2	2	2	3	2
CO 2	2	3	3	-	3	2	2	2	2	2	2	2	3	3
CO 3	2	3	3	-	3	2	2	2	2	2	2	2	3	3
CO 4	2	3	3	3	3	2	2	2	2	2	2	2	3	3
CO 5	-	3	3	3	3	2	2	2	2	2	2	2	3	3
CO 6	-	3	3	3	3	2	2	2	2	2	2	2	3	3
Avg.	1.5	3	2.83	1.5	2.83	2	2	2	2	2	2	2	3	2.83

SOFT SKILL DEVELOPMENT

Course		Credit			Marks(Weightage)		
Name	Soft Skill Development	L	T	P	Mid	End	Internal
Code	**UME04P22**	0	0	2	00	100	00

Development of Competency and Proficiency in English/Vernacular communication:
Oral/spoken communication skill & testing – voice and accent, voice clarity, voice modulation & intonation, word stress. Objectiveness in interpersonal and group argument. The 5 W-1H & 7 Cs for effective communication. Study of different pictorial expression of non-verbal communication and its analysis.

Concepts of Effective Communication:
Components of Effective Communication- Conviction, confidence & enthusiasm, listening virtues and modes, Communication Process & Handling them- KISS mode (keep it short & simple) in communication – composing effective messages. Awareness of Barriers to communication- Int. & Ext Barriers: - Motivation, Perception, Power of speech. Non-Verbal Communication – its importance and Nuances: - Facial Expression, Posture, Gesture, eye contact, Appearance.

Self & Time Management- Identifying one"s strength and weakness, Planning & Goal setting, managing self –emotions, ego, pride. Attendance, Discipline & Punctuality, Act in time on commitment, Quality/Productive time. personal and official documentation principles.

Presentation Skills- Preparation & introduction, Evaluation / feedback methods; Summarization / Conclusion.

Team Building / Coordination Skills : Team Building games, how to identify team players, team task / role play. Ginnetts Teams model, Team Effectiveness.

Group Dynamics - Group Theories, Group Norms, Group Roles, Group Cohesion Group Thinking, Group Development Stages, Sociometry and Group Decision Making.

Text Books:

i. *SOFT SKILL, 2015, Career Development Centre, Green Pearl Publications.*

Reference Books:

i. *Covey Sean, Seven Habits of Highly Effective Teens, New York, Fireside Publishers, 1998.*
ii. *Carnegie Dale, How to win Friends and Influence People, New York: Simon & Schuster, 1998.*
iii. *Thomas A Harris, I am ok, You are ok , New York-Harper and Row, 1972*

Daniel Coleman, Emotional Intelligence, Bantam Book, 2006

Course Outcome (*Soft Skill Development)*

No of C0s	Course outcome
UME04P22.1	Competency and Proficiency in all facets of professional communications
UME04P22.2	Self & Time Management skills for professional acclimatization
UME04P22.3	Empowerment with Team Building and Coordination Skills
UME04P22.4	Enabling Students to become more effective individuals through goal/target setting, by means of self- motivation and practicing creative thinking.
UME04P22.5	Function efficiently and effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality.
UME04P22.6	Enable to write precise briefs or reports and technical documents and enhance presentation skills

Mapping of course outcomes:

POs	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
UME04P22	**Soft Skill Development**													
UME04P22.1	-	-	2	-	-	-	-	-	-	3	-	3	1	1
UME04P22.2	-	-	2	-	-	-	-	-	2	-	2	2	2	2
UME04P22.3	-	1	2	-	-	-	2	-	3	2	-	-	1	1
UME04P22.4	-	2	-	2	2	2	2	1	2	2	2	-	2	2
UME04P22.5	2	2	2	1	-	2	-	2	3	-	2	-	1	2
UME04P22.6	-	-	-	-	2	-	-	-	-	2	-	-	2	-

Mechanical Engineering Department

Fifth Semester (Syllabus)

FIFTH SEMESTER

CODE	SUBJECT NAME	L-T-P	CREDIT
UME05C01	Heat & Mass Transfer	3-0-0	03
UME05C02	Design of Machine Elements-II	3-0-0	03
UME05C03	Manufacturing Technology - II	3-0-0	03
UME05C04	Fluid Machinery	3-0-0	03
UME05C06	Vibration and Control	3-0-0	03
UME05C05	Mechanical Measurement & Instrumentation	3-0-0	03
LABORATORIES			
UME05P30	ME Lab - V (Vibration Laboratory)	0-0-2	01
UME05P31	ME Lab - V (Machine Design Laboratory)	0-0-2	01
UME05P32	ME Lab - VI (Mechanical Measurement & Instrumentation Laboratory)	0-0-2	01
UME05P33	ME Lab - VI (Machining & Machine Tool Laboratory)	0-0-2	01
UME05P28	ME Lab - VII (Heat & Mass Transfer Lab)	0-0-2	01
UME05P29	ME Lab - VII (Fluid Machinery Laboratory)	0-0-2	01
UME05P27	Minor Project -I	0-0-3	01
	TOTAL	**18-0-15**	**25**

HEAT & MASS TRANSFER

Course		Credit-03			Marks(Weightage)		
Name	Heat & Mass Transfer	L	T	P	Mid	End	Internal
Code	**UME05C01**	3	0	0	30	50	20

Introduction
Various methods of heat transfer, Fourier's, Newton's and Stefan Boltzman's Law. Combined modes ofheat transfer, thermal diffusivity, overall heat transfer coefficient.

Conduction
The thermal conductivity of solids, liquids and gases, factor influencing conductivity, measurement. The general differential equation of conduction. One dimensional steady state conduction, linear heat flow through a plane and composite wall, tube and sphere, critical thickness of insulation. Effect of variable thermal conductivity. Conduction with heat sources, heat transfer from rods heated at one both ends. Heat transfer from fins of uniform cross-section. Errors of measurement of temperature in thermometer wells.

Convection (Forced)
Introduction, laminar boundary layer equations on a flat plate and in a tube, laminar forced convection on a flat plate and in a tube, simple Reynold's analogy. Dimensional analysis of forced convection, empirical relationship for forced convection.

Convection (Natural)
Dimensional analysis of natural convection; empirical relationship for natural convection. Convection with phase change. Description of condensing flow. A theoretical model of condensing flow. Boiling heattransfer, Empirical relationships for convection with phase change.

Heat Exchangers:
Different types of heat exchangers; Determination of heat exchanger performance, Heat exchangertransfer units, Analysis restricted to parallel and counter flow heat exchanger. Effectiveness, NTU.

Thermal Radiation
Introduction, absorption and reflection of radiant energy, Emission, Radiosity and irradiation, Black and nonblack bodies, Krichoff's law; intensity of radiation, radiation exchange between black surface, geometric configuration factor, grey body relation exchange between surfaces of unit configurationfactors. Grey body relation exchange between surfaces of unit configuration factors. Electrical analogy to simple problems. Nonluminous gas radiation. Errors in temperature measurement due to radiation.

Introduction to Mass Transfer
Mass and mole concentrations, molecular diffusion, eddy diffusion, Molecular diffusion from an Evaporating fluid surface, Introduction to mass transfer in laminar and turbulent convection, Combinedheat and mass transfer, the wet and dry bulb thermometer.

Text Books:

1. *Incropera, F.P. and Dewitt, D.P., "Fundamentals of Heat and Mass Transfer", 5thed., JohnWiley,2002.*

Reference Books:

1. *Holman, J.P., "Heat Transfer", 9th ed., McGraw-Hill, 2004.*
2. *Ozisik, M.N., "Heat Transfer - A Basic Approach", McGraw-Hill, 1985.*
3. *Cengel, Y.A., "Heat Transfer - A Practical Approach", McGraw-Hill, 1998.*

Rajput, R.K., "Heat & Mass Transfer" Khanna Publishers

Course Outcome (*Heat & Mass Transfer)*

No of COs	Course Outcome
U.2ME05C1.1	Understand and explain the basic modes of heat and mass transfer.
UM.2E05C01.2	Apply principles of conduction heat transfer to compute transfer coefficients, effectiveness, efficiency, etc.
UM.4E05C01.3	Compare and distinguish physical mechanism and performances of Forced and Natural Convection heat transfer processes.
UME05C01.4	Analyze working of various heat transfer equipment
UME05C01.5	Design and analyze radiation heat transfer process and equipment.
UME05C01.6	Investigate and explore problems on Mass transfer processes.

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME05C01	**Heat & Mass Transfer**													
U.2ME05C1.1	3	2	1	3	3	3	-	-	1	1	-	1	1	1
UM.2E05C01.2	3	3	2	2	1	2	1	1	2	1	-	1	2	1
UM.4E05C01.3	3	3	2	2	1	1	1	1	2	1	-	1	2	1
UME05C01.4	3	3	3	3	1	1	1	1	2	1	-	1	2	2
UME05C01.5	2	3	2	3	1	2	1	1	2	1	-	1	2	1
UME05C01.6	2	2	1	2	1	1	1	1	1	1	-	1	1	1

DESIGN OF MACHINE ELEMENTS-II

Course		Credit-03			Marks(Weightage)		
Name	Design of Machine Elements-II	L	T	P	Mid	End	Internal
Code	**UME05C02**	3	0	0	30	50	20

Fatigue consideration in design: Variable load- basic concept, Patterns of load or stress variations, S-N curve, fatigue strength and endurance limit, Factors influencing fatigue, Effect of stress concentration and fatigue stress concentration definition and its estimation from geometric stress concentration factor, Goodman and Soderberg's relations, design for infinite life and finite life, Methods for design of members under combined (steady and variable) loading conditions, Worked out examples on fatigue design problems.

Design of gear tooth Gears: Types and application and gear terminology, Analysis of forces on spur, and helical gears, Bending and contact stress in gear tooth, Lewisequation for design, Dynamic loading and wear-Buckingham equations for design, Force analysis on bevel and worm gears, Design approach for bevel gears- equivalent tooth, Design of fixed ratio gear box- general design procedure.

Design of sliding and journal bearings: Types of lubrication- hydro dynamic, hydro static and EHD lubrication, Petroff's equation and the bearing characteristic number, Lubrication regimes- boundary and film lubrication, Hydro dynamic bearings- Pressure distribution-eccentricity and minimum film thickness, Reynold's equation, Heat generation and thermal equilibrium.

Design/analysis of Brakes, clutches and fly wheels: Brakes and clutches -need and functioning, Plate clutches- design for uniform pressure and wear, brake-design/analysis, Flywheel- Coefficient of fluctuation of speeds, fluctuation of energy, energy stored in flywheel. Stresses on flywheel ring, arms, Design of shafts, hub and Key. Design of flywheel.

Text Books:

i. *Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016*

Reference Books:

i. *Shigley, J.E., Mechanical Engineering Design, 5th ed., McGraw-Hill, 1989.*
ii. *Bhandari, V.B., "Introduction to Machine Design" Tata McGraw-Hill*
iii. *Khurmi, R.S., Gupta, J.K., " A Text book of Machine Design" S. Chand Publication.*

Course Outcome *(Design of Machine Elements-II)*

CO-No.	Course Outcome
UME05C02.1	Understand various fundamentals of fatigue consideration in various machine elements.
UME05C02.2	Understand the basics of Goodman and Soderberg's relations.
UME05C02.3	Understand the design procedures involved in gear teeth using various standard equations.
UME05C02.4	Analyze the forces imparted on the tooth of different gears.
UME05C02.5	Design bearings by considering the basics ofhydro-static and hydro dynamic lubrication.
UME05C02.6	Use the standard design procedures of brakes, clutches and flywheels.

Mapping of course outcomes

POs	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
UME05C02	**Design of Machine Elements-II**													
UME05C02.1	**2**	**2**	-	-	2	-	-	-	-	-	-	2	2	2
UME05C02.2	2	2	**3**	-	2	-	-	-	-	-	-	2	2	2
UME05C02.3	**3**	**3**	**3**	-	-	-	-	-	-	-	-	2	3	2
UME05C02.4	**3**	-	**3**	-	-	-	-	-	-	-	-	2	2	3
UME05C02.5	2	**3**	**3**	-	2	-	-	-	-	-	-	2	2	3
UME05C02.6	3	**3**	**3**	-	-	-	-	-	-	-	-	**2**	2	3

MANUFACTURING TECHNOLOGY - II

Course		Credit-03			Marks(Weightage)		
Name	Manufacturing Technology - II	L	T	P	Mid	End	Internal
Code	**UME05C03**	3	0	0	30	50	20

Unit 1: Tool geometry, mechanism of chip formation. Mechanics of machining. Cutting Temperature: causes, effects, estimation, measurement and control. Cutting fluid applications. Role of geometrical and process parameters and cutting fluid on machinability.

Unit 2: Failure modes, wear and life of cutting tools. Cutting tool materials. Role of geometrical and process parameters and cutting fluid on machinability.

Unit 3: Mechanics of grinding. Economy of machining and grinding. Special techniques and advanced technology of machining and grinding. Concept and definition of machining and machine tools. History of development of machine tools.

Unit 4: Concept of producing geometrical surfaces by generatrix and directrix. Kinematic systems and structures of conventional machine tools. Electromechanical and hydraulic drives and control of machine tools. Machine tool automation. Classification and specification of machine tools. Construction, working principle and application of various semi-automatic and automatic lathes.

Unit 5: Flexible automation: need, principle and advantages. Basic constructional features, working principle and application of CNC machine tools, machining centre and FMS.

Text Books:

i. *Machining and Machine Tools by A.B.Chattopadhyay, Wiley.*
ii. *Manufacturing Technology (Manufacturing Processes) by R.K Rjput, Laxmi Publication (P)Ltd.*
iii. *Materials and processes in manufacturing by E. Paul, De Garmo and others*
iv. *Manufacturing Technology, Volume-2, by P. N. Rao*

HMT Production Technology, Tata McGraw-Hills Publishing Co. Limited

Reference Books:

i. *Workshop Technology, Vol - II by Chapman, W.A.J., , Oxford & IBH Publishing Co. Ltd.*
ii. *Jain R.K., Production Technology, Khanna Publishers, 2001*
iii. *Chapman, W.A.J., Workshop Technology,Vol - II, Oxford & IBH Publishing Co. Ltd., 1986.*
iv. *Manufacturing Process-II: NPTEL*

Course Outcome (*Manufacturing Technology – II)*

No. of Course Outcome	Course Outcome
UME05C03.1	Understand the basic concept of machining, tool geometry, mechanism of chip formation and the factors affecting machining process.
UME05C03.2	Select cutting fluids, tool materials and coatings to control tool wear and temperature.
UME05C03.3	Understand the mechanics of grinding, economy of machining and grinding, special techniques and advanced technology of machining and grinding.
UME05C03.4	Identify basic parts and operations, kinematic systems and structures of conventional machine tools.
UME05C03.5	Understand the electromechanical, hydraulic drives and control of machine tools, machine tool automation
UME05C03.6	Understand flexible automation and its need, working principle and application of CNC machine tools and FMS.

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME05C03	Manufacturing Technology - II													
UME05C03.1	3	2	2	-	-	-	-	-	-	2	-	3	3	3
UME05C03.2	3	2	2	-	-	-	-	-	-	2	-	3	3	3
UME05C03.3	3	2	2	-	-	-	-	-	2	2	-	3	2	2
UME05C03.4	3	2	2	-	-	-	-	-	-	2	-	-	3	2
UME05C03.5	3	-	2	-	-	-	-	-	-	2	-	-	3	-
UME05C03.6	3	-	2	-	-	-	-	-	2	2	-	-	3	-

FLUID MACHINERY

Course		Credit-03			Marks(Weightage)		
Name	Fluid Machinery	L	T	P	Mid	End	Internal
Code	**UME05C04**	3	0	0	30	50	20

Introduction

Basic Introduction of Fluid Machinery, Turbo machinery and their application, Types of turbo machines: power producing and power absorbing machines, axial and radial flow turbo machines, single stage and multi stage turbo machines, thermal and hydro turbo machines, Hydro Power Generation Fundamentals, Whirling of Fluids. Energy transfer in fluid Machine, Principles of similarity and dimensional analysis.

Turbine Characteristics

Performance characteristics of Kaplan, Francis turbine. Velocity diagrams, Impulse and reaction turbines principles. Positive displacement turbine, Dynamics turbine, Wind turbines, Governing, Selection and Performance of Hydraulic Turbines, Draft Tube and Cavitation, vanned diffuser.

Pump Characteristics

Reciprocating and Rotary pumps, pumps performance curves and matching pump to a piping system, pump cavitation and Net positive suction head, dynamics pumps, centrifugal pumps, Axial pumps, characteristics of centrifugal pump.

Turbine and Pumps Scalling laws

Dimensionless turbine parameters, Turbine specific speed, Dimensional analysis, pump specific speed, affinity law.

Jet Propulsion

Theory of Jet Propulsion, Pulse jet engine, ramjet engine, scram jet engine, Rot dynamic Machines,

Compressor Characteristics

Reciprocating and Rotary compressors, theory and applications

Reference Books:

i. *Introduction to Fluid Mechanics and Fluid Machines by S K Som, GautamBiswas, S Chakraborty*
ii. *Bansal, S.K., "Fluid Mechanics & Hydraulic Machines" Laxmi Publications.*
iii. *Fluid Machinery, by G. S. Sawhney*
iv. *Fluid Machinery (Hydraulic Machines), by Sadhu Singh*
v. *Hydraulic Machines: Fluid Machinery, by R. K. Singal and MridualSingal*
vi. *Fluid Machinery – Kerala, By S Ramachandran, R Devaraj, YvsKarthick.*

Course outcome (*Fluid Machinery)*

No. of Course Outcome	Course Outcome
UME05C04.1	Apply the affinity laws to turbo machinesand give examples of the main applications of turbo machines.
UME05C04.2	Recognize typical designs of turbines.
UME05C04.3	Recognize typical designs of pumps.
UME05C04.4	Carry out the dimensional and scalling analyses of turbomachines.
UME05C04.5	Characterize the jet propulsion
UME05C04.6	Determine the off-design behavior of compressors and relate it to changes in the velocity triangles.

Mapping of course outcomes

POs	**PO -1**	**PO -2**	**PO -3**	**PO -4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
	Fluid Machinery													
UME05C04.1	3	3	2	2	1	1	1	1	1	1	1	1	3	2
UME05C04.2	3	3	2	2	1	1	1	1	1	1	1	1	3	2
UME05C04.3	3	3	2	2	1	1	1	1	1	1	1	1	3	2
UME05C04.4	3	3	2	2	1	1	1	1	1	1	1	1	3	2
UME05C04.5	3	3	2	2	1	1	1	1	1	1	1	1	3	2
UME05C04.6	3	3	2	2	1	1	1	1	1	1	1	1	3	2

VIBRATION AND CONTROL

Course		Credit-03			Marks(Weightage)		
Name	Vibration and Control	L	T	P	Mid	End	Internal
Code	**UME05C06**	3	0	0	30	50	20

Unit 1: Undamped free vibration of single degree of freedom system, damped free vibration, forced vibration of single degree of freedom system, resonance, forced vibration with constant harmonic excitation, forced vibration with rotating and reciprocating unbalance

Unit 2: Forced vibration with excitation of support, forced vibration with coulomb damping& viscous, damping. Determination of equivalent viscous damping from frequency-response curve. Vibration isolation and transmissibility.

Unit 3: Vibration control, Vibration Isolation theory, Isolation theory for harmonic excitation, Practical aspects of vibration analysis, Shock isolation, Dynamic vibration absorbers, Vibration dampers

Unit: 4: Transverse vibration of shafts. Critical speed of shaft.

Unit 5: Torsional vibration- Single rotor, two rotor, and three rotor system. Torsional vibrations of a geared system. Vibration measuring instruments-seiosmometer, accelerometer.

Unit 6: Two degrees of freedom system.

Text Books:

ii. Grover, G.K., "Mechanical Vibrations"

Reference Books:

i. *Rattan, S.S., "Theory of Machine" Tata McGrawHill Publications.*
ii. *Khurmi, R.S., Gupta, J.K., "Theory of Machine" S. Chand.*
iii. *Rao, J.S. and Gupta, K., Introductory Course on Theory and Practice of Mechanical Vibration, New Age International Pvt. Ltd., 1984.*
iv. *Thomson, W.T., Theory of Vibration with Applications, CBS publishers, New Delhi, 1990.*
v. *B.C.Kuo, "Control Theory".*

Course Outcome (*Vibration and Control****)***

No. of Course Outcome	Course outcome
UME05C06.1	**Understanding** of basic importance of Vibration and its analysis in machine parts.
UME05C06.2	**Analysis** of various linear mathematical models for Single DOF Undamped Free Vibratory systems and its relation with the actual mechanical vibratory system.
UME05C06.3	**Obtain** linear mathematical models of Damped Free and forced vibratory systems from real life engineering systems and determine the vibratoryresponses to harmonic, periodic and non-periodic excitation
UME05C06.4	**Investigate** the causes and effect of Transverse and Longitudinal vibrations in Mechanical systems.
UME05C06.5	**Develop** the mathematical model of the two degrees of freedom systems and explain about the working principle of vibration absorber.
UME05C06.6	**Apply the knowledge** to practical engineering problem for better solutions by staying updated with the latest developments

Mapping of course outcomes

COs	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
UME05C06	**Vibration and Control**													
UME05C06.1	**2**	**2**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
UME05C06.2	**2**	**3**	**2**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**
UME05C06.3	**2**	**3**	**2**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**
UME05C06.4	**3**	**3**	**2**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**
UME05C06.5	**3**	**2**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**3**
UME05C06.6	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**3**

MECHANICAL MEASUREMENT & INSTRUMENTATION

Course		Credit-03			Marks(Weightage)		
Name	Mechanical Measurement & Instrumentation	L	T	P	Mid	End	Internal
Code	**UME05C05**	3	0	0	30	50	20

Vibration and Noise measurement: Seismic Instruments, Vibration pick ups and decibel meters

Basics of measurement: Characteristics of measuring instruments, elements of an instrument, calibration of instruments, generalized measuring system and functional elements, static and dynamic performance characteristics of measurement devices, accuracy, Precision, Resolution, Threshold, Sensitivity, Linearity, Hysteresis, Dead Band, Backlash, Drift calibration, and types of error in instruments, statistical analysis of errors., selection of instruments.

Basic Statistical Concepts : Types of Measured Quantities (Discrete and Continuous),Central Tendency of Data, Mode, Median, Arithmetic Mean, Best Estimate of true Value of Data, Measures of Dispersion, Range, Mean Deviation, Variance, Standard Deviation, Normal Distribution, Central Limit, theorem, Significance Test, Method of Least Squares, Graphical representation and Curve Fitting of Data.

Sensors and Transducers: Types of sensors, types of transducers and their characteristics

Signal transmission and processing: Devices and systems. Signal Display & Recording Devices

Measuring Standards: Classification of standards, basic standards used worldwide, airy points for minimum deflection

Speed measurement: various types of Tachometer, Stroboscope, Measurement- of displacement and angular velocity

Measurement of pressure: Gravitational, Directing acting, elastic and indirect type pressure transducers, Measurement of very low pressure

Strain Measurement: Types of strain gauges and their working, strain gauge circuits, Temperature compensation, Strain rosettes

Temperature Measurement: By thermometers, bimetallic, Thermocouples, thermistors and pyrometers.

Measurement of Flow: Obstruction meters, Variable head meters, hot wire and magnetic meters, Ultrasonic flow meters etc

Force measurement & Torque Measurement: Beam balance, various types of load cells, various types of dynamometers, characteristics of dynamo meters, direct power measurement systems.

TEXT BOOK

Sawney R, "Instrumentation and Mechanical Measurements", Dhanpat Rai and Sons, New Delhi (2003)

REFERENCE BOOKS

1. Nagrath and Gopal, "Control System Engineering", New Age Publishers.

2. Measurement and Instrumentation in Engineering, Francis S. Tse and Ivan E. Morse, Marcel Dekker.

3. Instrumentation, Measurement and Analysis – B.C. Nakra and K.K. Chaudhary, TMH

Course outcome (Mechanical Measurement & Instrumentation)

No. of Course Outcome	**Course Outcome**
UME05C05.1	Make accuracy statements for various types of measurements.
UME05C05.2	Differentiate between digital and analog measurements and describe the advantages of each.
UME05C05.3	Use basic electronic test equipment for simple troubleshooting applications.
UME05C05.4	Recognize the importance of pneumatic equipment.
UME05C05.5	Define pressure and understand the operation of pressure transducers.
UME05C05.6	Use pressure transducers to measure level and flow.

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME05C05	**Mechanical Measurement & Instrumentation**													
UME05C05.1	**3**	**-**	**-**	**3**	**-**	**2**	**2**	**2**	**-**	**3**	**-**	**2**	**2**	**1**
UME05C05.2	**2**	**-**	**-**	**3**	**-**	**2**	**2**	**2**	**-**	**2**	**2**	**2**	**3**	**1**
UME05C05.3	**3**	**-**	**-**	**3**	**-**	**2**	**2**	**2**	**-**	**2**	**-**	**2**	**1**	**2**
UME05C05.4	**2**	**-**	**-**	**3**	**-**	**3**	**2**	**3**	**-**	**3**	**-**	**3**	**2**	**2**
UME05C05.5	**3**	**-**	**-**	**3**	**-**	**2**	**3**	**2**	**-**	**2**	**2**	**2**	**3**	**2**
UME05C05.6	**2**	**-**	**-**	**3**	**-**	**3**	**2**	**2**	**-**	**3**	**2**	**2**	**2**	**2**

VIBRATION LABORATORY

Course		Credit-01			Marks(Weightage)		
Name	Vibration Laboratory	L	T	P	Mid	End	Internal
Code	**UME05P30**	0	0	2	00	100	00

***Course contents*:**

Exp-1: To Verify the relation of simple pendulum $T= 2\pi\sqrt{\frac{I}{g}}$

Exp-2: To determine the radius of gyration K of given pendulum

Exp-3: To verify the relation $T= 2\pi\sqrt{\frac{(OG)}{g(OG)}}$

Exp-4: To determine the radius of Gyration of given bar by using Bi-Flier suspension

Exp-5: To study the longitudinal vibration of helical spring and to determine the frequencyor time period of vibration (oscillation) theoretically and actually

Exp-6: To study the damped torsional oscillation and to determine the damping co-efficient (Ct).

Exp-7: To find the natural frequency of undammed free vibration of equivalent spring mass system

Exp-8: To study the force vibration of equivalent spring mass system

Exp-9: To study the torsional vibration (undamped) of single rotor shaft system determinesthe natural frequency of vibration theoretically and experimentally.

Exp-10: To study the free vibration of two rotor system and to determine the natural frequency of vibration theoretically and experimentally

Exp-11: To study the force lateral vibrations of the beam for different damping

Text Books: 1. *Mechanical Vibration, author: G.K Grover.*
2. Mechanical Vibration, author: S.S Rao.
Reference: *Lab Manual*

Course outcome (*Vibration Laboratory)*

No. of COs	Name of the Course Outcome
UME05P30.1	Understanding experimentally the effect of different parameters on the time period of a simple & compound pendulum.
UME05P30.2	Determine moment of inertia of member using experimental methods (calculating time period, bifilar suspension and trifilar suspension).
UME05P30.3	Understanding the effect of damping in mechanical systems responses.
UME05P30.4	Understanding undamped free and forced vibration of equivalent spring mass system. Vibration of Beams.
UME05P30.5	Experimentally understanding the torsional vibration of rotors (single and double rotor system).
UME05P30.6	Understanding and Analysis Damped Vibration, Forced Vibration Experimentally.

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME05P30	Vibration Laboratory													
UME05P30.1	-	3	-	3	-	-	-	-	3	-	-	-	-	3
UME05P30.2	3	3	-	3	-	-	-	-	3	-	-	-	-	3
UME05P30.3	-	3	-	3	-	-	-	-	3	-	-	-	-	3
UME05P30.4	3	3	-	3	-	-	-	-	3	-	-	-	-	3
UME05P30.5	-	3	-	3	-	-	-	-	3	-	-	-	-	3
UME05P30.6	3	3	-	3	-	-	-	-	3	-	-	-	-	3

MACHINE DESIGN LABORATORY

Course		Credit-01			Marks(Weightage)		
Name	Machine Design Laboratory	L	T	P	Mid	End	Internal
Code	**UME05P31**	0	0	2	00	100	00

1. **Introduction of the Course:**
   Computer based 3D modeling and simulation is an essential tool for a lot of industrial problems with diverse applications. In this session students learn and utilize the advanced methods/ techniques available within Mechanical CAD/ CAM/ CAE software.
2. **Course Objectives:**

   I. To impart students with the necessary skills for utilizing Advanced tools for Modeling and Assembly of machine components using CAD tool (in Solidworks).
   II. To impart students with the necessary skills for utilizing Advanced tools for Drafting of Model and Assemblies of machine components using CAD tool (in Solidworks).
   III. To impart students with the necessary skills for utilizing tools Structural Analysis of Parts and Assembly of machine components using CAD/CAE tool (in Solidworks).

   (The Solidworks CAD/CAM/CAE software is being chosen mainly because of the availability of license.)

3. **Course Contents:**

Ex. 1: Equations, Configurations, And Library Features in Solidworks.

Ex. 2: Advanced Modeling Tools in Solidworks.

Ex. 3: Top- Down Assembly method and Sub- Assemblies in Solidworks.
Ex. 4: Working with Blocks in Solidworks.
Ex. 5: Neutral file/ formats in Solidworks.
Ex. 6: Surfacing tools in Solidworks.
Ex. 7. Advanced Drafting in Solidworks.
Ex. 8. Introduction to FEA and Structural Analysis in solidworks.

Text Books:

1. "A Textbook of Machine Design" - By R.S. Khurmi.
2. "Automating SOLIDWORKS Using Macros- A guide to creating VSTA macros using the Visual Basic.NET Language"- SDC publications.
3. "Introduction to Finite Element Analysis using Solidworks" – SDC Publications.

Reference Books:

i. DOME Laboratory of ME Department, NIT Agartala
ii. Other Online/ Offline Resources available.

***Course outcome** (Machine Design Laboratory)*

No. of COs	Name of the Course Outcome
CO1	Ability to induce Automation in the process of Modeling and Assembly
CO2	Ability to create, import and utilize standards parts based on libraries.
CO3	Ability to create advanced assemblies using Reverse Engineering
CO4	Awareness of the Multi-CAD Environment and ability to work with Neutral Formats.
CO5	Understanding the concept of Class-A surfacing and representation of GD&T in Drafting sheet.
CO6	Ability to prepare CAE model and basic Structural Analysis.

Mapping of course outcomes

POs	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO 1	2	3	3	2	3	2	2	2	2	2	2	2	3	3
CO 2	3	3	2	2	3	2	2	2	2	2	2	2	2	3
CO 3	2	3	3	2	3	2	2	2	2	2	2	2	2	3
CO 4	2	3	3	3	3	2	2	2	2	2	2	2	2	3
CO 5	3	3	3	3	3	2	2	2	2	2	2	2	3	3
CO 6	3	3	3	3	3	2	2	2	2	2	2	2	3	3
Avg.	2.5	3	2.83	2.5	3	2	2	2	2	2	2	2	2.5	3

MECHANICAL MEASUREMENT & INSTRUMENTATION LABORATORY

Course		Credit-01			Marks(Weightage)		
Name	Mechanical Measurement & Instrumentation Laboratory	L	T	P	Mid	End	Internal
Code	**UME05P32**	0	0	2	00	100	00

Exp-1: Study and use of vernier calipers

Exp-2: Study and use of vernier height gauge

Exp-3: Study and use of micrometers.

Exp-4: Study of dial indicator and it's used.

Exp-5: Measurement of screw thread

Exp-6: Study & angular measurement using level protector

Exp-7: Study & working of tachometer.

Exp-8: Measurement of angle using sine-bar & slip gauges.

Exp-9: Study and use of limit gauges.

Exp-10: Measurement of spark plug gap using feeler gauges

Exp-11: Measurement of various elements of gear.

Exp-12: Estimate the response times.

1. Mercury – in glass thermometer
2. Thermocouple
3. Electrical resistance thermometer
4. Bio-metallic strip

***Course Outcome** (Mechanical Measurement & Instrumentation Laboratory)*

No. of COs	Name of the Course Outcome
UME05P32.1	Explain the basics of standards of measurement, limits, fits & tolerances industrial applications.
UME05P32.2	Understand and Describe the basic standards of measurements and application
UME05P32.3	Understand the significance of measurement system, errors, transducers, intermediate modifying and terminating devices
UME05P32.4	Understand and Apply the knowledge of geometric dimensioning and Industrial tolerancing
UME05P32.5	Understand how instruments are used for different mechanical measurements
UME05P32.6	Explain various measuring techniques for Pressure, Strain and Temperature with neat sketches

Mapping of course outcomes

POs	**PO -1**	**PO-2**	**PO-3**	**PO-4**	**PO -5**	**PO -6**	**PO -7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO -1**	**PSO -2**
UME05P32	Mechanical Measurement & Instrumentation Laboratory													
UME05P32.1	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**3**	**3**	**-**	**-**	**-**	**3**	**-**
UME05P32.2	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**-**
UME05P32.3	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**-**
UME05P32.4	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**-**
UME05P32.5	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**
UME05P32.6	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**3**	**-**

MACHINING & MACHINE TOOL LABORATORY

Course		Credit-01			Marks(Weightage)		
Name	Machining & Machine Tool Laboratory	L	T	P	Mid	End	Internal
Code	**UME05P33**	0	0	2	00	100	00

Exp 1: Making of Centre punch by MS round bar.

Exp 2: Making of MS Cuboid along with a slot inside it.

Exp 3: Making of External thread on MS round bar

Exp 4: Making Spur and helical gear using Universal Milling Machine.

Exp 5: Various types of Linear, Angular, Temperature, Force and Torque measurement techniques.

Exp 6: Checking the limits of dimensional tolerance using various Comparators.

Text Books:

i. *Hazra Chowdhury, "Workshop Technology - I", Media Promoters & Publishers.*

Reference Books:

i. *V.K.Jain, Advance Machining Processes, Allied Publisher Bombay*
ii. *Ghosh and Malik, Manufacturing Science,EWP Private Ltd.*
iii. *P.C. Pandey, Modern Machining Processes, TMH Publication, New Delhi*
iv. *Benedict G.F., Non Traditional Manufacturing Processes, Marcel Dekker*

J.A. McGough, Advanced Machining Methods

Course Outcome *(Machining & Machine Tool Laboratory)*

No. of COs	Name of the Course Outcome
UME05P33.1	Perform plain turning, step turning, knurling, threading, eccentric turning, chamfering and facing operations on a lathe.
UME05P33.2	Estimate the chip reduction coefficient and shear angle on a shaping machine.
UME05P33.3	Drill holes and produce internal threads.
UME05P33.4	Machine spur and helical gears on a milling machine, Understanding Indexing.
UME05P33.5	Prepare setups and measure dimensional and geometrical features of components.
UME05P33.6	Measure surface roughness of components.

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME05P33	**Machining & Machine Tool Laboratory**													
UME05P33.1	3	-	-	-	-	-	-	-	3	-	-	-	2	-
UME05P33.2	3	3	-	-	-	-	-	-	3	-	-	-	-	3
UME05P33.3	3	-	-	-	-	-	-	-	3	-	-	-	3	-
UME05P33.4	3	-	-	-	-	-	-	-	3	-	-	-	3	-
UME05P33.5	3	3	-	-	-	-	-	-	3	-	-	-	3	-
UME05P33.6	3	3	-	3	-	-	-	-	2	-	-	-	3	-

HEAT & MASS TRANSFER LAB

Course		Credit-01			Marks(Weightage)		
Name	Heat & Mass Transfer Lab	L	T	P	Mid	End	Internal
Code	**UME05P28**	0	0	2	00	100	00

Exp-1: Study of heat transfer through composite wall.

Exp-2: Study of heat transfer through lagged pipe.

Exp-3: Study of heat transfer through fin.

Exp-4: Study of un-steady state of heat transfer.

Exp-5: Study of heat transfer in forced convection

Exp-6: Study of heat transfer in natural convection.

Exp-7: Heat transfer study in parallel flow, counter flow heat exchanger walls.

Exp-8: Study of heat transfer through fin tube heat exchanger.

Exp-9: Heat transfer study shell & tube heat exchanger.

Exp-10: Study of critical heat flux in boiling.

Exp-11: Determination of Stefen-Boltzmann constant experimentally

Course outcome *(Heat & Mass Transfer Lab)*

No. of Course Outcome (c)	Course Outcome
UME05P28.1	Understand the basic laws of heat transfer
UME05P28.2	Use the necessary skills to bridge the gap between knowledge and the confidence to properly apply knowledge
UME05P28.3	Analyze the problems involving steady state, transient heat conduction in simple geometries
UME05P28.4	Perform numerical solutions for conduction, convection and radiation heat transfer problems
UME05P28.5	Perform experiments and evaluate heat transfer coefficients for natural convection and for forced convection on different geometries
UME05P28.6	Identify, formulate, and solve engineering problems related to heat transfer and able to use the techniques, skills, and modern engineering tools necessary for engineering practice

Mapping of course outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME05P28	Heat & Mass Transfer Lab													
UME05P28.1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
UME05P28.2	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**
UME05P28.3	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**3**
UME05P28.4	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**3**
UME05P28.5	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**3**
UME05P28.6	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**3**

FLUID MACHINERY LABORATORY

Course		Credit-01			Marks(Weightage)		
Name	Fluid Machinery Laboratory	L	T	P	Mid	End	Internal
Code	**UME05P29**	0	0	2	00	100	00

Experiment-1: To study the detail working characteristics of Pelton Wheel Turbine.

Experiment-2: To study the detail working characteristics of Francis Turbine.

Experiment-3: To study the detail working characteristics of Kaplan Turbine.

Experiment-4: To study the detail working characteristics of Reciprocating Pump.

Experiment-5: To study the detail working characteristics of Centrifugal Pump.

Experiment-6: To study the detail working characteristics of Reciprocating Compressor.

Text Books:

iii. *Cengel, Y.A., "Fluid Mechanics: Fundamentals & Applications (SI Units)", Tata McGraw-Hill Publications.*
iv. *Rajput, R. K., "Fluid Mechanics & Hydraulic Machines, S. Chand Publications.*

Reference Books:

vi. *Laboratory Manual from ME Department, NIT Agartala*
vii. *S.K. Som, G. Biswas, S. Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines".*

Course Outcome (*Fluid Machinery Laboratory****)***

No. of COs	Name of the Course Outcome
UME05P29.1	To understand the basic working principles of Pelton Wheel Turbines
UME05P29.2	To know about the power developed by the Francis and Kaplan Turbines.
UME05P29.3	To know the working principles of Reciprocating and Centrifugal Pumps.
UME05P29.4	To understand the working principles of Reciprocating Compressor and it's applications.
UME05P29.5	To study the various components of turbines and pumps and study their operating characteristics.
UME05P29.6	To design various components of dams, lock gates and draft tubes.

Mapping of course outcomes

POs	**PO -1**	**PO -2**	**PO -3**	**PO -4**	**PO-5**	**PO -6**	**PO -7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO -1**	**PSO -2**
UME05P29	**Fluid Machinery Laboratory**													
UME05P29.1	3	2	3	-	-	-	-	-	-	-	2	-	3	3
UME05P29.2	3	-	2	-	-	-	-	-	-	-	2	-	-	2
UME05P29.3	2	-	-	-	2	-	-	-	-	-	-	2	2	3
UME05P29.4	-	2	3	-	-	-	-	-	2	-	-	3	3	3
UME05P29.5	3	2	3	2	3	-	-	-	-	-	3	-	3	3
UME05P29.6	-	-	2	-	3	-	-	-	-	-	-	2	2	2
Avg.	2.8	2	2.6	2	2.67	-	-	-	2	-	2.33	2.33	2.6	2.67

MINOR PROJECT -I

Course		Credit-01			Marks(Weightage)		
Name	Minor Project -I	L	T	P	Mid	End	Internal
Code	UME05P27	0	0	2	00	100	00

No. of Course Outcome (C)	Course Outcome
UME05P27	At the end of this course, student will be able to
UME05P27 / C01	Survey and identify the problems related to Mechanical Engineering.
UME05P27 / C02	Develop a systematic model/approach to analyze and solve the technical problems as individual / team.
UME05P27 / C03	Design and Propose a conceptual Model / Design and Develop a Prototype / Perform a case study for societal benefit ethically considering environmental factors.
UME05P27 / C04	Conduct experiments / theoretical evaluation to some extent.
UME05P27 / C05	Summarize their survey, problem identification, approach, design, expected outcome and attained results with cost estimation optimistically by means of oral presentation and written reports

CO	PO1	PO2	PO3	PO4	POI5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
UME05P27	**Project Part – I**													
UME05P27 / C01	2	3										3	-	-
UME05P27 / C02			3						3				-	3
UME05P27 / C03			3	3		2	2	2					2	2
UME05P27 / C04				3	3								-	3
UME05P27 / C05										3	2		3	-
Average	2	3	3	3	3	2	2	2	3	3	2	3	2.5	2.67

Mechanical Engineering Department

Sixth Semester (Syllabus)

SIXTH SEMESTER

CODE	SUBJECT NAME	L-T-P	CREDIT
UME06C01	Dynamics of Machines	3-0-0	03
UME06C03	Advanced Manufacturing Processes	3-0-0	03
UME06C02	Refrigeration & Air Conditioning	3-0-0	03
UME06C04	I.C. Engines	3-0-0	03
UME06C06	Thermal Power Engineering	3-0-0	03
UME06C05	Industrial Engineering & Management	3-0-0	03
UME06B23	Environmental Engineering (Mandatory Course)	1-0-0	00
LABORATORIES			
UME06P31	ME LAB-VII(Refrigeration & Ac Lab)	0-0-2	01
UME06P32	ME LAB-VII (Thermal Power Lab)	0-0-2	01
UME06P33	ME LAB-IX(Advanced Manufacturing Process Laboratory)	0-0-2	01
UME06P34	ME LAB IX(I.C Engines Laboratory)	0-0-2	01
UME06P30	Minor Project -II	0-0-3	01
	Industrial Tour	0-0-0	00
	TOTAL CREDIT	**19-0-11**	**23**

DYNAMICS OF MACHINE

Course		Credit-03			Marks (Weightage)		
Name	Dynamics of Machine	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME06C01**	3	0	0	30	50	20

Inertia Force Analysis In Reciprocating Parts : Introduction , D-Alembert's principle, Velocity and Acceleration of the piston- Analytical & graphical, Torque in the crankshaft neglecting inertia and friction; Various forces acting on the reciprocating part considering friction and inertia but neglecting weight of the connecting rod , Correction couple ,Dynamically Equivalent system , Torque on Crank shaft considering weight of connecting rod.

Gyroscope: Principle of gyroscope couple; Effect of gyroscope couple and centrifugal force on vehicle taking a turn; Stabilization of sea vessels.

Turning Moment Diagram and Flywheel: -Turning moment diagram for different types of Engines, Fluctuation of energy and speed; Flywheel; Flywheel Rim dimensions; Operation of flywheel in punching press.

Governor: Simple functioning of a Governor, porter, Proell, Hartnell and spring controlled, governor effect, Power stability; Inertia effects.

Balancing of Rotating Masses: Balancing of rotating masses in the same and different planes; Static& Dynamic balancing.

Balancing of Reciprocating masses; Sawing couple; Hammer blow, tractive force, Primary and secondary balancing of a Locomotive and Internal combustion Engine; Balancing of V-Engines; Balancing machines.

Text Books:

i. *Shigley, J.E., Vicker Jr., J.J., Theory of Machines and Mechanisms, McGraw-Hill, 1995.*
ii. *S.S Ratan, Theory of Machines. MGH.*

Reference Books:

i. *Rao, J.S. and Dukkipati, R.Y., Mechanism and Machine Theory, 2nd ed., Wiley Eastern Ltd., 1995.*
ii. *Rattan, S.S., "Theory of Machine" Tata McGrawHill Publications.*
iii. *Khurmi, R.S., Gupta, J.K., "Theory of Machine" S. Chand*

Course Outcomes: *(Dynamics of Machine)*

COs	**Course outcomes**
UME06C01.1	**Analysis** of inertial and external force on mechanisms through analytical and graphical process.
UME06C01.2	**Investigate** the causes and effect of gyroscopic action in rotating mechanical systems.
UME06C01.3	**Analysis** of (i) turning moment and investigate its effect on the design of Flywheels (ii) balancing of rotating and reciprocating parts of the machinery.
UME06C01.4	**Understanding** of basic importance of force, its effect and distribution in various mechanism, different types of Governors
UME06C01.5	**Apply** basic ideas for overall solution of the problem in terms of stability and balancing.
UME06C01.6	**Apply the knowledge** to practical engineering problem for better solutions by staying updated with the latest developments.

CO-PO Matrices & CO-PSO Mapping of Courses

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
UME06C01	Dynamics of Machine													
UME06C01.1	3	-	-	-	-	-	-	-	-	-	-	-	2	2
UME06C01.2	-	-	3	-	-	-	-	-	-	-	-	-	3	2
UME06C01.3	3	3	3	-	-	-	-	-	-	-	-	-	3	2
UME06C01.4	3	-	3	-	-	-	-	-	-	-	-	-	3	2
UME06C01.5	-	3	3	-	-	-	-	-	-	-	-	-	3	2
UME06C01.6	-	3	-	-	-	-	-	-	-	-	-	3	2	2
Average	3	3	3	-	-	-	-	-	-	-	-	3	2.66	2.00

ADVANCED MANUFACTURING PROCESSES

Course		Credit-03			Marks (Weightage)		
Name	Advanced Manufacturing Processes	L	T	P	Mid	End	Internal
Code	**UME06C03**	3	0	0	30	50	20

Advanced Machining Processes: Introduction, Process principle, Material removal mechanism, Parametric analysis and applications of processes such as ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM) Abrasive water jet machining (AWJM), Electrochemical machining (ECM), Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM) processes, working principal of Plasma arc machining.

Advanced Welding Processes: Details of electron beam welding (EBW), laser beam welding (LBW), ultrasonic welding (USW).

Advanced Casting Processes: Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting.

Advanced Metal Forming Processes: Details of high energy rate forming (HERF) process, Electro-magnetic forming, explosive forming Electro-hydraulic forming, Stretch forming, Contour roll forming.

Other Processes: Additive manufacturing, 3D (Three-dimensional)Printing, Nano-manufacturing, Sustainable Manufacturing.

Text Books:

"Advanced Machining Processes" V.K. Jain, Allied Publishers Pvt. Ltd.
"Modern Machining Processes" P.C Pandey & H.S. Shan, McGraw Hill Education.
"Materials and Processes in Manufacturing" (8th Edition), E. P. DeGarmo, J. T Black, R. A. Kohser, Prentice Hall of India, New Delhi.
"Manufacturing Science" A. Ghosh, and A. K. Mallik, Affiliated East-West Press Pvt. Ltd. New Delhi.
Rao P N, "Manufacturing Technology", Tata McGraw Hill Publilishing Company.

Reference Books:

Mishra P K,"Non Conventional Machining", Narosa Publishers.
Singh K K "Unconventional Manufacturing Processes" Dhanpat Rai & Company, New Delhi.
"Nontraditional Manufacturing Processes", G.F. Benedict, Marcel Dekker, Inc. New York.

Course outcome **(**Advanced Manufacturing Processes)

COs	Course outcome
UME06C03.1	To understand the categorization of different material removal processes, joining, forming, and casting in advance stage as per requirements for the product.
UME06C03.2	To select material processing technique with the intention of cost reduction, reducing material wastage and less processing time.
UME06C03.3	To understand the process parameters affecting the product quality in various advanced machining of metals/ non-metals, ceramics, composites and in advance welding and forming processes.
UME06C03.4	Ability to combine and develop novel hybrid techniques.
UME06C03.5	To perform process analysis taking into account the various responses considered in a process.
UME06C03.6	To understand the utility of different advance technique in manufacturing and their limitations.

Mapping of Course Outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME06C03.1	1	2	1	3	2	1	3	1	2	2	1	1	2	3
UME06C03.2	2	1	2	3	2	-	2	1	-	2	1	1	2	2
UME06C03.3	2	-	-	2	1	1	2	1	-	1	2	2	3	2
UME06C03.4	1	1	2	3	2	-	1	1	-	1	2	2	2	3
UME06C03.5	1	2	1	2	1	-	2	1	-	1	1	1	2	2
AVG	2	2	1	3	2	1	2	-	-	1	1	1	2	3

REFRIGERATION & AIR CONDITIONING

Course		Credit-03			Marks (Weightage)		
Name	Refrigeration & Air Conditioning	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME06C02**	3	0	0	30	50	20

Principles of Refrigeration & Refrigeration cycle: Introduction to Refrigeration, Reversed Carnot Cycle, Methods of producing Low Temperatures Refrigerants-Designation and trade name, Physical, Chemical & Thermodynamic properties of principal refrigerants

Vapour Compression Refrigeration Cycle: Performance Aspects and Cycle Modifications, Deviation from actual cycle, Multi-Stage Vapour Compression Refrigeration Systems Multi-Evaporator and Cascade Systems, Air Refrigeration Systems-Bell-Coleman Cycle, evaporation & bootstrap evaporation type, T-S & p-h diagrams, COP.

Vapour: Absorption Refrigeration Systems: Vapour Absorption Refrigeration Systems Based On Water-Lithium Bromide Pair and Ammonia-Water Pair, Electrolux Refrigerator. Refrigeration Equipments—Types of Compressors, Condensers, Expansion devices & Evaporators, Application of Refrigeration

Psychrometrics: Atmospheric air, air and humidity, terms and calculation, psychrometric chart, air humidity processes, humidification &dehumidification, By-pass factor, summer and winter air load, housing system.

Comfort air conditioning: Effective temperature, comfort chart, ventilation requirements.

Solar Radiation: Distribution of solar radiation, direct and diffuse radiation, Direct solar radiation on a vertical, horizontal, inclined surface, heat gain through glass, heat transfer in building structures through walls and roofs. Empirical methods to evaluate heat transfer through walls and roofs, infiltration, passive heating and cooling of building. Air distribution system, basic theory, air duct losses, design of air duct system, air delivery and distribution

Air conditioning systems: Unit conditioners, central air conditioning, control of air conditioning apparatus, space cooling load calculation, heat transmission through barriers, solar radiation, infiltration, occupants, electric lights &appliances, product load, outside air and ventilation, SHR By-pass factor, ADP, refrigeration load. Fluid flow and pressure loss, equivalent length system & duct design, air distribution system, basic control system. Solar heating and cooling, air conditioning through solar system, building designs for air conditioning

References:

1. Arora,C.P.,—Refrigeration and Air Conditioning",2nd ed., Tata McGraw-Hill2000.

2. Ananth Narayanan, —Basic Refrigeration & Air Conditioning‖, Tata McGraw-Hill

3. Khurmi, Gupta, —Refrigeration and Air Conditioning", S. Chand Publishers

Course outcome (Refrigeration & Air Conditioning):

	Course outcome
UME06C02.1	Understand the principles of refrigeration and air conditioning design, and consideration that influence the design including human comfort, weather and environmental parameters and building structure
UME06C02.2	Use the necessary skills to bridge the gap between knowledge and the confidence to properly apply knowledge
UME06C02.3	Perform the computational methods in refrigeration and air conditioning design
UME06C02.4	Implement the basic design skills to estimate life-cycle costing and choose the right type of system
UME06C02.5	Understand the load estimation and analysis, psychometric analysis of a system and climate data and its use;
UME06C02.6	Develop analytical cognitive skills and improve problem solving skills in refrigeration and air conditioning

CO-PO Matrices & CO-PSO Mapping of Courses

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
UME06C02	**Refrigeration & Air Conditioning**													
UME06C02.1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
UME06C02.2	3	-	-	-	-	-	-	-	3	-	-	-	-	-
UME06C02.3	3	3	3	-	3	-	-	-	3	-	-	-	3	3
UME06C02.4	3	3	2	-	-	-	-	-	3	-	-	-	2	3
UME06C02.5	3	-	-	-	-	-	-	-	-	-	-	-	3	-
UME06C02.6	-	3	-	-	-	-	-	-	-	-	-	-	-	2
Average	**3**	**3**	**3**	**-**	**3**	**-**	**-**	-	**3**	**-**	**-**	**-**	3	3

IC ENGINE

Course		Credit-03			Marks (Weightage)		
Name	IC Engine	L	T	P	Mid	End	Internal
Code	**UME06C04**	3	0	0	30	50	20

Basic types of engines, air standard cycle, fuel air cycles, actual cycles, losses in actual engine operation, MEP, thermal efficiency. Desirable characteristics of fuels for I.C. engines. Octane number, cetane number, performance numbers. Properties of air-petrol mixtures.

Elimentary carburetor, complete carburetor, petrol injection.

Diesel injection system, fuel pump, fuel injectors and nozzles.

Battery ignition system, Magneto injection system, Electronic ignition system using contract breaker, ignition system and spark advance.

Theories of combustion in S.I and C.I. engine, methods of reduction of detonation and knock.
Combustion chamber types in S.I. and C.I. engine, Supercharging, Scavenging of I.C. engines, two stroke S.I and C.I. engines.
Lubrication of I.C. engines, properties of lubricating oils, lubricating systems, cooling of I.C engines, air and water cooling systems.
Fundamentals of free piston and rotary engines, performance and testing of I.C. engines, Pollutant emission formation and control.

Text Books:

1. Ganesan, V., —Internal Combustion Engines", 2nd ed., Tata McGraw-Hill, 2003.
2. Sharma, Mathur,. —Internal Combustion Engine, Dhanpat Rai & Sons.

Reference Books:

1. Crouse, Anglin., —Automotive Mechanics|| Tata McGraw-Hill
2.. Kirpal Singh, Automotive Engineering, Vol. I & II, Standards Publishers, New Delhi, 2002.

Course Outcomes(IC Engine)

UME06C04.1	Knowledge of various types of I.C. Engines and Cycles of operation. Desirable characteristics of fuels for I.C. engines. (Octane number, cetane number, performance numbers). Identify the effect of various operating variables on engine performance.
UME06C04.2	Identify the different kind of fuel metering and fuel supply systems for different types of engines Understand the different Ignition systems employed in I.C. Engines (Battery ignition system, Magneto injection system, Electronic ignition system using contract Breaker)
UME06C04.3	Understand the theories of combustion in S.I and C.I. engines, methods of reduction of detonation and knock
UME06C04.4	Combustion chamber types in S.I. and C.I. engines, factors influencing combustion chamber design. Basic Knowledge of Supercharging, Scavenging of I.C. engines& two stroke S.I and C.I. engines.
UME06C04.5	Identify the necessity of lubrication& cooling systems of I.C. engines. Properties of lubricating oils, lubricating systems, and the basic knowledge of air- and water-cooling systems of I.C engines.
UME06C04.6	Develop the ability to interpret, participate and communicate in interactive group discussions on emission formation mechanism of IC engines, its effects and their control. Evaluate methods for improving the IC engine performance parameters by testing of I.C engines.

Mapping of Course Outcomes

POs	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
UME06C04.1	3	3	2	1	-	-	-	-	-	1	1	2	2	2
UME06C04.2	2	2	2	1	2	-	-	-	-	1	1	1	1	1
UME06C04.3	3	2	3	2	1	1	-	-	-	-	1	1	2	1
UME06C04.4	3	3	2	2	3	1	-	1	1	1	1	2	1	2
UME06C04.5	2	2	2	1	1	1	-	-	-	1	1	1	1	2
UME06C04.6	3	2	2	2	1	1	-	-	1	1	1	1	2	2

THERMAL POWER ENGINEERING

Course		Credit-03			Marks (Weightage)		
Name	Thermal Power Engineering	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME06C06**	3	0	0	30	50	20

Generator: Combustion equipment for burning coal, Fuel bed combustion, mechanical strokers, pulverized coal firing system-its advantages & disadvantages-burners & furnaces, Fluidized bed combustion, Numerical Problems

Boiler-mounting & accessories, fire tube boilers, water tube boilers-La Mont boiler, Loeffler boiler-Benson Boiler, Drum internals, steam drum separation, water wall, air preheater, economizer,super-heater & electrostatic precipitators. Steam generator, losses & heat balance

Principle of circulation-natural forced circulation, drafts-natural, forced, Induced & balanced drafts, pressurized fluidized bed boiler.

Flow through nozzle, nozzle shape, critical pressure ratio, maximum flow, Numerical Problems on nozzle, Effect of friction in nozzle flow under-expansion & over-expansion in nozzle, super saturated flow through nozzle.

Steam Turbine: Principles of action of turbines, classification, Flow through impulse turbine blading, velocity diagram, Blade efficiency, optimum velocity ratio, Numerical Problems on impulse turbine.

Multistage & its advantages, velocity compounded impulse, Reheat factor, internal efficiency, State point locus, Flow through reaction turbine blading, velocity diagram, degree of reaction, blade work, blade height, Stage efficiency, optimum velocity ratio, axial thrust in reaction turbine, number of parallel exhausts, Numerical Problems on reaction turbine, Back pressure turbines, pass-out turbines, mixed-press turbine. Losses in turbines, principles of turbine governing.

Text Books:

Thermal Power - P. L. Balaney, Khanna Publishers, ISBN: 9788174090317

ThermalEngineering-J.K.Gupta, R.S.Khurmi, S.Chand, Limited, 1997,ISBN: 8121913373

Gas Turbine- V. Ganesan, Publisher: McGraw Hill, ISBN: 9780070681927, 0070681929

Reference Books:

i. *R.S. Amano, B. Sundén, "Thermal Engineering in Power Systems" WIT Press Ashurst Lodge, Ashurst, Southampton, SO40 7AA, UK*

ii. *Gilberto Francisco Martha de Souza, Thermal Power Plant Performance Analysis, Springer Publisher.*

iii. *ViorelBadescu, George CristianLazaroiu, Linda Barelli, Power Engineering Advances and Challenges, Part A: Thermal, Hydro and Nuclear Power, CRC Press Book.*

Mapping of Course Outcomes (*Thermal Power Engineering)*

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	P O8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
UME06C06	Thermal Power Engineering													
UME06C06.1	3	-	-	-	-	-	-	-	-	-	-	-	3	3
UME06C06.2	3	2	3	-	-	-	-	-	-	-	-	-	2	3
UME06C06.3	2	3	2	3	2	-	3	-	-	-	-	-	-	3
UME06C06.4	3	3	3	-	-	-	-	-	-	-	-	-	3	2
UME06C06.5	3	2	3	-	-	-	-	-	-	-	-	-	-	3
UME06C06.6	3	3	3	-	-	-	-	-	2	-	2	-	-	3

INDUSTRIAL ENGINEERING & MANAGEMENT

Course		Credit-03			Marks (Weightage)		
Name	Industrial Engineering Management	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME06C05**	3	0	0	30	50	20

Industrial Engineering:-Concept of Industrial Engineering- its role & applications, Operation Research, Work study : time & motion study, Method study , Principles of motion economy, Workplace layout, Stop watch time study, SIMO chart, Man-machine chart, Therbligs, PMTS, MTM, Work sampling.

Organization: -Organization structures, Types, Principles of organization structures, Features of various Ownerships, Company formations- its management and finance, Public limited & private limited company.

Material Management: -Functions of material management, Inventories- its types, Just In Time (JIT) inventory, Concept of EOQ & EBQ, Simple EOQ model with and without stock outs, Simple EOQ model with varying demand and production, P- type & Q- type of inventory policies, Selective inventory control like ABC, VED, SDE techniques etc.

Production Planning & Control :-Functions and role, Value analysis, Exponential smoothing constant and moving average method in demand and production forecasting, Break even analysis.

Quality Management:-Quality vs reliability, Quality maintenance and quality assurance, SQC technique, Acceptance sampling, Concept of TQM, ISO Standards.

Plant Layout:-Location factors, Principles and design, Types of layout, Tools & technique.

Plant Maintenance:-Break down, Scheduled and Preventive maintenance, Steps in preventive maintenance, TPM concept.

Operational Research:-Concept of O.R, Methods of O.R, Concept of optimization, Linear programming, simplex method Transportation problem, Queuing theory. Decision theory, Integer programming, Revised simplex method, network techniques (PERT & CPM), theory of games, Simulation Technique.

Reference Books:

1. *Industrial Engineering & Production Management* — *By M. Mahajan, Dhanpat Raj & Sons Publication*
2. *Industrial Engineering & Management* — *By O.P. Khanna, Dhanpat Raj & Sons*
3. *Industrial Engineering & Management* — *By Bunga& Sharma, Khanna Publishers*

Work Study ILO
Operation research --- Taha.
Operation Research – Hira Gupta.

Course outcome:

No. of Course Outcome (c)	Course Outcome
UME06B20.1	Describe and analyze distinct concepts within production planning and explain how these can be used to plan and control the physical flow of information and products in the production companies.
UME06B20.2	Schedule production by using different techniques and evaluate different capacity alternatives/strategies to meet the customer demand.
UME06B20.3	Know about inventory control techniques and other concepts such JIT and value engineering.
UME06B20.4	Understand the role and origin of quantitative methods and operations research technique and are to differentiate between different types of deterministic ad probabilistic models.
UME06B20.5	Plan all the projects in the real life on the basis of different phases of operation research.
UME06B20.6	Communicate effectively.
UME06B20.7	Use the techniques, skills, and modern engineering tools necessary for engineering practice

CO-PO Matrices & CO-PSO Mapping of Courses

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
UME06B20	Engineering Management													
UME06B20.1	3	3	-	-	-	–	–	–	-	-	3	-	2	2
UME06B20.2	-	3	3	-	-	-	-	-	-	-	3	-	3	3
UME06B20.3	3	3	-	3	-	–	–	–	-	-	3	-	3	-
UME06B20.4	3	-	3	3	-	–	–	–	-	–	3	-	2	2
UME06B20.5	-	-	2	-	-	-	–	–	-	-	3	3	3	3
UME06B20.6	–	–	–	–	–	–	–	–	-	3	–	–	-	-
UME06B20.7	3	3	-	3	-	2	–	–	-	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**-**	2	–	–	**-**	**3**	**3**	**3**	2.666	2.6

ENVIRONMENTAL ENGINEERING

Course		Credit-03			Marks (Weightage)		
Name	Environmental Engineering	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME06B23**	3	0	0	30	50	20

Introduction: Basic ideas of environment, Definition, scope and importance of environmental studies.

Natural resources: Forest Resources: Use and over – exploitation of forests, deforestation, timber extraction, mining, dams and their effects on forests and tribal people.
Water Resources: Use and over – utilization of surface and groundwater, floods, droughts, conflicts over water, dams – benefits and problems.
Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources.
Agricultural Land and Food Resources : Land as a resources, land degradation, man induces landslides, soil erosion and desertification
.**Ecosystem and Biodiversity: Ecosystems :** Concept of an ecosystem, structure and function of an ecosystem, Food chain, food webs and ecological pyramids, Energy flow in ecosystem, producers and consumers, Ecological succession.
Biodiversity and its Conservation: Introduction, definition, genetic, species and ecosystem diversity, value of biodiversity, Consumptive use, productive use, Social, ethical, aesthetic and optional values, biodiversity at global, national and local values, India as a mega-diversity nation,
Environmental Pollution: Causes, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear radiation hazards, Solid waste management- sources of solid wastes, effects and control measures of urban industrial wastes; Pollution case studies.
Environment and Society: Role of an individual in prevention of pollution, consumerism and waste products, unsustainable to sustainable development, water conservation, rainwater harvesting, watershed management, Environmental Protection Acts, population growth, variation among nations, Environment and human health: epidemics, Role of information technology in environment and human health.

References:

Text Books:

iii. A Textbook of Environmental Studies- Dr D .K Aasthana, S.Chand Publishing Private Ltd.

Reference Books:

iv. Henry J.G. and Heinke G.W. (2004), "Environmental Science and Engineering", Second Edition, Prentice Hall of India, New Delhi

ii Masters, G. M., "Introduction to Environmental Engineering and Science", Prentice-Hall of India Pvt. Ltd., 1991.

iii. Garg, S.K and Garg, R., (2006), Ecological and Environmental Studies, Khanna Publishers, Delhi.

iv. De A.K. (2002), "Environmental Chemistry", New Age India Publication Company, New Delhi.

Course outcome:

No. of Course Outcome (c)	Course Outcome
UME06B23.1	Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
UME06B23.2	Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
UME06B23.3	Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
UME06B23.4	Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners.
UME06B23.5	Describe a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
UME06B23.6	Critically analyze technical subject matter for scientific merit apply learned environmental knowledge and understanding to solve technical /research problems in new contexts

CO-PO Matrices & CO-PSO Mapping of Courses

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
UME06B23	**Environmental Engineering**													
UME06B23.1	3	3	2	2	2	-	2	2	2	-	2	2	2	-
UME06B23.2	3	2	2	-	2	2	-	2	3	2	2	2	-	2
UME06B23.3	3	2	-	2	-	-	2	-	2	2	-	-	2	-
UME06B23.4	3	2	-	-	-	2	-	-	-	-	2	-	-	2
UME06B23.5	3	3	2	2	2	-	2	2	2	2	-	2	2	-
UME06B23.6	3	2	2	-	2	2	-	2	-	2	2	2	-	2

REFRIGERATION & AIR CONDITIONING LAB

Course		Credit-01			Marks (Weightage)		
Name	Refrigeration & Air Conditioning Lab	L	T	P	Mid	End	Internal
Code	**UME06P29**	0	0	2	-	100	-

Introduction to the Measurement techniques/Safety aspects related to Refrigeration and Air Conditioning Laboratory Introduction to Refrigeration, Study of Open type Reciprocating Compressor, Study of Hermitically Sealed Reciprocating Compressor, Study of Throttling Device & Thermostatic Switch, Performance test on Vapour Compression Test Rig, Performance analysis of a Domestic Refrigerator, Introduction to Basic Psychrometry & Air conditioning, Study of Sensible Heating in Air Conditioning System, Study of Air Conditioning Test Rig, Study of COP of Cooling Coil in Sensible Cooling Process

References:

1. Arora,C.P.,—Refrigeration and Air Conditioning",2nd ed., Tata McGraw-Hill2000.

2. Ananth Narayanan, —Basic Refrigeration & Air Conditioning‖, Tata McGraw-Hill

3. Khurmi, Gupta, —Refrigeration and Air Conditioning", S. Chand Publishers

Course outcome:

CO	Course outcome:
UME06P29.1	Understand the principles of refrigeration and air conditioning design, and consideration that influence the design including human comfort, weather and environmental parameters and building structure
UME06P29.2	Use the necessary skills to bridge the gap between knowledge and the confidence to properly apply knowledge
UME06P29.3	Perform the computational methods in refrigeration and air conditioning design
UME06P29.4	Implement the basic design skills to estimate life-cycle costing and choose the right type of system
UME06P29.5	Understand the load estimation and analysis, psychometric analysis of a system and climate data and its use;
UME06P29.6	Develop analytical cognitive skills and improve problem solving skills in refrigeration and air conditioning

CO-PO Matrices & CO-PSO Mapping of Courses

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
UME06P29.1	3	-	2	-	-	2	2	-	3	-	-	-	3	-
UME06P29.2	3	-	-	-	-	-	-	-	3	-	-	-	-	-
UME06P29.3	-	3	3	3	-	-	-	-	3	-	-	-	2	3
UME06P29.4	3	3	-	-	-	-	-	-	3	-	-	-	2	2
UME06P29.5	3	3	-	-	-	-	-	-	2	-	-	-	3	2
UME06P29.6	3	3	-	-	-	-	-	-	2	-	-	-	-	3
avg	3	3	3	3	-	2	2	-	3	-	-	-	3	3

THERMAL POWER LAB

Course		Credit-01			Marks (Weightage)		
Name	Thermal Power Lab	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME07P26**	0	0	3	00	100	00

- Determination of power input, heat output and coefficient of performance
- Production of heat pump performance curves over a range of source and delivery temperatures.
- Plotting the vapour compression cycle on a p-h diagram & comparing with the ideal cycle.
- Production of heat pump performance curves based on the HFC134a properties at a variety of Evaporating and condensing temperature

- Visual demonstration of nozzle chocking
  Determination of the effect of inlet pressure on mass flow rate ,given a constant back pressure
  Comparison with the theoretical predictions.

  Determination of the effect of back pressure on the mass flow rate.
  Determination of jet reaction and specific thrust.

- Visual demonstration of pressure distribution
  Determination of the effect of back pressure on the position of recompression.
  Determination of the effect of inlet pressure on mass flow rate, given a constant back pressure & comparison with the theoretical predictions.
  Determination of the effect of back pressure on the mass flow rate.

Course outcomes:

CO No.	Course Outcomes
UME07P26.1	Understand the concept of VCR Cycle, comparison between VCR Cycle With VAR Cycle, also understand the concept of determination of power input, heat output and coefficient of performance and production of heat pump performance curves over a range of source and delivery temperatures.
UME07P26.2	Understand the concept of plotting the vapor compression cycle on a P-H diagram & comparing it with the ideal cycle and Production of heat pump performance curves based on the HFC134a properties at a variety of Evaporating and condensing temperature.
UME07P26.3	Understand the concept of Inlet pressure, back pressure, exit pressure, Mach No, Different kind of flows (supersonic, sonic, subsonic, hypersonic flow),Types of nozzle and their working principles and visual demonstration of nozzle chocking. 1. Determination of the effect of inlet pressure on mass flow rate ,given a constant back pressure. 2. Comparison with the theoretical predictions. Determination of the effect of back pressure on the mass flow rate. Determination of jet reaction and specific thrust.
UME07P26.4	Understand the concept of Visual demonstration of nozzle chocking. Visual demonstration of pressure distribution. Determination of the effect of back pressure on the position of recompression.
UME07P26.5	Understand the concept of Determination of the effect of inlet pressure on mass flow rate ,given a constant back pressure & comparison with the theoretical predictions. Determination of the effect of back pressure on the mass flow rate.
UME07P26.6	student will be able to determine the applications of the instruments/apparatus and hence able to apply individually and by group.

CO-PO Matrices & CO-PSO Mapping of Courses

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO2
UME07P26	Thermal Power Lab													
UME07P26.1	3	2	1	-	3	1	-	-	-	1	-	2	3	3
UME07P26.2	2	-	1	2	2	1	-	-	-	1	-	2	-	2
UME07P26.3	3	2	3	2	2	1	-	-	1	-	-	2	2	3
UME07P26.4	2	2	3	2	2	2	-	-	1	1	-	2	3	3
UME07P26.5	2	2	3	2	2		-	-	1	1	-	2	3	3
UME07P26.6	2	2	2	2	2	2	-	-	1	1	1	2	2	2

ADVANCED MANUFACTURING PROCESSES LAB

Course		Credit-01			Marks (Weightage)		
Name	Advanced Manufacturing Processes Lab	L	T	P	Mid	End	Internal
Code	**UME06P33**	0	0	2	-	100	-

- To study die sinking EDM and wire cut EDM.
- To study ultra-sonic machining process.
- To study plasma arc machining process.
- To study of chemical and electrochemical machining process.
- To study experiment on high-energy-beam Machining

  – Laser-beam machining (LBM)

  – Electron-beam machining (EBM)

- To study influence of process parameters in water-jet machining and abrasive-jet machining.

- To study the advanced joining process and 3-D printing

Text Books:

–*Advanced Machining Processes" V.K. Jain, Allied Publishers Pvt. Ltd.*
"Modern Machining Processes" P.C Pandey & H.S. Shan, McGraw Hill Education.
"Materials and Processes in Manufacturing" (8th Edition), E. P. DeGarmo, J. T Black, R. A. Kohser, Prentice Hall of India, New Delhi.
"Manufacturing Science" A. Ghosh, and A. K. Mallik, Affiliated East-West Press Pvt. Ltd. New Delhi.
Rao P N, "Manufacturing Technology", Tata McGraw Hill Publilishing Company.

Reference Books:

Mishra P K,"Non Conventional Machining", Narosa Publishers.
Singh K K "Unconventional Manufacturing Processes" Dhanpat Rai & Company, New Delhi.
"Nontraditional Manufacturing Processes", G.F. Benedict, Marcel Dekker, Inc. New York.

Course outcome

No of COs	Course outcome:
UME06P33.1	Broad understanding of advanced machining processes using different energy sources.
UME06P33.2	Understand the concept of machining the hard material using mechanical energy, chemical energy, electrochemical energy and thermal energy. Able to implement the mechanical energy, chemical, water and electrochemical based unconventional machining processes.
UME06P33.3	To identify the process parameters affecting the product quality in various advanced machining of metals/ non-metals, ceramics and composites.
UME06P33.4	Able to think about the possibility of combining different processes to develop a more efficient machining process.
UME06P33.5	To understand the different metals and non-metals joining techniques, casting techniques and additive manufacturing.

Mapping of Course Outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME06P33	Advanced Manufacturing Processes Lab													
UME06P33.1	2	1	-	2	3	2	1	1	2	1	1	1	3	2
UME06P33.2	2	2	1	2	3	1	2	1	2	-	1	1	3	2
UME06P33.3	3	2	1	1	2	2	1	1	2	-	1	1	2	2
UME06P33.4	2	2	1	2	3	2	1	1	2	-	1	1	2	3
UME06P33.5	3	2	1	1	2	1	1	1	2	1	1	1	2	2

IC ENGINE LAB

Course		Credit-01			Marks (Weightage)		
Name	IC Engine Lab	L	T	P	Mid	End	Internal
Code	**UME06P34**	0	0	2	-	100	-

Course content:

UNIT:1 To Study The Function and Working Principle Of Ignition System of S.I Engine with Sketch.

UNIT 2: To Study The Function and Working Principle Of Carburetor of S.I Engine with Sketch.

UNIT 3: To Study The Function and Working Principle Of Injector & Injection Pump of C.I Engine with Sketch.

UNIT 4: To Study The Function and Working Principle Of Lubrication System of IC Engine with Sketch.

UNIT 5: To Study The Function and Working Principle Of Cooling System of IC Engine with Sketch.

Unit 6: Detection Of Valve Timing Diagram For SI & CI Engines

UNIT 7: Measurement Of Brake Power, Brake Specific Fuel Consumption by Rope Brake Dynamometer.

UNIT 8: Analysis Of Engine Performance Using Computerized Engine Test Rig.

UNIT 9: Measurement & Analysis of Of Engine Emission With Variable Loads.

Text Books:

1. Ganesan, V —Internal Combustion Engines", 2nd ed., Tata McGraw-Hill, 2003.
2. Sharma, Mathur,. —Internal Combustion Engine, Dhanpat Rai & Sons.

Reference Books:

1. *Crouse, Anglin., —Automotive Mechanics‖ Tata McGraw-Hill*

2.. Kirpal Singh, Automotive Engineering, Vol. I & II, Standards Publishers, New Delhi, 2002.

No of COs	Course outcome:
UME06P34.1	Demonstrate the vehicle construction, lubrication system and cooling system in automobile.
UME06P34.2	Describe the principle and working of Carburetors, fuel injection system and Ignition system.
UME06P34.3	Differentiate between: CI & SI engine, 2 Stroke & 4 Stroke engines etc.
UME06P34.4	Identify the Ignition coil, Fuel pump, injector, carburetor, spark plug of a vehicle.
UME06P34.5	Appraise the recent trends in alternate fuels and automobile safety system
UME06P34.6	Measure Performance (Brake Power etc) and emission of engine by the help of experimental setup.

Mapping of Course Outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME06P34.1	3	-	-	-	-	-	-	-	3	3	-	-	3	-
UME06P34.2	2	-	-	-	-	-	-	-	3	-	-	-	3	-
UME06P34.3	3	2	-	-	-	-	-	-	3	-	-	-	3	-
UME06P34.4	3	2	-	-	-	-	-	-	2	-	-	-	3	-
UME06P34.5	2	-	-	-	-	-	-	-	3	-	-	3	2	-
UME06P34.6	3	2	-	3	-	-	-	-	3	-	-	-	-	3

MINOR PROJECT –II

Course		Credit-01			Marks (Weightage)		
Name	Minor project –II	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME06P30**	0	0	3		100	

Course outcome

No. of Course Outcome (C)	Course Outcome
UME06P30	At the end of this course, student will be able to
UME06P30 / C01	Survey and identify the problems related to Mechanical Engineering.
UME06P30 / C02	Develop a systematic model/approach to analyze and solve the technical problems as individual / team.
UME06P30 / C03	Design and Propose a conceptual Model / Design and Develop a Prototype / Perform a case study for societal benefit ethically considering environmental factors.
UME06P30 / C04	Conduct experiments / theoretical evaluation to some extent.
UME06P30 / C05	Summarize their survey, problem identification, approach, design, expected outcome and attained results with cost estimation optimistically by means of oral presentation and written reports

Mapping of course outcomes

CO	PO1	PO2	PO3	PO4	POI5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
UME06P30	**Project Part – I**													
UME06P30 / C01	2	3										3	-	-
UME06P30 / C02			3						3				-	3
UME06P30 / C03			3	3		3	3	3					3	3
UME06P30 / C04				3	3								-	3
UME06P30 / C05										3	3		3	-
Average	2	3	3	3	3	3	3	3	3	3	3	3	3	3

Mechanical Engineering Department

Seventh Semester (Syllabus)

SEVENTH SEMESTER

CODE	SUBJECT NAME	L-T-P	CREDIT
UME07E03	Elective-I (Power Plant Engineering)	3-0-0	03
UME07E04	Elective-I (Industrial Tribology)		
UME07E05	Elective-II (Automobile Engineering)	3-0-0	03
UME07E06	Elective-II (Product design for manufacturability and assembly)		
UME07C82	Mechanical System Design & Industrial Automation	3-0-2	04
UME07B91	Entrepreneurship Development	1-0-0	01
PRACTICAL			
	Industrial Training & Seminar	0-0-2	01
UME07P102	Major Project- I	0-0-6	02
	TOTAL CREDIT	**10-0-10**	**14**

POWER PLANT ENGINEERING (Elective-I)

Course		Credit-03			Marks (Weightage)		
Name	Power Plant Engineering	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME07E03**	0	0	3	30	50	20

INTRODUCTION TO POWER PLANTS AND BOILERS

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

STEAM POWER PLANT

Fuel and ash handling, Combustion Equipment for burning coal, Mechanical Stokers. Pulveriser, Deaerator, Electrostatic Precipitator, Feed water heaters, Draught- Different Types, Surface condenser types, cooling Towers, Steam Turbines.

NUCLEAR AND HYDEL POWER PLANTS

Nuclear Energy-Fission , Fusion Reaction, Types of Reactors, Pressurized water reactor ,Boiling water reactor, Fast breeder reactor, Waste disposal and safety. Hydel Power plant- Essential elements, Selection of turbines, Governing of Turbines, Micro hydel developments, Site selection, Specific speed, Cavitation, Draft tube.

DIESEL AND GAS TURBINE POWER PLANT

Types of diesel plants, components, Selection of Engine type, applications. Gas turbine power plant- Fuels- Gas turbine material – open and closed cycles- reheating –Regeneration and intercooling – combined cycle .

OTHER POWER PLANTS AND ECONOMICS OF POWER PLANTS

Geothermal, OTEC, Tidel, Wind, Solar central receiver system, MHD power generation, Cost of electric Energy, Fixed and operating costs, Energy rates, Types tariffs- Economics of load sharing, comparison of various power plants.

TEXTBOOKS:

1. Nag P.K,"Power Plant Engineering". Third edition Tata McGraw- Hill , 2007.
2. Arora S.C and Domkundwar S, "A Course in Power Plant Engineering", DhanpatRai, 2001.

REFERENCES:

1. *EI-Wakil M.M, Power "Plant Technology", Tata McGraw-Hill 1984.*
2. *K.K.Ramalingam, "Power Plant Engineering", Scitech Publications, 2002.*
3. *G.R,Nagpal, "Power Plant Engineering", Khanna Publishers 1998.*
4. *G.D.Rai, "Introduction to Power Plant technology" Khanna Publishers, 1995.*

Course outcomes

No. of Course Outcome	Course Outcomes
CO1	Basic concept of power plant
CO2	Operation of steam power plant and its performance
CO3	Performance and Emission of Diesel Power Plant
CO4	Optimum operation and performance of Gas Turbine Power Plant
CO5	Concept of non conventional power plant.
CO6	Power plant layout and economy

CO-PO Matrices & CO-PSO Mapping of Courses

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
UME07E03	Power Plant Engineering													
UME07E03.1	3	2	-	-	-	-	-	-	-	-	-	-	3	-
UME07E03.2	3	-	-	2	-	-	-	-	-	-	-	-	-	3
UME07E03.3	3	3	-	3	-	-	-	-	3	-	-	-	-	3
UME07E03.4	3	-	2	-	-	-	3	2	-	-	-	2	-	3
UME07E03.5	-	3	3	-	-	-	-	-	-	-	-	-	-	3
UME07E03.6	2		3	-	-	-	-	-	-	-	-	-	-	3

INDUSTRIAL TRIBOLOGY (Elective-I)

Course		Credit-03			Marks (Weightage)		
Name	Industrial Tribology	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME07E04**	3	0	0	30	50	20

Tribology: - Introduction, History, Industrial Importance, Available literature.

Engineering surface-Properties and measurement: - Introduction, Measurement Methods, Statistical Description, Fractal Description.

Surface contact: - Introduction, Non-Conforming Surface contact geometry, Stresses in Non-conforming Contacts, Contact of rough surface, Numerical Surface contact model.

Adhesion: - Introduction, Adhesion at solid-Solid contact, Adhesion Model, Factor Influencing

Adhesion produced by surface tension, Stiction, Adhesion at contact between rough surfaces.

Friction: - Introduction, Measurement method, Origin of friction, Friction theories, Other Mechanism, Friction metals, Friction of nonmetallic material.

Wear :- Introduction, Adhesive wear, Abrasive wear, Corrosive wear, Fatigue wear , Minor forms of wear, Delaminating theory of wear, Wear debris analysis, Wear testing methods, Wear of metals, Wear of ceramic, Wear of polymers, System approach for wear reduction.

Thermal consideration in sliding contact: - Introduction, Measurement of surface temporary sliding, Theoretical analysis.

Surface engineering: - Introduction, Surface treatment, Surface coating, Selection of surface treatment / surface coating.

Boundary lubrication: - Introduction, Mechanism of boundary lubrication, Metal working lubrication, Solid film lubrication.

Liquid lubricant- properties and measurement:- Introduction, Oil lubricant, Greases ,Viscosity, other properties , additives.

Basic equation for fluid film lubrication: - Introduction, Navier-strok equation, Continuity equation, Reynolds equation,, Dimensionless number, Flow rate AND shear force .

Hydrodynamic thrust bearing :- Introduction, pressure development mechanism, Plane slider bearing with exponential film profile, Fixed inclination slider bearing, Tilting pad slider bearing, Parallel step slider bearing, Finite width thrust bearing, Design procedure.

Hydrodynamic journal bearing: - Introduction, Infinitely long journal bearing, infinitely short journal bearing, finite length journal bearing: numerical solution, Effective temperature of lubricant, Design procedure, Hydrodynamic instability, Oil supply grove.

Hydrodynamic squeeze film bearing: - Introduction, Infinitely long parallel surface bearing, infinitely long journal bearing, Special causes.

Hydrostatic bearing: Introduction, Circular step thrust bearing annual thrust bearing, Rectangular thrust bearing, Hydrostatic journal bearing.

Gas lubricated bearing :- Introduction, Governing Equation, Infinitely long plain surface bearing, Infinitely long journal bearing, Finite journal bearing, Other Gas-bearing types, Squeeze Film Lubrication, Instability in Gas-Lubricated bearing.

Elasto hydrodynamic lubrication :- Introduction, Line-contact: Rigid Cylinders, Line-contact: Elastic Cylinders, Point Contacts, Thermal Correction Factors, Surface roughness Correction Factors, Lubricant Rheology, Different Rheology in EHL Contacts.

Rolling Element Bearing: - Introduction, Geometry, Kinematics, Load capacity, Fatigue Life, Lubrication.

Nano-tribology: - Introduction, Measurement Tools, Measurements, Fabrication Techniques for MEMS/NEMS, Atomic Scale Simulation.

Fractal Analysis in Tribology :- Introduction, Fractal Geometry , Fractal Characterization of rough Surface, Evaluation of Fractal Dimension, Fractal Contact Model, Fractal Analysis of adhesive contact, Critical to Fractal Theory.

AUTOMOBILE ENGINEERING (Elective-II)

Course		Credit-03			Marks (Weightage)		
Name	Automobile Engineering	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME07E05**	3	0	0	30	50	20

Introduction
Classification of automobiles.
Transmission
Clutch-Details, Requirements of Clutches, Types of Clutches and Clutch materials, Design of clutch, Fluid coupling
necessityofgear.box,Slidingmesh,Constantmesh,Synchromeshandepicyclicgearbox,Overdrivesandhydrodynamic torque converter. Automatic transmission
Drive line:
Propeller shafts and universal joints: Types and construction, Different types of universal joints and constant velocity joints. Live axle and differential: Necessity of differential, Conventional and non-slip differential.
Brakes
Requirement of brake, braking of front wheel, Rear wheel Brake. Introduction to antilock braking system (ABS)
Steering and Front axles
Steering geometry, Steering requirements, Steering linkages and steering gears, over steer and under steer, Cornering power, Reversibility of steering gears, Types of front axles

Suspension
Objects of suspension, Basic requirements, Independent suspension, Forces acting in independent suspension, Sprung and unsprung mass, --bicycle model analysis. Pitching, rolling and bouncing, Shock absorbers.
Wheels and Tyres
Requirements of wheel sand tyres, Constructional features, Types of tyres, Inflation Pressure and its importance, Application to ride and stability.

Body Engineering
Importance of Body design, Materials for body construction-Styling forms-Coach and bus body style, layouts of passenger cars, Bus and truck bodies. Chassis types and structure types. Frames: functions and types of frames, Loads on frames, Load distribution of structure, Location of power plant.
Aerodynamic drag-Aerodynamic lifts and pitching moments, Side force, Yawing moments and rolling moments. Negative aero foil-applications
Ergonomics and safety: Geometrical relations to drivers seat, Dimensions of foot and pedal control, visibility. Air bags

TextBooks:

- *Garrett, T. K., Newton, K., & Steeds, W. (2000). Motor Vehicle. Butterworth-Heinemann.*
- *Heisler, H. (2002). Advanced vehicle technology. Elsevier.*
- *Singh, Kirpal. Automobile Engineering. Standard Publishers, Vol I and II.*
- *Nunney, M. J. (2007). Light and heavy vehicle technology. Routledge.*

Course outcomes

No. of Course Outcome	Course Outcomes
UME07E05.1	To understand the basic fundamentals of Automobile Engineering.
UME07E05.2	To apply knowledge of automotive engineering & practices to pursue successful career in the field of automotive technology.
UME07E05.3	To contribute to the academics and research for socio-technological development.
UME07E05.4	To demonstrate lifelong learning skills by engaging in professional activities and up-gradation of knowledge quotient.
UME07E05.5	To be able to communicate the research findings confidently and effectively.
UME07E05.6	To develop a strong base for understanding future developments in the automobile industry

CO-PO Matrices & CO-PSO Mapping of Courses

CO	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
UME07E05	Automobile Engineering													
UME07E05.1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
UME07E05.2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
UME07E05.3	3	-	-	-	-	-	2	-	-	-	-	-	2	-
UME07E05.4	3	-	-	-	-	2	-	-	-	-	-	2	-	2
UME07E05.5	-	-	-	3	-	-	-	-	3	-	-	-	-	3
UME07E05.6	-	3	2	-	3	-	-	-	-	-	-	-	-	2

PRODUCT DESIGN FOR MANUFACTURABILITY AND ASSEMBLY (Elective-II)

Course		Credit-03			Marks (Weightage)		
Name	Product Design For Manufacturability And Assembly	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME07E06**	3	0	0	30	50	20

Introduction: - Need Identification and problem definition, Concept generation and Evaluation, Embodiment Design

Selection of Materials and shape: Properties of Engineering Materials, Selection of materials, Selection of shapes, Co-selection of Materials and shapes

Selection of Manufacturing Processes:-

Review of Manufacturing Processes, Design for casting, Design for Bulk deformation processes, Design for Sheet metal forming processes, Design for Machining, Design for polymer Processing, Design for powder metallurgy, Co-selection of Materials and Processes

Design for Assembly:-

Review of Assembly processes, Design for welding, Brazing and Soldering, Design for joining of polymers, Design for Heat treatment

Design for Reliability and quality:-

Failure mode and effect analysis, Design for Quality and reliability, Approach to Robust design,Design for optimization

Course Outcomes

No. of Course Outcome	Course Outcomes
UME07E06.1	Understand how to formulate the need analysis leading to definition of the design problem. Conceptualization of design problem leading to embodiment design.
UME07E06.2	Select material base on target function, objective, constrains, and free variables of a design problem. Able to calculate material index for strength and shape factor.
UME07E06.3	Select manufacturing process and to consider design as per the process adopted for the design problem.
UME07E06.4	Select assembly process out of various assembly processes suitable to the design problem.
UME07E06.5	Understand the importance of reliability and quality, evaluation of FMEA and its application to enhance the reliability of a system
UME07E06.6	Analyse and apply the concept of reliability to increase the quality of a design problem.

CO-PO Matrices & CO-PSO Mapping of Courses

CO	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
UME07E06	Product Design For Manufacturability And Assembly													
UME07E06.1	3	3	1	-	-	1	2	-	2	1	1	1	3	1
UME07E06.2	2	2	3	-	-	1	2	1	-	1	1	-	2	3
UME07E06.3	3	-	1	-	-	-	1	-	2	1	-	1	2	2
UME07E06.4	3	-	1	-	-	-	1	-	2	1	-	1	2	2
UME07E06.5	3	2	2	-	2	1	-	1	-	1	1	-	1	2
UME07E06.6	2	2	2	-	1	1	-	1	1	1	1	1	1	2

MECHANICAL SYSTEM DESIGN & INDUSTRIAL AUTOMATION

Course		Credit-03			Marks (Weightage)		
Name	Mechanical System Design & Industrial Automation	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME07C82**	3	0	0	30	50	20

Course Contents:

Introduction of Design of Systems Introduction- Concept of Systems- General Model of A System- Application of A System Elements/Components of a System-Classification of a System in Mechanical Systems Design

Engineering Processes and the System Approach Introduction (System Approach)- Application of Systems Concepts in Engineering Identification of Engineering Functions of Systems-Characteristics of a System in "Manufacturing Systems Design"-Role of Engineer in "Mechanical System Design"-Concurrent Engineering

Design of Material Handling Equipment's Objectives of material handling system, Principal groups of materials handling equipment and classification, Scope of Material Handling, Criteria for selection of Material Handling Equipment's. Introduction to Belt Conveyors, Screw conveyors and their applications, Design of Belt conveyor- Belt selection procedure , Idler design. Design of bucket Elevator: Introduction, Types of Bucket Elevator, Design of Bucket Elevator-loading and bucket arrangements

Simulation of Mechanical Systems: Surface modeling, Solid modeling, Assembly design, modeling and simulation of mechanisms, Optimum design

Text Books:

S.P.Patil, "Mechanical System Design", Jaico Publishing House, 2005.
R.C. Mishra, "Mechanical System Design",Prentice Hall of India Private Ltd., 2009.
Ibrahim Zeid, "CAD/CAM: Theory and practice", TMH
A.K. Arora, S.K Arora, "Industrial Automation and Robotics", Laxmi Publications (P) Ltd., 2007

Reference Books:

S. Mukhopadhyay, S. Sen and A. K. Deb, "Industrial Instrumentation, Control and Automation",Jaico Publishing House, 2013.
R. Krishnan, "Electric Motor Drives, Modelling, Analysis and Control", Prentice Hall India, 2002
Herbert E. Merritt,"Hydraulic Control Systems", Wiley, 1991
Conveyor Equipment Manufacturer's Association, "Belt conveyors for bulk materials" 6th edition, The New CEMA Book
Rudenko N., "Materials handling equipment", Elnvee Publishers, 1970
Alexandrov, M., "Materials Handling Equipments", MIR Publishers, 1981.

***Course Outcomes*:**

No of COs	Course Outcomes
UME07C82.1	Classify mechanical systems
UME07C82.2	Apply systems concepts in manufacturing system design
UME07C82.3	Design material handling systems
UME07C82.4	Simulate mechanical systems
UME07C82.5	Prepare architecture of Industrial Automation Systems
UME07C82.6	Do part programming

Mapping of Course Outcomes

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME07C82.1	3	2	-	-	-	1	-	-	-	-	1	-	2	1
UME07C82.2	3	-	3	-	2	-	-	-	-	-	-	3	-	3
UME07C82.3	3	3	3	2	-	-	-	-	2	2	2	-	-	3
UME07C82.4	1	-	3	2	3	-	2	-	2	3	-	1	-	3
UME07C82.5	3	-	3	-	-	-	-	-	1	-	1	-	-	2
UME07C82.6	2	-	-	2	2	-	-	-	-	-	2	1	-	3

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ENTREPRENEURSHIP DEVELOPMENT

Course		Credit-01			Marks (Weightage)		
Name	Entrepreneurship Development	L	T	P	Mid	End	Internal
Code	**UME07B91**	0	0	2	-	100	-

Course Content:-

Entrepreneur – Types Of Entrepreneurs – Difference Between Entrepreneur And Intrapreneur Entrepreneurship In Economic Growth, Factors Affecting Entrepreneurial Growth.

Major Motives Influencing An Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps Involved In Setting Up A Business – Identifying, Selecting A Good Business opportunity, Market Survey And Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources Of Information – Classification of Needs And Agencies.

Need – Sources Of Finance, Term Loans, Capital Structure, Financial Institution, Management Of Working Capital, Costing, Break Even Analysis, Taxation – Income Tax, Excise Duty – Sales Tax.

Sickness In Small Business – Concept, Magnitude, Causes And Consequences, Corrective Measures – Business Incubators – Government Policy For Small Scale Enterprises – Growth Strategies In Small Industry – Expansion, Diversification, Joint Venture, Merger And Sub Contracting.

Text Books:

Entrepreneurship Development & Small Business Enterprises, Poornima M. Charantimath, Pearson

Reference Books:

Khanka. S.S., "Entrepreneurial Development" S.Chand& Co. Ltd.,Ram Nagar, New Delhi, 2013.
Donald F Kuratko, " Entreprenuership – Theory, Process And Practice", 9th Edition, Cengage Learning 2014
Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, 2013.
Mathew J Manimala, "Enterprenuership Theory At Cross Roads: Paradigms And Praxis" 2nd Edition Dream Tech, 2005.
Rajeev Roy, 'Entrepreneurship' 2nd Edition, Oxford University Press, 2011.
EDII "Faulty And External Experts – A Hand Book For New Entrepreneurs Publishers: Entrepreneurship Development", Institute Of India, Ahmadabad, 1986.

Course Outcomes:

UME07B91.1	Understanding different terms in the field of Entrepreneurship. Knowing about different related factors and importance, challenges of Entrepreneurship.
UME07B91.2	Understanding the influencing motives of an Entrepreneur, learning and developing different management techniques essential for becoming a successful entrepreneur.
UME07B91.3	Students will be able to identify business opportunities and feasibility of any opportunity. They will be able to conduct market survey, write business plans and project reports with logically analyzing the survey outcomes.
UME07B91.4	Students will be able to identify and act accordingly to convince the investors, financial sources for their business. In this process, students will be able to prepare different analysis reports for enhancing their chances of higher investments. The students will be aware of different Tax systems, norms, clearances needed and guidelines for setting up a business.
UME07B91.5	Students will be aware about the process to start a small business / enterprise by following the government policies. They will be able to plan and implement the strategies for business and also to manage uncertain situations by taking appropriate measures in advance.
UME07B91.6	The students will be motivated to start a business of their own with proper market survey, planning, exploring financial sources and with proper strategy. They will be able to write effective business plans which they can implement into reality.

Mapping of Course Outcomes

POs	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
UME07B91.1	-	-	-	-	-	-	3	-	-	-	-	-	-	-
UME07B91.2	-	-	-	-	-	-	-	-	3	-	3	-	-	-
UME07B91.3	-	-	-	-	-	3	3	3	-	-	-	-	-	-
UME07B91.4	-	-	-	-	-	-	3	-	-	3	-	-	-	-
UME07B91.5	-	-	-	-	-	-	-	-	3	-	3	-	-	-
UME07B91.6	-	-	-	-	-	-	-	-	3	-	3	-	2	-

INDUSTRIAL TRAINING & SEMINAR

Course		Credit-01			Marks (Weightage)		
Name	Industrial Training & Seminar	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code		0	0	3		100	

Course outcomes

No. of Course Outcome	Course Outcomes
CO 1	Survey and identify current trends being practiced in real time in industry / research in the field of Mechanical Engineering.
CO 2	Narrate the ethical and safety practice currently being followed in industry, Merits and demerits associated with the technology being adapted.
CO 3	Outline the process adapted in development of system or component for engineering application.
CO 4	Summarize the possible alternate technology available for the existing problem, societal benefit of the available technology / product / system developed.
CO 5	Summarize their survey, observations and inference by means of oral presentation and written reports

CO-PO Matrices & CO-PSO Mapping of Courses

CO	PO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
	Industrial Training & Seminar													
CO 1	-	**2**	-	-	-	-	-	-	**3**	-	-	**3**	-	-
CO 2	**3**	-	-	-	-	**2**	**2**	**2**	-	**3**	-	-	-	-
CO 3	**3**	-	-	-	-	-	-	-	-	**3**	-	-	**3**	-
CO 4	**3**	-	-	-	-	**2**	-	-	-	**3**	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	**3**	**3**	-	-	-	-

MAJOR PROJECT-I

Course		Credit-02			Marks (Weightage)		
Name	Major Project-I	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME07P102**	0	0	3		100	

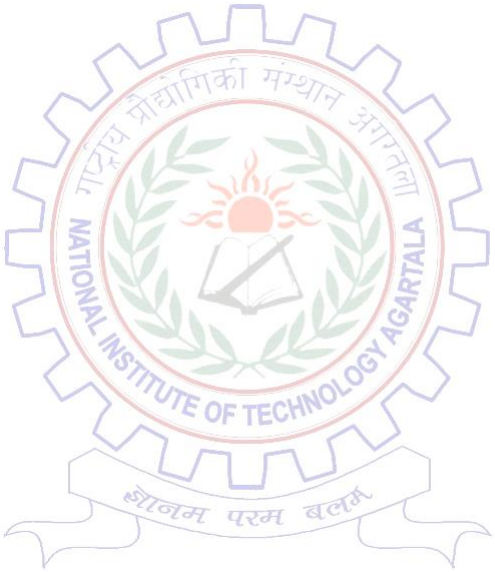
Course Outcomes

No. of Course Outcome	Course Outcomes
UME07P102.1	At the end of this course, student will be able to
UME07P102.2	Survey and identify the problems related to Mechanical Engineering.
UME07P102.3	Develop a systematic model/approach to analyze and solve the technical problems as team.
UME07P102.4	Outline the past, present and expected performance based on systematic survey.
UME07P102.5	Outline a new design of product / system in association with multidisciplinary team for societal benefit ethically in environmental friendly manner.
UME07P102.6	Conduct experiments / theoretical evaluation to some extent.

CO-PO Matrices & CO-PSO Mapping of Courses

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
UME07P102	Major Project-I													
UME07P102.1	-	3	-	-	-	-	-	-	-	-	-	3	-	-
UME07P102.2	3	3	3	-	-	-	-	-	3	-	-	-	-	3
UME07P102.3	-	-	-	-	-	-	-	-	-	3	-	3	2	-
UME07P102.4	-	-	-	-	3	2	2	2	-	-	-	-	2	3
UME07P102.5	-	-	-	2	-	-	-	-	-	-	-	-	2	-
UME07P102.6	-	-	-	-	-	-	-	-	-	3	2	-	3	-

Mechanical Engineering Department



Eighth Semester (Syllabus)

EIGHTH SEMESTER

CODE	SUBJECT NAME	L-T-P	CREDIT
UME08E51	Elective-III (Computational Fluid Dynamics)	3-0-0	03
UME08E52	Elective-III (Additive Manufacturing)		
UME08E53	Elective-IV (Powder Metallurgy)	3-0-0	03
UME08E54	Elective-IV (CAD and Geometric Modeling)		
UME08E55	Elective-V (Advanced Machine Design)	3-0-0	03
UME08E56	Elective-V (Boundary Layer Theory)		
PRACTICAL			
UME08P100	Viva-Voce	0-0-0	01
UME08P101	Major Project- II	0-0-9	03
	TOTAL CREDIT	**9-0-9**	**13**
FOR STUDENTS CARRYING OUT PROJECT WORK IN INDUSTRY/ORGANIZATION			
UME08P102	Industrial Project		10
UME08P103	Project Seminar		2
UME08P104	Comprehensive Viva		1
	TOTAL CREDIT		**13**

COMPUTATIONAL FLUID DYNAMICS (Elective-III)

Course		Credit-03			Marks (Weightage)		
Name	Computational Fluid Dynamics	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME08E51**	3	0	0	30	50	20

Course Contents

Basic Thoughts

Philosophy of Computational Fluid Dynamics, the impact of Computational Fluid Dynamics – some other examples- Automobile and Engineering applications, Industrial Manufacturing applications, Civil Engineering applications, Environmental Engineering applications. The governing equations of fluid dynamics: their derivation, a discussion of their physical meaning and presentation of forms particularly suitable to CFD: Introduction, finite control volume, infinitesimal fluid element, the substantial derivative, divergence of velocity-its physical meaning, physical boundary condition, Comments on the conservation form, shock fitting & shock capturing. Comparison of FDM, FVM and FEM technique.

Different Equations:

Mathematical Behavior of Partial Differential Equation – The Impact on CFD: Classification of quasi-linear partial differential equation, a general method of determining the classification of partial differential equations: the eigen value method, general behavior of the different classes of partial differential equation: impact on physical & computational fluid dynamics.

Basics of the Numerical Discretization

Basic aspect of Discretization methods; finite difference and finite volume formulations, difference equation, explicit and implicit approaches: definition and contrasts, Errors and an analysis of stability.

Numerical Solutions

Numerical solution of elliptical equations - Linear system of algebraic equations, Numerical solution of parabolic equations, Numerical solution of hyperbolic equations - Burgers equation.

Some Simple CFD Techniques

The lax-Wendroff Technique, MacCormack's Technique, The Relaxation Technique & its use with Low-Speed Inviscid flow, Aspects of Numerical Dissipation and Dispersion; Artificial Viscosity, The Alternating Direction Implicit (ADI)Technique. Incompressible Navier-Stokes equations and algorithms - Basics of grid generation.

Text Books:

i) *J.Andeson J.D., Computational Fluid Dynamics – The basics with applications, Mc Graw-Hill, 1995.*

ii) *Tannehill, J.e., Anderson, D.A., and Pletcher, R.H., Computational Fluid Mechanics andHeat Transfer, 2nd ed., Taylor & Francis, 1997.*

ii) *Hoffmann, K.A. and Chiang, S.T., Computational Fluid Dynamics for Engineers,Engineering Education Systems, 2000.*

Reference Books:

i) *Versteeg, H.K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics –The finite volume method, Longman Scientific & Technical, 1995.*

ii) *Patankar, S.V., Numerical Heat Transfer & Fluid Flow, Hemisphere, 1980.*

iii) *3. P.J. Roache, Fundamentals of Computational Fluid Dynamics.*

Course Outcomes:

UME08E51	Course Outcome
UME08E51.1	Comprehensive, theory-based understanding, fundamentals of computational fluiddynamics and its application, Conceptual understanding of mathematical behavior of partial differential equation and its impact onCFD.
UME08E51.2	In-depth understanding of basic aspect of discretization methods and its applications.
UME08E51.3	Application of engineering methods to Numerical Established solutions.
UME08E51.4	Understand Some Simple CFD Techniques.
UME08E51.5	Understand and apply different algorithms, CFD technique and Basics of various grid generation.

***Mapping of Course Outcomes with Program Outcomes*:**

UME08E51	PO1	PO2	PO3	PO-**4**	PO-**5**	PO-**6**	PSO-**1**	PSO-**2**
UME08E51.1	3	3	3	2	3	2	3	2
UME08E51.2	3	3	3	2	3	2	3	2
UME08E51.3	3	3	3	2	3	2	3	2
UME08E51.4	3	3	3	2	3	2	3	2
UME08E51.5	3	3	3	2	3	2	3	2
UME08E51.6	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**2**

ADDITIVE MANUFACTURING (Elective-III)

Course		Credit-03			Marks (Weightage)		
Name	Additive Manufacturing	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME08E52**	3	0	0	30	50	20

Syllabus Content

Introduction: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.
Liquid-based AM Systems: Stereo lithography Apparatus (SLA): Models and specifications,
Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Poly jet: Process, Principle, working principle, Applications,
Advantages and Disadvantages, Case studies. Micro fabrication.

Solid-based AM Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Powder Based AM Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three- dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.
AM Applications: Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry

Text Books:

i) By C. K. Chua, K. F. Leong, C. S. Lim: Rapid Prototyping: Principles and Applications

ii) Additive manufacturing by C.P PAUL

Reference

i) Additive Manufacturing Technologies" by Ian Gibson and David Rosen

ii) Design for Additive manufacturing by Dr. Tom

iii) ADDITIVE MANUFACTURING by Amit Bandyopadhyay, Susmita Bose

Course outcomes

UME08E52	**Course Outcome**
CO1	Basic of Additive manufacturing, Liquid based AM systems andit's Applications, Solid based AM systems and it's applications, Powder based AM systems .
CO2	Classification of Various processes of AM
CO3	Study of various materials of AM process
CO4	Study of various AM processes AM
CO5	Various case studies on AM processes
CO6	AM Applications

CO-PO Mapping

CO	**PO-1**	**PO-2**	**PO-3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**
CO 1	1	2	2	3	1	3	3	2
CO 2	1	2	3	3	2	3	3	2
CO 3	1	1	-	3	2	3	3	2
CO 4	1	1	3	3	2	3	3	2
CO 5	1	1	2	3	3	2	2	2
CO 6	1	-	2	2	3	3	3	3

POWDER METALLURGY (Elective-IV)

Course		Credit-03			Marks (Weightage)		
Name	Powder Metallurgy	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME08E53**	3	0	0	30	50	20

Course Contents:

Production of Metal Powders: Introduction to a) Mechanical Processes: Machining, Crushing, Milling, Shotting Graining, Atomization. b) Physico – Chemical Processes: Condensation, Thermal Decomposition, Reduction, Electrodeposition, Precipitation From Aqueous Solution, Intergranular Corrosion, Oxidation and Decarburization.

Characterization and Testing of Metal Powders: Sampling, Particle Size and Distribution- Sieve Analysis, Light Scattering, Sedimentation, Microscopy and Image Analyzer, Chemical Analysis of Metal Powders, Surface Area, Density and Porosity of Metal Powder, Apparent and Tap Density of Metal Powder, Flow Rate, Compressibility and Green Strength.

Consolidation of Metal Powder: Powder Conditioning, Cold Die Compaction Techniques, Choice of Tooling System for Die Compaction, Role of Lubrication, Hot and Cold Isostatic Pressing of Metal Powders, Roll Compacting, Powder Forging, Injection Molding, High Energy Rate Forming Process.

Sintering: Different Stages of Sintering and Development of Microstructures During Sintering, Different Mechanisms of Sintering, Liquid Phase Sintering and Activated Sintering, Sintering Furnaces and Furnace Atmospheres.

Secondary operations Performed on Powder Metallurgical Material, Inspection and Quality Control on Powder Metallurgical Materials. Application: Detailed Study on
Processing of any 03 Components used in following applications: Bearing Materials, Tool Materials, Ferrites, Cermets, Friction Materials, Medical and Dental Applications, Nuclear Applications, Automotive Applications.

Ceramic Materials: Crystalline structure, Glasses and other non-crystalline ceramics, Processing of Ceramics, Traditional and Technical Ceramics, Electrical, Thermal and Mechanical properties of ceramics, Effect of Temperature on Mechanical Behaviour, Strengthening of Ceramics

Text Books:

i. Powder Metallurgy: Science, Technology, and Materials, Anish Upadhyaya, Gopal Shankar Upadhyaya, CRC Press

ii. Powder Metallurgy: Science, Technology and Applications, P. C. Angelo, R. Subramanian

Reference Books:

1. *ASM W.D.Kingery, Introduction to Ceramic Material, Volume 18, Wiley 1960.*
2. *Powder Metallurgy, ASM Handbook, Vol – VII, 1984.*
3. *Rehamann, Processing of Ceramics and Sintering 2nd edition, 2007*
4. *Sands & Shakespeare - Powder Metallurgy, Newnes: 1966.*
5. *Barsaum - Fundamentals of Ceramics- 2003.*

***Course outcomes*:**

UME08E53.1	Identify various powder manufacturing processes
UME08E53.2	Explain effect of particle size and shape on compressibility of powders, consolidation of powder, secondary operations and applications
UME08E53.3	Apply various characterization techniques for knowing phase transformation and properties
UME08E53.4	Analyze sinter part for sinter ability of the powders
UME08E53.5	Evaluate microstructural features of sintered products
UME08E53.6	Design sintering cycle and process for the given alloy

Mapping of course outcomes

CO No.	PO-1 (C4)	PO-2 (C4/A4)	PO-3 (C3/A4)	PO-4 (C3/C5)	PO-5 (C5/P5)	PO-6 (A3/C5)	PO-7 (A2)	PO-8 (C5)	PO-9 (P2)	PO-10 (P6)	PO-11 (A2/C3)	PO-12 (C2/P3)	PSO1	PSO2
CO-1	3	2	2	-	-	-	1	-	1	-	-	1	3	-
CO-2	3	2	2	-	1	-	1	-	1	-	-	1	2	-
CO-3	3	2	2	-	1	-	1	-	1	-	-	1	3	2
CO-4	3	2	2	-	-	-	1	-	1	-	-	1	2	2
CO-5	3	2	2	-	1	-	1	-	1	-	-	1	1	-
CO-6	3	2	2	-	1	-	1	-	1	-	-	1	1	3
Avg.	3	2	2	-	1	-	1	-	1	-	1	1	2	2.33

CAD AND GEOMETRIC MODELING (Elective-IV)

Course		Credit-03			Marks (Weightage)		
Name	CAD and Geometric Modeling	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME08E54**	3	0	0	30	50	20

Course Contents:

Product life cycle, Role of CAD in design process, CAD hardware and software, Criteria to evaluate CAD softwares, Computer Communications, Principle of networking, classification networks

D Modeling

Parametric representation of analytic curves, parametric representation of synthetic curves like Bezier curve, B-spline curve; Representation of synthetic surfaces like Bezier surface, B-spline surface

Solid Modeling

Solid modeling, Boolean operations, Methods, Boundary Representation, Constructive Solid Geometry, Sweep, solid manipulations, solid modeling based applications: mass properties calculations

Transformations

Transformation of geometric models: translation, scaling, reflection, rotation, homogeneous representation, concatenated transformations, Inverse Transformations, Mapping

Data Exchange Formats

Introduction to CAD/Cam data exchange formats. Direct and Indirect translators. Neutral file formats: Data Exchange format (DXF), Standard Triangular Languages (STL), Initial Graphics Exchange Specification (IGES)

Course Outcomes:

UME08E54.1	Choose suitable CAD hardware and software tools
UME08E54.2	Develop synthetic representation of curves
UME08E54.3	Develop synthetic representation of surfaces
UME08E54.4	Apply techniques for solid modeling
UME08E54.5	Transform the models
UME08E54.6	Apply data exchange formats

Mapping of Course Outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME08E54.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
UME08E54.2	-	3	3	2	-	-	-	-	3	-	-	-	-	3
UME08E54.3	3	2	2	2	-	-	-	-	3	-	-	-	2	2
UME08E54.4	3	-	3	-	-	-	-	-	3	-	-	-	-	3
UME08E54.5	-	3	3	-	-	-	-	-	3	-	-	-	-	3
UME08E54.6	-	3	3	3	-	-	-	-	3	-	-	2	-	3

Text Books:

i) *Ibrahbim Zeid, "CAD / CAM Theory and Practice", Tata McGraw Hill Publishing Company*

ii) *Rogers / Adams, "Mathematical Elements for Computer Graphics". McGraw Hill Education*

Reference Books:

i) *M.E. Mortenson, "Geometric Modeling", Industrial Press Inc., USA*

ii) *Jim Browne, "Computer Aided Engineering and Design". New Age International publisher*

ADVANCED MACHINE DESIGN (Elective-V)

Course		Credit-03			Marks (Weightage)		
Name	Advanced Machine Design	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME08E55**	3	0	0	30	50	20

Course Contents:

Basic curves, Advanced curves. Combination Cams.

Flat Belt Drives, Types, Belt materials, Belt slip and Creep, Design procedure of Flat and V-belt.

Material Handling System, Design principles, Design of Conveyor belt, Different types of Conveyers, Safety devices.

Design of general purpose Gear box, Automobile Gear box, Machine tool Gear box. Use of design data in gear box designing.

Design of Crankshaft, Connecting rod, Cylinder, Cylinder head, Crank Shaft Materials.

Approach to solve design problems of a system for its kinetics, kinematics along with power transmission. Optimization, Optimum design, Mathematical Methods of optimization, Johnson's Method of Optimization.

Course Outcomes:

UME08E55.1	Understand fundamentals of various machine tools and mechanical systems.
UME08E55.2	Analyze & design important machine parts and can solve numerical problems in these topics in connection to design requirement.
UME08E55.3	Understand different material handling machineries in a detailed manner. They will be able to design the widely used material handling machineries (in industries) like Flat belts, V belts. They will be able to design important operational parameters in Conveyer Belt systems.
UME08E55.4	Design a Gear Box with full detail as per requirement from the user. The students will be able to solve practical problems related to power transmission.
UME08E55.5	Design different types of Cams/ combination cams as per the design requirement and analyze their motions.
UME08E55.6	Students will be able to design and analyze in team/ individual, design and optimize the parameters involved to obtain optimum design output, for different real life problems.

Mapping of Course Outcomes

POs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME08E55.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
UME08E55.2	-	3	3	2	-	-	-	-	3	-	-	-	-	3
UME08E55.3	3	2	2	2	-	-	-	-	3	-	-	-	2	2
UME08E55.4	3	-	3	-	-	-	-	-	3	-	-	-	-	3
UME08E55.5	-	3	3	-	-	-	-	-	3	-	-	-	-	3
UME08E55.6	-	3	3	3	-	-	-	-	3	-	-	2	-	3

Reference Books:

1. *Cam Design Hand Book, McGraw Hill Publications. Harold A. Rothbarth*
2. *Shigley's Mechanical Engineering Design, 9th Edition, Richard. G. Budyans& J. Keith Nisbett.*
3. *Design of Machine Elements, Fourth Edition, V.B . Bhandari*
4. *Design of Machinery, Robert. L. Norton.*
5. *Engineering & Science Application for Belt Conveyors, Iswar. G. Mulani.*
6. *Design of Transmission Elements, T.J. Prabhu*
7. *Hand Book of Gear Design, Gitin. M. Mitra, Tata McGraw Hill Publications*
8. *Machine Design Data Book, V.B. Bhandari*
9. *PSG Design Data Book & ISO 11592, ISO 8730*
10. *Design data Hand Book, K. Balaveera Reddy, K. Mahadevan*
11. *Optimization for Engineering Design: Algorithms and Examples, K.Deb. PHI Publications*.

BOUNDARY LAYER THEORY (Elective-V)

Course		Credit-03			Marks (Weightage)		
Name	Boundary Layer Theory	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME08E56**	3	0	0	30	50	20

Course Contents:

Unit: 1
Review of basic concepts and introduction of boundary layer phenomena and its
Unit: 2
ClassificationsBoundary layer thickness, displacement, momentum thickness, wall friction
Unit: 3
Derivations and applications of laminar, transition and turbulent boundary layer
Unit: 4
EquationsAnalyses and solutions of thermal boundary layer
Unit: 5
Analyses and solutions of separation of boundary layer

Text Books:
1. H. Schlichting, 'Boundary Layer Theory', McGraw- Hill.

Reference Books:
1. Introduction to Fluid Mechanics and Fluid Machines: by S. K. Som, Gautam Biswas and Suman Chakraborty, McGraw-Hill Education.

Course outcomes:

CO	Statement
UME08E56.1	Understand the basic principles of boundary layer phenomena
UME08E56.2	Understand the boundary layer parameters
UME08E56.3	Explain the concepts of boundary layer regimes
UME08E56.4	Gain the knowledge to use thermal boundary layer thickness
UME08E56.5	Explain the separation of boundary layer
UME08E56.6	Understand the interrelation of separation of boundary layer

Mapping of course outcomes

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
UME08E56.1	3	2	2	2	1	1	1	1	1	1	1	1	3	2
UME08E56.2	3	2	2	2	1	1	1	1	1	1	1	1	3	2
UME08E56.3	3	2	2	2	1	1	1	1	1	1	1	1	3	2
UME08E56.4	3	2	2	2	1	1	1	1	1	1	1	1	3	2
UME08E56.5	3	2	2	2	1	1	1	1	1	1	1	1	3	2
UME08E56.6	3	2	2	2	1	1	1	1	1	1	1	1	3	2

VIVA–VOCE

Course		Credit 01			Marks (Weightage)		
Name	Viva–Voce	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	UME08P100	0	0	0		100	

Course Outcomes

CourseOutcome	Course outcomes
UME08P100.1	Comprehend any given problem / concept related to mechanical engineering field.
UME08P100.2	Recall, recognize, visualize, demonstrate, criticize and appraise the aspects of mechanical engineering systems and the interaction among them.

CO-PO Matrices & CO-PSO Mapping of Course

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
UME08P100	Viva–Voce													
UME08P100.1	3	3	-	2	-	-	-	-	3	3	-	2	-	-
UME08P100.2	3	2	2	-	-	-	-	-	3	3	-	2	-	-

MAJOR PROJECT-II

Course		Credit 03			Marks (Weightage)		
Name	Major Project-II	**L**	**T**	**P**	**Mid**	**End**	**Internal**
Code	**UME08P101**	0	0	9		100	

Course Outcomes

No. of Course Outcome	Course outcomes
UME08P101.1	Demonstrate the role of Mechanical Engineers in the Design, Processing and Testing stages of product / system with ethical responsibility
UME08P101.2	Approach, identify, demonstrate and solve the technical problems using various available modern tools and techniques
UME08P101.3	Outline the past, present and expected performance of a product / system in Engineering practice, knowledge of safety and environmental standards, cost estimation, scheduling of project, team management and ethical practice.
UME08P101.4	Develop new product / system in association of multidisciplinary team which is useful to society, cost effective and understand the importance of rendering service after sales.
UME08P101.5	Survey, Analyze, summarize, infer and communicate their chosen domain problems and result optimistically by means of oral presentation and written reports

CO-PO Matrices & CO-PSO Mapping of Course

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
UME08P101	Project (Part - II)													
UME08P101.1	3	3	3	-	-	2	3	2	3	-	-	-	3	2
UME08P11.2	-	-	-	3	3		-	-	3	-	-	3	-	3
UME08P101.3	-	-	-	-	-	3	-	3	3	-	-	3	3	-
UME08P101.4	-	-	3		-	3	-	-	3	-	3	-	3	3
UME08P101.5	-	3		2	-	-	-	-	3	3	-	3	3	2