SCHEME OF COURSES FOR
BE (Mechanical Engineering)

First Semester

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UMA001	Mathematics - I	3	1	0	3.5
2.	UTA001	Engineering Graphics	2	4	0	4.0
3.	UTA003	Computer Programming	3	0	2	4.0
4.	UPH001	Physics	3	1	2	4.5
5.	UES006	Engineering Mechanics	2	1	0	2.5
6.	UHU001	Communication Skills	2	0	2	3.0
		Total	**15**	**7**	**6**	**21.5**

Second Semester

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UMA002	Mathematics - II	3	1	0	3.5
2.	UTA002	Manufacturing Processes	2	0	3	3.5
3.	UES002	Solid Mechanics	3	1	2	4.5
4.	UES001	Electrical and Electronics Science	3	1	2	4.5
5.	UES004	Thermodynamics	3	1	0	3.5
6.	UEN001	Environmental Studies	3	0	0	3.0
7.	UCB002	Chemistry Lab	0	0	3	1.5
		Total	**17**	**4**	**10**	**24.0**

Third Semester

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UMA032	Numerical and Statistical Methods	3	1	2	4.5
2.	UES031	Fluid Mechanics	3	1	2	4.5
3.	UES032	Material Science and Engineering	3	1	2	4.5
4.	UME301	Industrial Engineering	3	0	2	4.0
5.	UME302	Kinematics of Machines	3	1	0	3.5
6.	UME303	Machine Drawing	1	2	2	3.0
		Total	**16**	**6**	**10**	**24.0**

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Fourth Semester

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UMA031	Optimization Techniques	3	1	0	3.5
2.	UES033	Measurement Science and Techniques	3	1	0	3.5
3.	UHU031	Organizational Behavior	3	1	0	3.5
4.	UME401	Computer Aided Design	2	0	4	4.0
5.	UME402	Dynamics of Machines	3	1	0	3.5
6.	UME403	Engineering Metrology	1	0	2	2.0
7.	UME404	Mechanics of Deformable Bodies	3	1	0	3.5
8.	UHU033	Total Quality Management	3	1	0	3.5
		Total	**21**	**6**	**6**	**27.0**

Fifth Semester

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UME501	Applied Thermodynamics	3	1	2	4.5
2.	UME502	Automobile Engineering	3	0	2	4.0
3.	UME503	Industrial Metallurgy and Materials	3	1	0	3.5
4.	UME504	Machine Design	3	2	0	4.0
5.	UME505	Manufacturing Technology	3	0	3	4.5
6.		Elective-I	3	1	0	3.5
7.	UME591	Summer Training (Six weeks during summer vacations after 2nd year)				4.0
		Total	**18**	**5**	**7**	**28.0**

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Sixth Semester

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UME691	Project Semester*				16.0
		Total				**16.0**

OR

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UME692	Project				6.0
2.	UME601	Industrial Automation	2	0	2	3.0
3.	UME602	Production and Inventory Control	3	2	0	4.0
5.		Elective-II	2	2	0	3.0
		Total	**7**	**4**	**2**	**16**

* To be carried out in Industry/Research Institution.

Seventh Semester

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UME701	Advance Machine Design	3	2	0	4.0
2.	UME702	Computer Aided Manufacturing	3	0	2	4.0
3.	UME703	Fluid Machinery	3	1	2	4.5
4.	UME704	Heat and Mass Transfer	3	1	2	4.5
5.	UME705	Machining Science	3	1	2	4.5
6.	UME706	Mechanical Vibrations	3	2	0	4.0
		Total	**18**	**5**	**10**	**25.5**

Eight Semester

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UHU081	Engineering Economics	3	1	0	3.5
2.	UME801	Mechanical System Design	1	0	6	4.0
3.	UME802	Mechatronics	3	2	0	4.0
4.	UME803	Refrigeration and Air Conditioning	3	1	2	4.5
5.	UME804	Turbomachines	3	1	0	3.5
6.		Elective-III	3	1	0	3.5
		Total	**16**	**6**	**8**	**23.0**

Approved by the Senate in its 70th meeting held on May 25,2009

List of Electives

Elective-I

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UCH715	Alternate Energy Sources	3	1	0	3.5
2.	UTA004	Information Technology	2	1	2	3.5
3.	UEE522	Energy Auditing and Management	3	1	0	3.5
4.	UPH062	Nano Science and Nano Materials	3	1	0	3.5
5.	UMA061	Advanced Numerical Method	3	1	0	3.5
6.	UMA062	Graph Theory and Applications	3	1	0	3.5

Elective-II

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UME621	Facilities Planning	2	2	0	3.0
2.	UME622	Industrial Design and New Product Development	2	2	0	3.0
3.	UME623	Management Information Systems	2	2	0	3.0
4.	UME624	Waste Heat Recovery Systems	2	2	0	3.0

Elective-III

S. No.	Course No.	Course Name	L	T	P	Cr
1.	UME831	Computational Fluid Dynamics	3	1	0	3.5
2.	UME832	Finite Element Methods	3	1	0	3.5
3.	UME833	Inspection and Quality Control	3	1	0	3.5
4.	UME834	Internal Combustion Engines	3	1	0	3.5
4.	UME835	Metal Forming	3	1	0	3.5
5.	UME836	Operations Management	3	1	0	3.5
6.	UME837	Power Plant Engineering	3	1	0	3.5
7.	UME838	Principles of Robotics Engineering	3	1	0	3.5

Total Number of Credits: 189.0

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UES003 APPLIED MECHANICS

L	T	P	Cr
3	1	2	4.5

(For Biotechnology, Chemical Engineering and Electrical Engineering Branches Only)

Equivalent Force Systems: Vector Algebra, Planar force systems, Coplanar collinear forces, Concurrent forces, Coplanar parallel forces, Basic concepts of force-couple systems, Varignon's theorem, Simplest equivalent for general force system, Distributed force systems.

Equations of Statics and its Applications: Simple frictionless rigid body assemblies; Equations of equilibrium, Free body diagrams, Support reactions, Two-force members; Plane trusses.

Centre of Gravity, Mass and Area Moment of Inertia: Centroid of simple and built up section, Second moment of area.

Axial stress and strain: Concept of stress and strain, Generalized Hooke's law, Stress-strain diagram of ductile and brittle materials, properties of engineering materials, statically determinate and indeterminate problems, Compound and composite bars, Thermal stresses.

Torsion of Circular shafts: Basic assumptions, Torsion formula, Power transmitted by shafts, Design of solid and hollow shafts based on strength and stiffness.

Shear force and Bending Moment Diagrams: Types of load on beam, Classification of beams, Shear force and bending moment diagrams: Simply supported, Overhung and Cantilever beams subjected to any combination of point loads, Uniformly distributed and varying load and moment, Relationship between load, shear force and bending moment.

Theory of Pure Bending: Derivation of flexural formula for straight beams, Bending stress calculation for beams of simple and built up sections, Flitched beams.

Shear Stresses in Beams: Shear stress formula for beams, Shear stress distribution in beams.

Analysis of Plane Stress and Strains: Transformation equations for plane stress and plane strain, Mohr's stress circle, Relation between elastic constants, Strain measurements, Strain rosettes.

Laboratory Work

- ***Tests for Hardness, Bending, Impact, Tensile strength, Torsion and Compression tests.***

List of Experiments

1. Rockwell/Brinell hardness number of given specimens.
2. Vicker's hardness number test.
3. Torsion test (Destructive): To determine the torsional rigidity of the material.
4. Tensile test on strip/universal testing machine – to obtain the young's modulus of elasticity, tensile strength and percentage elongation of the material.
5. Impact strength of the given material – Izod's and Charpy tests.

6. Experimentally determine the value of E of the beam material using deflections formula for cantilever and simply supported beams.
7. Non-destructive torsion test to determine modulus of rigidity of the shaft material.
8. To study the behavior of the material on UTM.

Textbooks

1. *Bhattacharyya, B., Engineering Mechanics, Oxford University Press (2009).*
2. *Singh, D.K., Mechanics of Solids, Pearson Education Ltd. (2002).*

Reference books

1. *Nanda, S., Basu, N. and Nayak, P.C., Introduction to Mechanics, Narosa Publishing House (1999).*
2. *Shames, Irving H. and Piltarresi, J. M., Solid Mechanics, Prentice Hall of India (1993).*
3. *Crandall, S.H., Dahl, N.C. and Lardner, T.J., An Introduction to the Mechanics of Solids: An Introduction, Tata McGraw Hill (2007) 2nd ed.*

UTA003 COMPUTER PROGRAMMING

L	T	P	CR
3	0	2	4.0

Prerequisite(s): None

Introduction: Elements of computer processing, Hardware and software, Introduction and feature wise comparison of various Operating Systems, Including DOS, Windows and Linux, Problem solving-algorithms and flowcharts.

C Programming Basics: Basic program construction, Structure of a C program, Compilation process. Various compilers available on different OS/ environments including Turbo C, Borland C, gc, gcc, MSVC. Console I/O (printf, scanf), preprocessor directives, Comments, Data types, Type conversions, Operators - arithmetic, Relational, Logical, Conditional, Increment/decrement, Library functions, Header files.

Loops and Decision Statements: *for* loop, *while* loop, *do* loop, Various forms of *if* statement, *switch* statement, *break* statement, *continue* statement, *goto* statement, arrays and strings, Declaring an array, Initializing arrays, Accessing the array elements, Working with multidimensional arrays, Declaring and initializing string variables, Arithmetic operations on characters, String handling functions (string.h), Pointers, Pointers to pointers, Declaring and initializing pointers, Pointer expressions, Pointer increment and scale factor, Pointers and arrays, Pointers and strings.

Functions: Defining functions, Passing arguments to functions, Returning values from functions, Reference arguments, Variables and storage classes, Static functions, Pointers and functions.

Structures and Union: Declaring and initializing a structure, Accessing the members of a structure, Nested structures, Array of structures, Using structures in functions, Pointers and structures, Declaring and initializing a union.

Files: Reading and writing to text and binary files, Character I/O, String I/O, File pointers, Error handling, Redirection, Command line arguments.

Structured Programming vs. Object Oriented Programming.

Laboratory work

Introduction to Hardware - CPU, Storage devices & media, VDU, I/O Devices. Basic Operating System (DOS/UNIX) commands. Simple programs to demonstrate the use of constants, Variables, printf, scanf and operators. Programs using Loops: Solution of quadratic equation, Summation of finite series, Fibonacci series, Prime numbers, Factorial. Menu driven programs using switch statement. Use of continue and break statements, Conditional operators. Passing variables to functions by values and by reference, Number conversion using array, Sorting, Merging, Arithmetic operations on matrices. String manipulation: Comparing, Copying, Reversing , Finding length, Extracting characters. Simple programs demonstrating the concept of Pointers, Passing values to functions using pointers for arrays, Structures. Creating various types of records using structures. Storing and retrieving records from a file, Copying a data file. Randomly accessing a record, Use of command line arguments.

Text Books

1. *KernighanBrian W. and Ritchie, Dennis M, The C Programming language, Dorling Kingsley(2008) 2nd ed.*
2. *Balagurusamy, E., Programming in Ansi C, TMH Publications (2007) 3rd ed.*

Reference Books

1. *Stroustrup, Bjarne, The C++ Programming Language,. Addison Wesley (2000) 3rd ed.*
2. *Kanetkar, Yashavant, Let Us C, BPB 7th Ed. (2006) 8th ed.*

UES001 ELECTRICAL AND ELECTRONICS SCIENCE

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Introduction: Basic electrical quantities, Electric circuit sources and circuit elements and their behavior (Active and passive).

Supply Systems: AC Supply system (Single phase, Three phase–three wire, Three phase–four wire), DC supply system, Their specifications and Comparison. D.C. Networks: Mesh and Nodal Analysis, Star–Delta Transformation, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Step voltage response of RL and RC series circuits.

Sinusoidal Steady-State Response of Circuits: Concept of Phasors, Phasor representation of circuit elements, Complex notation representation, Series and parallel circuits, Power and power factors, Resonance in series and parallel circuits, Balanced 3–phase voltage, Current and power relations, 3–phase power measurement.

Magnetic Circuits: Concept of Magnetic circuits, B–H curve, Calculation of Magnetic Circuits, Iron Losses.

Single–Phase Transformers: Constructional feature, EMF equation, Ideal transformer, Open and short circuit tests, Voltage regulation and efficiency.

Rotating Electrical Machines: Construction, Operating principles and Applications of DC generator, DC motor, Three phase Induction motor and Single phase induction motors.

Electrical safety and Wiring: Electrical safety and standards, House hold wiring and electric appliances.

Energy Management: Conservation efforts, Auditing.

Electronic Devices: P–N diode, BJT, SCR, FET, MOSFET, Their V–I characteristics and applications (Diode as rectifier, Zener diode as voltage regulator).

Laboratory Work

Kirchhoff's laws, Network theorems, A.C. series and parallel circuits, Resonant circuit, Measurement of power 3–phase circuits, Reactance calculation of variable reactance choke coil, Tests on transformers, Starting methods of DC motor, Three phase induction motor and single phase induction motor, Identification and testing of devices (R,L,C, Diode and Transistor), V–I Characteristics of P–N diode, Zener diode , BJT as amplifier, Use of diode as half wave and full wave rectifier.

Textbooks

1. *Smith, I.M., Hiley, J. and Brown, K., Electrical and Electronic Technology, Dorling Kingsley (2007) 9th ed.*
2. *Nagrath, I.J. and Kothari, D.P., Basic Electrical Engineering, Tata McGraw–Hill (2002) 2nd ed.*
3. *Naidu, M.S. and Kamashaiah, S., Introduction to Electrical Engineering, Tata McGraw–Hill (2004).*

Reference Books

1. *Chakrabarti, A., Basic Electrical Engineering, Tata McGraw–Hill (2008).*
2. *Del Toro, V., Electrical Engineering Fundamentals, Prentice–Hall of India Private Limited (2008) 2nd ed.*

UES033 MEASUREMENT SCIENCE AND TECHNIQUE

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): None

Introduction: Definition, Application and types of measurements, Instrument classification, Functional elements of an instrument, Input-output configuration of measuring instruments, Methods of correction for interfering and modifying inputs, Standards, Calibration, Introduction to Static characteristics and Dynamic characteristics, Selection of instruments, Loading effects.

Error Analysis: Types of errors, Methods of error analysis, Uncertainty analysis, Statistical analysis, Gaussian error distribution, Chi-Square test, Correlation coefficient, Student's t-test, Method of least square, Curve fitting, Graphical analysis, General consideration in data analysis, Design of Experiment planning.

Sensors and Transducers: Definition, Types, Basic principle and applications of Resistive, Inductive, Capacitive, Piezoelectric, Hall-Effect, Photoemissive, Photo Diode/ Photo Transistor, Photovoltaic, LVDT, Strain Gauge and Digital Transducers, Signal Conditioning Circuits (Bridges, Op-Amps, Instrumentation Amplifiers, Filters).

Measurement of Parameters: Measurement of Length, Angle, Area, Temperature, Pressure, Flow, Speed, Force, Torque, Vibrations, Level, Concentration (Conductivity and pH) measurement, Voltage (PMMC, Dual slope), Current and Power. Telemetry, Display devices and Recorders: Telemetry and Remote Sensing, GIS (Geographical Information System), Various display devices and Recorders, CRO (Basic block diagram, Deflection sensitivity, Application: Voltage, Current, Frequency and phase angle measurement), Digital frequency meter and universal counter.

Text Books

1. *Doeblin, E.O., Measurement systems, Tata McGraw Hill (2007).*
2. *Nakra, B.C. and Chaudhry, K.K., Instrumentation Measurement and Analysis, Tata McGraw–Hill (2003) 2nd ed.*

Reference Books

1. *Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall of India (2008) 2nd ed.*
2. *Sawhney, A.K. and Sawhney, P., A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai (2008) 18th ed.*

UTA001 ENGINEERING GRAPHICS

L	T	P	Cr
2	4	0	4.0

Prerequisite(s): None

Introduction: Use of drafting tools, Lettering, Dimensions and Standards, Line Conventions.

Projection Systems: Projection Planes, Projection systems, Orthographic projections of points in first angle projection system and third angle projection system, Orthographic projections of lines on reference planes, True length of line using rotation of view method, Traces of lines, Auxiliary planes and their applications, Projections of Lamina parallel/inclined to reference planes, Projection of solids- Polyhedra, Solids of revolution, Sections of solids- Section plane parallel / inclined to reference planes, Intersection of solids.

Development of Surfaces: Development of surfaces like Prism, Pyramid, Cylinder, Cone, Sphere etc. using Parallel Line Method, Radial Line Method, Triangulation method.

Orthographic Projections: Extracting Orthographic projections from given pictorial views.

Isometric Views: Extracting Isometric projections from given Orthographic views using box method, Offset method.

Missing Lines and Missing Views: Evaluating missing lines and missing views from given orthographic views.

Computer Aided Drafting: Introduction to computer drafting tools like AutoCAD. Demonstration of commands like Line, Circle, Arc, Rectangle, MText and Dimensioning etc.

Text Books

1. *Gill, P.S., Engineering Drawing - Geometrical Drawings, S.K. Kataria (2008).*
2. *Mohan, K.R., Engineering Graphics, Dhanpat Rai Publishing Company (P) Ltd (2002).*

Reference Books

1. *French, Thomas E., Vierck, C. J. and Foster, R. J., Fundamental of Engineering Drawing & Graphics Technology, McGraw Hill Book Company (2005).*
2. *Bhatt, N.D. and Panchal, V.M., Engineering Drawing: Plane and Solid Geometry, Charotar Publishing House (2006) 49th ed.*

UTA002 MANUFACTURING PROCESSES

L	T	P	Cr
2	0	3	3.5

Prerequisite(s): None

Introduction: Common engineering materials and their important mechanical and manufacturing properties, General classification of manufacturing processes.

Metal Casting: Principles of metal casting, Patterns, Their functions, Types, Materials and pattern allowances, Characteristics of molding sand, Types of cores, Chaplets and chills, their materials and functions, Moulds and their types, Requisites of a sound casting, Introduction to Die Casting.

Metal Forming and Shearing: Forging, Rolling, Drawing, Extrusion, Bending, Spinning, Stretching, Embossing and Coining, Die and Punch operation in press work, Shearing, Piercing and blanking, Notching, Lancing.

Machining Processes: Principles of metal cutting, Cutting tools, their materials and applications, Geometry of single point cutting tool, Cutting fluids and their functions, Basic machine tools and their applications, Introduction to non-traditional machining processes (EDM, USM, CHM, ECM, LBM, AJM, and WJM).

Joining Processes: Electric arc, Gas, Resistance and Thermit welding, Soldering, Brazing and Braze welding, Adhesive bonding, Mechanical fastening (Riveting, Screwing, Metal stitching, Crimping etc.).

Plastic Processing: Plastics, their types and manufacturing properties, Compression molding, Injection molding and Blow molding, Additives in Plastics.

Modern Trends In Manufacturing: Introduction to numerical control (NC) and computerized numerical control (CNC) machines, Programmable automation (FMS, CIM, etc.).

Laboratory Work

Relevant shop floor exercises involving practice in pattern making, Sand casting, Machining, Welding, Sheet metal fabrication techniques, Fitting work and surface treatment of metals, Demonstration of Forge welding, TIG/MIG/GAS/Spot/Flash butt welding, Demonstration on Shaper, Planer and Milling machine.

Text Books

1. *Degarmo, E. P., Kohser, Ronald A. and Black, J. T., Materials and Processes in Manufacturing, Prentice Hall of India (2008) 8th ed.*
2. *Kalpakjian, S. and Schmid, S. R., Manufacturing Processes for Engineering Materials, Dorling Kingsley (2006) 4th ed.*

Reference Books

1. *Martin, S.I., Chapman, W.A.J. , Workshop Technology, Vol.1 & II, Viva Books (2006) 4th ed.*
2. *Zimmer, E.W. and Groover, M.P., CAD/CAM - Computer Aided Designing and Manufacturing, Dorling Kingsley (2008).*
3. *Pandey, P.C. and Shan, H. S., Modern Machining Processes, Tata McGraw Hill (2008).*
4. *Mishra, P. K., Non Conventional Machining, Narosa Publications (2006).*
5. *Campbell, J.S., Principles of Manufacturing, Materials and Processes, Tata McGraw Hill Company (1999).*
6. *Lindberg, Roy A., Processes and Materials of Manufacture, Prentice Hall of India (2008) 4th ed.*

UES004 THERMODYNAMICS

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): None

Basic Concepts: Concept of Continuum, Macroscopic approach, Thermodynamics system & properties, Various processes, Thermodynamic equilibrium, Ideal gas, Vander Waals equation of state, Compressibility chart, Process: Flow and non flow process, Cycle concept of work and heat, Specific heats, Zeroth law, Energy and its form, Pure substance, Thermodynamic diagrams, Triple point, Steam tables and their use.

First Law of Thermodynamics: Concept of internal energy & enthalpy, Energy equation as applied to a close and open system, PMMI, Transient flow processes.

Second Law of Thermodynamics & its Corollaries: Kelvin Plank and Clausius statements, Reversible and Irreversible processes, Carnot cycle, Clausius theorem and concept of entropy, Principle of increase of entropy, PMM2, Thermodynamic temperature scale, Second law analysis of control volume, Availability, Irreversibility, Availability function for open and closed system & second law efficiency.

Thermodynamic Cycles: Rankine cycle, Vapour compression refrigeration cycle, Air standard cycles: Otto, Diesel, Dual and Brayton cycles.

Non-Reacting Gas Mixtures: Properties of mixtures of gases and vapours, Adaibatic saturation, Properties of air.

Thermodynamic Relations: Maxwell & T-ds equations.

Text Books

1. *Sonntag, R.E., Borgnakke, C. and Van Wylen, G.J., Fundamentals of Thermodynamics, John Wiley (2007) 6th ed.*
2. *Nag, P.K., Engineering Thermodynamics, Tata McGraw Hill (2008) 3rd ed.*

Reference Books

1. *Rao, Y.V.C., Thermodynamics, Universities Press (2004).*
2. *Ratha Krishana , E., Fundamentals of Engineering Thermodynamics, Prentice Hall of India (2005) 2nd ed.*
3. *Cengel, Y. A. and Boles, M., Thermodynamics: An Engineeing Approach, Tata McGraw Hill (2008).*
4. *Rogers, G. and Mayhew, Y., Engineering Thermodynamics, Pearson Education (2007) 4th ed.*

UES032 MATERIALS SCIENCE AND ENGINEERING

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Crystal Structure and Chemical Bonding: Materials and their classification, Mechanical, Chemical, Electrical properties, Structure-property relationship in engineering materials, Miller Indices, Crystal planes and directions, Determination of crystal structure using X-rays, Chemical bonding in solids, Primary and Secondary bonds.
Structure of Solids: Crystalline and non-crystalline materials, Inorganic solids, Silicate structures and its applications.
Crystal Imperfections: Point defects, Line defects, Surface defects, Movement of Dislocation, Dislocation energy.
Diffusion: Laws of diffusion, Temperature dependence of diffusion coefficient, Determination of activation energy.
Mechanical Properties of Materials: Elastic, Anelastic and Viscoelastic behaviour, Plastic behaviour of solids, Critical shear stress, Twinning and slipping phenomenon, Creep.
Equilibrium Diagram: Solids solutions and alloys, Gibbs phase rule, Isomorphous and eutectic phase diagrams and their construction, Lever arm rule, Application of phase diagrams, Zone refining.
Corrosion Process: Corrosion, Cause of corrosion, Types of corrosion, Protection against corrosion.
Conducting and Resistor Materials: Conducting and resister materials, Coefficient of thermal expansion, Matthiessen and Nordheim rules for alloys and their engineering application.
Semiconductors: Semiconducting materials, Element and compound semiconductors their properties and applications.
Magnetic Materials: Magnetic materials, Soft and hard magnetic materials their properties and applications.
Dielectric Materials: Dielectric materials, Polarization, Dielectric loss and dielectric breakdown, Ferro, Piezo-and Pyroelectric materials, their properties and applications.
Biomaterials and Applications: Biomaterials with reference to biopolymer and bioceramics.
Modern Materials: Introduction and application to nanomaterials, Smart materials and structures, Optical materials, Superconducting materials, Materials for nuclear and space applications.

Laboratory Work

1. To determine Curie temperature of a ferrite sample and to study temperature dependence of permeability in the vicinity of curie temperature.
2. To study cooling curve of a binary alloy.
3. Determination of the Young's modulus and Ultimate strength of a given fiber strand.
4. To determine the dielectric constant of PCB laminate.
5. Detection of flaws using ultrasonic Flaw Detector (UFD).
6. To study the intensity response of L.D.R and voltage response of a V.D.R.
7. To prepare two metallic specimens for metallographic examination and measure their grain size.
8. Estimation of band-gap energy of Germanium.
9. To determine the light intensity response of a Silicon Solar Cell.
10. To determine the resistivity of a given sample using four probe method.
11. To determine Fiber and void fraction of a glass fiber reinforced composite specimen.
12. To investigate creep of a given wire at room temperature.
13. To estimate the Hall coefficient, carrier concentration and their mobility in Ge Crystal

Using Hall effect.

14. To estimate the Band-gap of energy of Ge Crystal using Four Probe Technique.
15. To Study the Corrosion behavior of metallic materials.

Text Books

1. *Smith, W.F., Materials Science and Engineering, Tata McGraw Hill (2008) 4th ed.*
2. *Raghavan, V., Materials Science and Engineering: A first Course prentice Hall of India (2005) 5th ed.*
3. *Callister, William D., Materials Science and Engineering: An Introduction, John Wiley (2006) 6th ed.*

Reference Books

1. *Kasap, S.O., Electronic Materials and Devices, Tata McGraw Hill (2007) 3rd ed.*
2. *Van Vlack, L.H., Elements of Material Science and Engineering, Pearson Education (2006) 6th ed.*

UES005 ELECTRICAL ENGINEERING MATERIALS

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Basic Concept: Brief review of nature of bonding with special reference to PE well curve of all types of materials, Crystal structure and its determination, Defects and their nature, Brief idea of defect induced properties.

Electrons in a Crystal: Fermi distribution function, free electron theory, Fermi energy and Fermi surface, Density of states, Population density, Band model and its consequences, Concept of effective mass.

Electrical Conduction in Solids: Classical theory: Drude model, Temperature dependence of resistivity, Matthiessen's rule, Temperature coefficient of resistivity, Solid solutions, Nordheim's rule, Mixture rules for heterogeneous mixtures, Resistivity of some silver alloys used as electrical contact materials and their phase diagrams, Hall effect and Hall devices.

Thermal Conduction in Solids: Heat capacity: classical theory, Einstein model and Debye model, Electronic contribution to heat capacity, Thermal conduction: metals, alloys and dielectric materials.

Dielectric Properties: Polarization, Polarization vector, Polarization mechanisms in solids, Local field, Clausius–Mossotti equation, Frequency dependence of dielectric constant and dielectric losses, Dielectric strength and insulation breakdown in solids.

Magnetic Properties: Magnetic materials: Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnitism, Ferrimagnnetism, Exchange interactions, Saturation magnetization, Curie temperature, Soft and hard magnetic materials, Application of magnetic materials in electrical and electronic industries: Magnetic recordings materials, Recording heads materials, Thin film recording materials, Magnetic memories, Ferrite core memories.

Semiconductor Materials: Energy band diagrams, Fermi level, Conduction in semiconductors, Temperature dependence of conductivity, Carrier concentration, Drift mobility, Recombination and minority carrier injection.

Superconducting Materials: Zero resistance and Meissner effect, Type type II superconductors and Critical current density, High temperature superconductors, Applications of superconductors, I.

Laboratory Work

1. To Determine the Curie temperature of a ferrite sample.
2. To study cooling curve for two hypoeutectic alloy and find the solute concentration.
3. To determine the dielectric constant of PCB laminate.
4. Detection of flaws using Ultrasonic Flaw Detector (UFD).
5. To determine the Curie temperature of ferroelectric material.
6. To prepare the two metallic specimens for metallographic examination and measure their grain size.
7. Estimation of Band-Gap energy of Germanium using diode in reverse bias mode.
8. To determine the light intensity response of a Silicon Solar cell.
9. To determine the resistivity of a given sample using four probe method.
10. To determine the band gap of germanium using four probe method.
11. To determine the Hall coefficient, carrier concentration and their mobility in Ge crystal using Hall effect.
12. To study the response of a LDR and VDR.

Text Books

1. *Kasap, S. O., Electronic Materials and Device, Tata McGraw Hill (2007) 3rd ed.*
2. *Raghvan, V., Material Science and Engineering: A First Course, Prentice Hall India (2005) 5th ed.*
3. *Kittle, Charles, Introduction to Solid State Physics, John Wiley (2007) 7th ed.*
4. *Omar, M. Ali, Elementary Solid State Physics, Addison Wesley (2008) 4th ed.*

Reference Books

1. *Smith, W.F., Principles of Materials Science and Engineering: An Introduction, Tata Mc-Graw Hill (2008).*
2. *Callister, William D., Materials Science and Engineering, John Wiley (2006) 6th ed.*

UES031 FLUID MECHANICS

L	T	P	Cr
3	1	2	4.5

Prerequisite(s): None

Introduction: Physical properties of fluids, Types of fluids.

Fluid statics: Basic equation for pressure field, Measurement of pressure, Hydrostatic forces on immersed plane and curved surfaces, Buoyancy and flotation.

Fluid kinematics: Methods of describing fluid motion, Velocity and acceleration of a fluid particle, Type of fluid flows, Displacement of a fluid particle, Circulation and vorticity, Continuity equation, Velocity potential and stream function.

Fluid dynamics: Euler's equation, Bernoulli's equation, Momentum equation, Kinetic energy and momentum correction factors.

Flow though pipes: Energy losses, HGL and TEL, Concept of equivalent pipe, Pipes in series and parallel, Flow through a siphon, Transmission of power.

Flow measuring devices: Venturimeter, Orificemeter, Pitot tube, Rotameter, Circular orifice, Current meter, Notches.

Dimensional analysis: Methods of dimensional analysis, Model studies.

Open channel flow: Types of channels, Classification of flows, Uniform flow formulae.

Turbines and pumps: Brief description of types and working of turbines and pumps.

Laboratory work

Verification of Bernoulli's Theorem, Calibration of Venturimeter, Determination of hydrostatic force and its location on a vertically immersed surface, Calibration of orifice meter, To check the stability of a ship model, Determination of friction factor for pipes of different materials, Determination of hydraulic coefficients of an orifice, Verification of momentum equation, Determination of loss coefficients for various types of pipe fittings, Calibration of a triangular notch, To check the calibration of rotameter, Visualization of laminar and turbulent flow.

Text Books

1. *Streeter, V.L., Wylie E. B. and Bedford, K.W., Fluid Mechanics, McGraw Hill Book Company (1998).*
2. *Jain, A.K., Fluid Mechanics including hydraulic machines, Khanna Publishers (2004).*
3. *Kumar D.S., Fluid Mechanics and Fluid Power Engineering, S. K. Kataria(2009).*

Reference Books

1. *Subramanya, K., Theory and Application of Fluid Mechanics, Tata McGraw Hill (2001).*
2. *Modi P.N. and Seth S.M., Hydraulics and Fluid Mechanics, Standard Book House (2002).*
3. *Shames I.H., Mechanics of Fluid, McGraw Hill (2005).*
4. *Fox, R.W. and McDonald, A.T., Introduction to Fluid Mechanics, John Wiley and Sons (2008) 5th ed.*

UME301 INDUSTRIAL ENGINEERING

L	T	P	Cr
3	0	2	4.0

Prerequisite(s): None

Introduction to Industrial Engineering: Relevance of industrial engineering for achieving performance excellence in industry.

Productivity Management*:* Productivity measurement and improvement, Resource waste minimization, Lean manufacturing.

Plant Location & Layout*:* Factors effecting plant location, Selection of plant site, Quantitative techniques of plant location decision, Plant layout, Principles of layout design, Methods for evaluation of a layout, Quantitative techniques of developing layouts.

Materials Management: Objectives and functions, Procurement, Types of inventories, Inventory costs, Inventory control models, Determination of EOQ (under deterministic conditions), MRP, Bill of materials.

Product Engineering: Product designs considerations, Product development, Detailing, Value Engineering and its role in product design and cost rationalization, IPR, Patents, Copyright.

Work Science: Purpose and scope, Productivity and work-study, Method Study and Work Measurement, Principles of Motion Economy, Elements of Work Sampling, Predetermined Motion Time Systems, Principles of Work Design.

Ergonomics: Role of Ergonomics in industry, Introduction to anthropometry, Task analysis to reduce Musclo-Skeletal disorders, Posture analysis, Introduction to bio-mechanics, Effect of physical environment on performance.

Maintenance Management: Objectives, Nature of maintenance problems, Maintenance strategies, Organization, Maintenance Information Systems, Spare Parts Management, Maintenance Cost Control, Introduction to Total Productive Maintenance.

Laboratory Work

Lab exercises related to work study, Ergonomics, Plant layout, Exercises on Facilities Planning, Simulation using QUEST software.

Text Books

1. *Shankar, R., Industrial Engineering and Management, Galgotia Publications (2003).*
2. *Monks, J.G., Production/Operations Management, McGraw Hill (2004).*

Reference Books

1. *Chitale, A. K. and Gupta, R.C., Product Design and Manufacturing, Prentice Hall of India (2005) 4th ed.*
2. *Sanders, M. and McCormic, E., Human factors in Engineering, McGraw Hill (1993) 7th ed.*
3. *Introduction to Work Study, ILO, Geneva (2004) 4th ed.*

Approved by the Senate in its 70th meeting held on May 25,2009

4. Currie, R.M., Work Study, McGraw Hill (1992) 4th ed.

UME302 KINEMATICS OF MACHINES

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): None

Motion Analysis: Kinematics links, Pairs and chains, Type of motions, Type of mechanisms, Inversion of mechanisms, Velocity analysis of different mechanism by vector and instantaneous method, Acceleration analysis of different mechanism, Coriolis acceleration.

Gear Drives: Law of Gearing, Types of gears, Gear terminology, Gear Trains, Types and applications of gear trains, Train value, Analysis of Simple, Compound, Inverted and Epicyclical gear trains.

Cam Mechanism: Types of Cams and Followers, Types of follower motions, Construction of cam profiles, Analysis of motion of follower, Operating different types of cam.

Steering Mechanism, Hook's Joint.

Synthesis: Introduction to Synthesis of mechanisms.

Text Books

1. *Rattan, S.S., Theory of Machines, McGraw Hill (2005) 2nd ed.*
2. *Bevan, T., Theory of Machines, Longman's Green & Company (2005) 3rd ed.*

Reference Books

1. *Ghosh, A. and Malik, A.K., Theory of Mechanism and Machines, Affiliated East West Press (2000) 3rd ed.*
2. *Shigley, J.E., Kinematic Analysis of Mechanisms, McGraw-Hill (1995) 2nd ed.*
3. *Myszka, D.S., Machines & Mechanisms: Applied Kinematic Analysis, Prentice Hall of India (2006) 3rd ed.*

UME303 MACHINE DRAWING

L	T	P	Cr
1	2	2	3.0

Prerequisite(s): None

Introduction to Mechanical Drawing: Classification of drawings, Principles of drawing, Conventions according to IS, Sectional Views and rules of sectioning, Machining and Surface Finish symbols indicating tolerances in dimensioning, Detailed Drawings.

Manual Drafting and Computer Aided Drafting using s/w like Pro-desktop or Pro-E or AutoCAD, Standards, Types, Practical applications and working of:

(a) Machine Components: Screw fasteners, Keys cotters and joints, Shaft couplings, Pipe joints and fittings, Riveted joints and welded joints.

(b) Assemblies: Bearings (Plumber Block, Footstep, Swivel), Hangers and Brackets, Steam and I.C. Engine Parts, Machine components, Valves.

Case Studies in Computer Plots and Industrial Blueprints.

Laboratory Work:

Manual Drafting (MD) and/or Computer Aided Drafting (CAD) (using s/w like Pro-E or AutoCAD) of: (a) Machine Components: Screw fasteners, Keys cotters and joints, Shaft couplings, Pipe joints and fittings, Riveted joints and welded joints. (b) Assemblies: Bearings (Plumber Block, Footstep, Swivel), Hangers and Brackets, Engine Parts, Machine components, Valves.

Exercise in computer plots of drawings/ blueprints.

Text Books

1. *Gill, P.S., Machine Drawing, S.K.Kataria and Sons (2008).*
2. *Bhatt, N.D. and panchal, V.M., , Machine Drawing, Charotar Publishing House (2008).*

Reference Books

1. *Pohit, G. and Ghosh, G., Machine Drawing with AutoCAD, Dorling Kindersley (2007).*
2. *French, T.E. and Vierck, C.J., Graphic Science and Design, McGraw Hill (2000).*
3. *Dhawan, R.K., Machine Drawing, S. Chand (2003).*
4. *Narayana, K.L., Kannaiah P. and Venketareddy, K., Machine Drawing, New Age International Publishers (2004).*

UME401 COMPUTER AIDED DESIGN

L	T	P	Cr
2	0	4	4.0

Prerequisite(s): Exposure to UME303 Machine Drawing

Fundamentals of CAD: Introduction, Application of computers in stages of the Design Process, Benefits of CAD.

Use of CAD Software like ProEngineer: Techniques and functions used for Parametric Solid Modeling, Assembly Modeling, Drawing creation and detailing.

Geometric Modeling: Parametric sketching, Constrained model dimensioning, Material addition and removal for extruded, Revolved, Swept and Blended features, References and construction features of points, Axis, Curves, Planes, Surfaces. Feature and sequence of feature editing. Cosmetic features, Chamfers, Rounds, Standard holes. Advanced features for non parallel blend, Helical sweep, Swept blend, Variable section sweep, Draft, Ribs, Sketched holes. Assembly modeling. Mechanism design and assembly for motion analysis. Automatic production drawing creation and detailing. File formats for data transfer.

Software Productivity Enhancement Tools: Feature patterns, Duplication, Grouping, suppression. Assembly analysis tools. Top-down vs. bottom-up design. Parametric relations and design optimization parameters creation and customized analysis features. Mass property analysis. Software automation and customization tools. Colors and rendering.

Introduction to CAE using software like ProMechanica. Introduction to sheet metal part modeling, Surface modeling using software like in ProEngineer suit of software.

Introduction to 2D and 3D Geometric transformations, Scan conversion, Graphics programming in C/ C++.

Laboratory Work

CAD Software like ProEngineer, Study of various solid modeling features of the software, Solid Modeling of simple and complex parts and components. Parametric Designing. Assembly of mechanical systems, Interference checking. Computer Aided Drafting and automated production drawing generation & detailing. BOM creation. Mass property analysis of models & assemblies. Software Productivity enhancement tools and commands.

Text Books

1. *Gill, P.S., Machine Drawing, S.K.Kataria Publishers (2008).*
2. *Kelley, D. S., Pro/Engineer Wildfire 3.0 Instructor, McGraw Hill (2008).*

Reference Books

1. *Zimmer, E. W. and Groover, M.P., CAD/CAM: Computer Aided Design and Manufacturing, Pearson Education Asia (2008).*
2. *Radhakrishnan, P. and Kothandaraman, C.P., Computer Graphics and Design (CADD), Dhanpat Rai (2005).*
3. *Zeid, I., Mastering CAD\CAM: Theory and Practice, Tata McGraw Hill (2004).*

Approved by the Senate in its 70th meeting held on May 25,2009

4. *MacMohan, C., CAD/CAM Principles, Practice and Manufacturing Management, Pearson Education Asia (2002).*
6. Newman, W. M., Principles of Interactive Computer Graphics, McGraw Hill (2008).
7. Plastock, A. and Kelley, Schaum's Outline of G., Computer Graphics, Schaum's Outline Series - McGraw Hill (2006).

UME402 DYNAMICS OF MACHINES

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): Exposure to UME302 Kinematics of Machines

Force Analysis: Static and dynamic force analysis of mechanisms.

Flywheel: Turning moment diagrams, Fluctuation of energy, Coefficient of fluctuation of energy and speed, Application in engines and punching presses.

Belts Ropes and Chain Drives: Types of belt drives, Velocity ratio, Slip, belt length, Crowning of pulleys, V-belts, Condition for transmission of maximum power, Centrifugal tension, Chain drive, Types of chains, Merits and demerits of chain drive over belt drive, Expression for chain length, Chordal action.

Friction Devices: Fundamentals of friction, Pivots and Collars, Plate and Cone Clutches, Centrifugal Clutches, Friction in mechanism.

Brakes and Dynamometers: Short shoe brakes, Pivoted shoe brakes, Long shoe brakes, Band brakes, Different types of Dynamometers.

Governors: Function, Types, Force analysis, Characteristics.

Gears: Law of gearing, Tooth profiles, Interference, Minimum number of teeth on gear and pinion to avoid interference, Path of contact and arc of contact, Force analysis of spur, Helical, Bevel and worm gears, Efficiency of gears.

Balancing: Balancing of rotating and reciprocating masses, Balancing of inline and v-engines.

Gyroscope: Gyroscopic effect, Application in ships, Vehicles etc.

Text Books

1. *Rattan, S.S., Theory of Machines, Tata McGraw Hill (2005).*
2. *Bevan, T., Theory of Machines, C.B.S. Publications (2005) 3rd ed.*

Reference Books

1. *Ghosh, A. and Malik, A.K., Theory of Mechanism and Machines, Affiliated East West Press (2000) 3rd ed.*
2. *Shigley, J.E., Kinematics Analysis of Mechanism, McGraw Hill (1995).*

UME403 ENGINEERING METROLOGY

L	T	P	Cr
1	0	2	2.0

Prerequisite(s): None

Introduction: General linear and angular measurement instruments.

General Measurement: Measurements of taper, Radius, Geometric features (circularity, flatness).

Thread Measurements: Screw thread measurements, Screw thread micrometers, Two wire and three wire method, Gear Metrology.

Comparators: Various types of comparators: Mechanical, Optical, Opto-mechanical, Electrical and Pneumatic and Electronic.

Surface Measurements: Surface finish measurements: Roughness and waviness measurements.

Gauge Calibration: Gauge repeatability and gauge reproducibility studies.

Laboratory Work
Use of Comparators (Mechanical, Opto-Mechanical & Electrical (LVDT)), Projectors (Profile & Tool Maker's Microscope), Angular Measurements using Combination Set, Bevel Protactor & Sine Bar, Linear Measurements using Vernier Caliper (Depth Caliper, Height Gauge) and Micrometers (Outside, Inside Rod type, Inside Jaw type & Point / Ball Micrometer), Radius Measurement using Radius Gauge & Profile Projector, Inside Diameter Measurement using Bore Gauge, Measurement of Pitch Diameter of External Threads, Use of Plug & Ring Gauges, Snap Gauge (Fixed & Adjustable both), Working Principle of a Pneumatic Air Gauge, Use of Slip Gauges of various types and their Setup, Gauge Repeatability & Reproducibility Study using the $\overline{X} - R$ Method, Measurement of Surface Roughness parameters such as R_a, R_t and R_{tz}.

Text Books

1. *Jain, R. K., Engineering Metrology, Khanna Publishers (2008).*
2. *Gupta, I.C., Engineering Metrology, Khanna Publishers (2005).*

Reference Books

1. *Gayler J. F. W. and Shotbolt, C. R., Metrology for Engineers, Cassell (1990).*
2. *Hume, K. J., A History of Engineering Metrology, Professional Engineering Publishing (1980).*

Approved by the Senate in its 70th meeting held on May 25,2009

UME404 MECHANICS OF DEFORMABLE BODIES

L	T	P	Cr
3	1	0	3.5

Prerequisite(s): None

Three-Dimensional Stress Analysis: Stresses on an arbitrary plane, Principal stresses and stress invariant, Mohr's stress circles, Differential equations of equilibrium in Cartesian and cylindrical coordinates, Three-dimensional strain analysis, Rectangular strain components, Principal strains and strain invariant, Compatibility conditions.

Stress-Strain Relations: Generalized Hooke's law, Stress-strain relations for isotropic materials.

Energy Methods: Principle of superposition, Work done by forces- elastic strain energy stored, Maxwell-Betti's theorem, Castigliano's theorems, Strain energy expressions, Fictious load method, Statically indeterminate problems.

Unsymmetrical Bending: Flexure formula for unsymmetrical bending, Shear centre and its determination for various sections.

Curved Flexural Members: Winkler-Bach formula, Stresses in curved beams having rectangular, Circular and trapezoidal sections, Stresses in rings and chain links.

Torsion of Non-circular Members: Torsion of prismatic bars, Elastic membrane analogy, Torsion of sections composed of narrow rectangles, Thick Cylinders and Rotating Discs, Lame's theory for stresses in thick cylinders, Composite tubes, Shrink fits and Laminated cylinders, Thin rotating rings, Stresses in rotating discs and cylinders, Discs of uniform strength.

Helical Springs: Analysis of closely coiled and open coiled helical springs subjected to axial load and moment, Stresses and deflections in springs.

Elastic Stability: Euler's buckling load, Beam-column equations, Beam column with concentrated load, Critical load for columns with different end conditions.

Theories of Elastic Failure: Various theories of failure, Significance and applications, Graphical comparison for plane stress case.

Text Books

1. *Srinath, L.S., Advanced Mechanics of Solids, Tata Mc-Graw Hill (2009) 3rd ed.*
2. *Kumar K. and Ghai, R. C., Advanced Mechanics of Materials, Khanna Publishers (2002) 6th ed.*

Reference Books

1. *Shames, I.H., Mechanics of Deformable Solids, Prentice Hall of India (2000).*
2. *Popov, E.P., Engineering Mechanics of Solids, Prentice Hall of India (2007) 2nd ed.*
3. *Ryder, G.H., Strength of Materials, B.I. Publishers (2005).*

Approved by the Senate in its 70th meeting held on May 25,2009

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UME501 APPLIED THERMODYNAMICS

L	T	P	Cr
3	1	2	4.5

Review of Thermodynamic Laws, Vapour Power Cycles: Rankine cycle and Modified Rankine cycle; Losses; internal and stage efficiencies; Reheat, regenerative and binary cycles, Combustion, Enthalpy and internal energy of reaction; Enthalpy of formation; Adiabatic flame temperature; Heating values of fuels, Boiler performance; Equivalent evaporation; Boiler efficiency; Boiler trial, heat balance, boiler draught, Chimney height, and fan power, Steam Engines: Constructional details and principle of working.

I.C.Engines: Review of air cycles, classification and application, Combustion in S.I. engine: Flame propagation, pre-ignition, detonation, engine variables effects, mixture requirements, fuel rating; Fuel supply system, Combustion in C.I.Engine, delay period, knocking, engine variables effects, fuel requirements, rating, combustion chambers; Fuel supply system, Engine cooling and lubrication, Performance of engines: Variable and constant speed tests as per ISI standards. Performance curves, heat balance.

Laboratory Work: Study of Nestler Boiler, Lancashire Boiler, Babcock and Wilcox boiler, Locomotive boiler, Compound steam engine, Mountings and Accessories of a Boiler, Petrol/ Diesel Engine (Both two stroke and Four Stroke), Two Stroke Krimo Engine, Multi cylinder petrol engine.

Text Books

1 *Pulkrabek, W. W., Engineering Fundamentals of Internal Combustion Engines, Pearson education Asia, New Delhi (2007).*
2 *Vasandani, V. P. and Kumar, D. S., Heat Engineering, Metropolitan Book Company, New Delhi (2003).*

Reference Books

1 *Heywoold, J. B., I.C .Engine, McGraw Hill, New Delhi (1988).*
2 *Joel, R., Basic Engineering Thermodynamics, Pearson Education Asia, New Delhi (1996).*
3 *Granet, I., Thermodynamics & Heat Power, Pearson Education Asia, New Delhi (2003).*
4 *Ganeshan, V., Internal Combustion Engines, Tata McGraw Hill, New Delhi (2007).*
5 *Nag, P. K., Power Plant Engineering, Tata McGraw Hill, New Delhi (2008).*

UME502 AUTOMOBILE ENGINEERING

L	T	P	Cr
3	0	2	4.0

Introduction: Conventional motor vehicle, frame and frameless construction, vehicle classification, vehicle dimensions gear ratio for maximum acceleration. Power requirements, vehicle performance.

Transmission: Requirements for manual and automatic transmission, their constructional details, steering mechanisms and steering system including power steering.

Braking system and their types, brake compensation.

Suspension: Suspension Principle, rigid axle suspension and independent suspension, Suspension system elements.

Starting motor drives.

Wheel and Tyres: Description, types and Manufacturing.

Vehicular Emission: Vehicular emission and its control.

Electrical and electronic systems in automobiles.

Trouble shooting in various components.

Automotive accessories and safety features in automobile.

Latest developments in the field of automotives.

Laboratory Work: Study of single plate and multi-plate clutch in an automobile, Construction and working of following gear boxes: Contact Mesh Gear box, Synchronous Gear box, parts of automatic transmission system, construction of the following components of IC Engine: Carburetor, Fuel injection system for IC and SI engine, components of suspension system of automobile (2 wheel, 4 wheel), Steering system of an automobile, Electric system, starting system, and other accessories of an automobile, Braking system of an automobile.

Text Books

1 *Crouse, W. and Anglin, D., Automotive Mechanics, Tata McGraw Hill, New Delhi (2006).*
2 *Nunny, M. J., Light and Heavy Engine Technology, Elsevier, Amsterdam (2006).*

Reference Books

1 *Garrett, T. K., Newton, K. and Steeds, W., The Motor Vehicle, Butterworth-Heinemann, Great Britain, London (2001).*
2 *Norton, A A Book of the Car, Automobile Association, London (1977).*
3 *Heinz, H., Advance Vehicle Technology, Arnold Publishers, Butterworth-Heinemann, London (1999).*
4 *Heinz, H, Engine and Vehicle Technology, Arnold Publishers, Butterworth-Heinemann, London (2002).*

UME503 INDUSTRIAL METALLURGY AND MATERIALS

L	T	P	Cr
3	1	0	3.5

Equilibrium Diagrams: Phases and their significance, components, degrees of freedom, Gibb's phase rule, equilibrium heating/ cooling, classification of phases in binary alloys, Equilibrium diagrams for single component systems, coring and its effects in Type I systems, factors and techniques for elimination of coring, equilibrium diagrams for binary systems having unlimited solubility in liquid and solid states, equilibrium diagrams for binary eutectic systems, Inverse lever rule.

Iron-Carbon Systems: Components and phases of Iron-Carbon system, Iron and Iron Carbide diagram, Invariant reactions of Iron-Carbon systems, Critical temperatures and critical temperature lines.

Kinetics of Austenite Transformations: Kinetics of formation of austenite in eutectoid steels, factors affecting the decomposition of austenite, classification of steels on basis of austenite grain growth when heated beyond the upper critical temperature, austenite grain size, Time Temperature Transformation diagrams (TTT Diagrams), Features of super cooled austenite transformation.

Heat Treatment of Steels: Need and main steps in heat treatment processes, classification of heat treatment processes on basis of heat treatment temperature and on the basis of purpose, various types of annealing, normalising, hardening and tempering treatments, factors affecting the hardenability of steels.

Surface Heat Treatment (Case Hardening) Methods: General features of surface hardening processes, Flame and Induction hardening of steel; Chemical heat treatment of steels: carburising, nitriding, and cyaniding of steels.

Alloy Steels: Effect of various alloying elements in steel, Structural and wear resistant steels, carbon and alloy tool steel, High Speed Steels.

Text Books

1 *Avner, S.E., Introduction to Physical Metallurgy, McGraw Hill, New Delhi (2009).*
2 *Singh, V., Physical Metallurgy, Standard Publishers, New Delhi (2002).*

Reference Books

1 *Hill, R.E.R., Physical Metallurgy Principles, Affiliated East-West Press, New Delhi (2008).*
2 *Rajan, T.V., Sharma, C.P and Sharma, A., Heat Treatment: Principles & Techniques, Prentice Hall of India, New Delhi (2006).*
3 *Lakhtin, Y., Engineering Physical Metallurgy, CBS Publishers and Distributors, New Delhi (2005).*

UME504 MACHINE DESIGN

L	T	P	Cr
3	2	0	4.0

Design Processes: Introduction, standards and preferred numbers, Stress-concentration, Endurance limit, Fatigue and reliability considerations, factor of safety and its selection, selection of materials, review of theories of failure.

Manufacturing considerations in Design: Tolerance, type of fits, selection of fits, limits.

Analysis and Design of fasteners and joints: Key and keyed joints, cotter and knuckle joints; bolts and bolted joints with and without initial tightening loads, Seals and Gaskets, Riveted joints, boiler joints, structural joints, welded joints, Bolted, riveted and welded joint under eccentric loading.

Couplings: Rigid and Flexible types. Design of levers.

Design of shaft: shafts subject to combined loading; subjected to fatigue loading.

Design of other mechanical components: Power screws, pulleys and flywheels, Pipe joints: circular, oval and square flanged pipe joints.

Text Books

1 *Bhandari, V. B., Design of Machine Elements, Tata McGraw Hill, New Delhi (2007).*
2 *Norton, R.L., Machine Design: An Integrated Approach, Pearson Education, New Delhi (2006).*

Reference Books

1 *Spotts, M. F. and Shoup, T. E., Design of Machine Elements, Pearson Education, New Delhi (2003).*
2 *Juvinall, R. C. and Marshek, K. M., Fundamental of Machine Component Design, John Wiley & Sons, New York (2005).*
3 *Shigley, J., Mechanical Engineering Design, McGraw Hill, New York (2003).*
4 *Sharma, C. S. and Purohil, K., Design of Machine Elements, Prentice Hall, New Delhi (2003).*

UME505 MANUFACTURING TECHNOLOGY

L	T	P	Cr
3	0	3	4.5

Metal Casting: Review of sand casting, sand testing, machine moulding, cupola, charge estimating, inspection of castings, casting defects; Shell moulding; investment casting; die casting; centrifugal casting.

Welding: Review of welding processes, weldability, principles and application of TIG and MIG welding, friction and inertia welding, hard facing and metallizing, welding defects.

Metal Cutting: Machinability, factors affecting machinability; Milling, milling cutters and milling machines.

Grinding and other abrasive finishing processes, grinding wheel selection, surface grinding, centreless grinding, Abrasive finishing Processes.

Metal Forming: Hot and cold forming, forming processes, forging machines, forging design considerations, forging defects; High energy rate forming processes.

Shaping Non- metallic materials: Basic manufacturing processes for processing of plastics & ceramics.

Powder Metallurgy; Rapid Prototyping and Tooling.

Laboratory Work: Experimental work pertaining to study & use of sand testing equipment, performance on MIG & resistance welding, exercises on horizontal & vertical milling machines, planer, shaper, centreless & surface grinders, Performance in foundry shop for hollow casting, Experiment on die-casting; experiment on blow molding; experiment on NDT (Dye penetrant/ ultrasonic testing/ magnetic particle) and DT of welded joints (Tensile/ bending test); profile cutting in vertical milling machine. Experiment on cylindrical grinding, and TIG welding.

Text Books

1 *Rao, P.N., Manufacturing Technology: Foundry, Forming & Welding, Tata Mc-Graw Hill, New Delhi (2003).*

2 *Rao, P.N., Manufacturing Technology: Metal Cutting & Machine Tools, Tata Mc-Graw Hill, New Delhi (2003).*

Reference Books

1 *Ostwald, J.M., Manufacturing Processes & systems, John Wiley & Sons (Asia) Pvt Ltd, Singapore (2007).*

2 *Champbell, J.S., Principle of Material and Process, Tata Mc-Graw Hill, New Delhi (1995).*

3 *Singh, C.K., Manufacturing Technology, Pearson Education Asia, New Delhi (2002).*

4 *Doyle, L.E., Manufacturing Process & Materials for Engineers, Prentice Hall of India, New Delhi (1984).*

5 *Lindberg, R.A., Manufacturing Process & Materials, Prentice Hall of India, New Delhi (2006).*

6 *Degarmo, E.P., Materials and Processes in Manufacturing, Prentice Hall of India, New Delhi (2002).*

UME601 INDUSTRIAL AUTOMATION

L	T	P	Cr
2	0	2	3.0

Introduction: Concept and scope of industrial automation, socio-economic considerations, Pneumatic Logic Circuits: un-complementation algorithm.

Fluid Power Control: Fluid Power Control elements and standard graphical symbols for them, Construction and performance of fluid power generators, Hydraulic & pneumatic cylinders - construction, design and mounting, Hydraulic & pneumatic valves for pressure, flow & direction control, Servo valves and simple servo systems with mechanical feedback, Simple hydraulic and pneumatic circuits.

High Volume Production Systems: Transfer devices & feeder, classification, construction & application, Automated flow lines, analysis of automated flow lines for reliability and efficiency, assembly systems.

Mechatronics: Mechanical system interfacing, Simple Mechatronics devices: Stepping motors, DC motors, Analog / digital convertors.

Controllers: Function and types.

Laboratory Work: Exercise on basic Pneumatic circuits, control of single acting & double acting cylinders, Speed control of Pneumatic cylinders- inlet pressure & exhaust control, air-bleed control, Use of HYDRAUSIM, Designing of combinational/ sequential pneumatic logic circuits, Motion Control using servomotor drive with PC interface.

Text Books

1 *Esposito, A., Fluid Power with Applications, Prentice Hal of India, New Delhi (2005).*
2 *Majumdar, S. R., Pneumatic Systems, Tata McGraw Hill, New Delhi (1995).*
3 *Groover, M.P., Automation, Production Systems & Computer Integrated Manufacturing, Prentice Hall of India, New Delhi (2008).*

Reference Books

1 *Auslander, D. M. and Kempf, C. J., Mechatronics: Mechanical System Interfacing, Prentice Hall Inc., New Jersey (1996).*
2 *Deppert, W. and Stoll, K., Pneumatic Control, Vogel Verlag, Wurzburg, Germany (1987).*
3 *Herbert, E.M., Hydraulic Control System, John Wiley & Sons, New York (1991).*
4 *Hall, D.V., Microprocessors & Interfacing: Programming & Hardware, McGraw Hill, New York (2006).*
5 *Mukhopadhaya, A. K., Microprocessors, Microcomputers and their Applications, Wheeler Pub, New Delhi (2003).*
6 *Fitch, E.C and Surjaatmadja, J.B., Introduction to Fluid Logic, McGraw Hill, New York (1978).*

UME602 PRODUCTION AND INVENTORY CONTROL

L	T	P	Cr
3	2	0	4.0

Production Control: Necessity of planning and control; functions of production control department; various functions under production control; factors determining control procedure, types of control.

Short term and long term trends in business, financial aspects of planning, analysis of machine capacity, capacity and manpower requirement planning.

Process Planning: Routing, routing procedures, progress reporting and expediting methods; shop floor control.

Scheduling: Loading, departmental and shop schedule charts, Gantt charts, multiple-dimension rule, employee scheduling, and various priority rules.

Inventory Management and Control: Importance of inventory control, methods of inventory control, ordering quantity to order, economic run lengths.

Applications of Computers in production control and inventory control activities.

Text Books

1 *Monks, J. G., Operations Management: Theory and Problems, McGraw Hill, New York (1987).*

2 *Krajewski, L. J., Ritzman, L. P. and Malhotra, M. K., Operations Management, Prentice Hall of India, New Delhi (2009).*

Reference Books

1 *Ebert, J and Adams, D.J., Production/Operations Management, Prentice Hall of India, New Delhi (2007).*

2 *Chase, R. B., Aquilano, N. J. and Jacob, F. R., Production and Operations Management: manufacturing and services, Tata McGraw Hill, New Delhi (1999).*

UME621 FACILITIES PLANNING

L	T	P	Cr
2	2	0	3.0

Facilities Planning: Need for facilities planning, Importance of plant layout in plant design, classifications of production process structures, types of layout, Characteristic features, suitability and applications of different types of layout.

Plant Location: Factors affecting plant location, optimum decision on choice of plant location, quantitative techniques for making plant location decision.

Planning Design And Presentation: Principles of plant layout design, Procedure for plant layout design, evaluate alternative layouts, installation of layout, Quantitative techniques for developing alternative layouts, Design of process and product layouts, line balancing techniques.

Material Handling: Principles of material handling, classification of material handling systems, characteristic features of key material handling equipment, concept of unit load, introduction, guidance methods, applications.

Text Books

1 *Muther, R., Practical Plant Layout, McGraw Hill, New York (1961).*
2 *Tompkins, J.A and White, J.A, Facilities Planning, John Wiley & Sons, New York (2002).*

Reference Books

1 *Sheth, V.S., Facilities Planning and Materials Handling, Marcel Dekker, New York (1995).*
2 *Moore, J.M., Plant Layout & Design, Mac Millan Publishing Company Inc., New York (2003).*
3 *Sharma, S. C., Plant Layout & Material Handling, Khanna Publishers, New Delhi (2003).*
4 *Krajewski, L. J., Operations Management, Pearson Education Asia, New Delhi (2002).*
5 *Martinich, J. S., Production and Operations Management, John Wiley & Sons, New York (1997).*

UME622 INDUSTRIAL DESIGN AND NEW PRODUCT DEVELOPMENT

L	T	P	Cr
2	2	0	3.0

General: Product design objectives, requirements of a good product design, product life cycle, product specification and range, safety, liability and warranty aspects, patents and copyrights.

Designing for Specific Requirements: Design features and requirements with regard to manufacturing and assembly, safety, energy conservation, storage, transportation and maintenance, quality v/s cost, packaging design.

Visual Design: Objectives, form, function, material and process, relationship, product graphics, role of color.

Product Development: Concept and objectives, information sources, role of innovation in product development and competitiveness, part approval process, design failure mode and effect analysis, use of computers in product design and development.

Text Books

1 *Niebel, B. W. and Draper, A. B., Product Design and Process Engineering, McGraw Hill, New York (1999).*

2 *Mayal, W. H., Industrial Design for Engineers, McGraw Hill, New York (1988).*

Reference Books

1 *Asimov. M, Fundamentals of Engineering Design, Printice Hall of India, New Delhi (1996).*

2 *Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, Printice Hall of India, New Delhi (1998).*

UME623 MANAGEMENT INFORMATION SYSTEMS

L	T	P	Cr
2	2	0	3.0

Introduction: Introduction to computer-based information systems, philosophies governing information systems, role of computer-based information systems in organizations, work centered analysis of information systems, computer-based information system taxonomies, characteristics of information systems. Computer-based Information system planning.

System Analysis & Design: Methodologies & implications of system analysis & design, tools for analysis and design of computer-based information systems, database management.

Strategic CBIS: business information systems, information system security & control, ERP.

Laboratory Work: Development of modules of CBIS in the Lab/Practical class.
Development of TPS, MIS and DSS for Inventory management information systems, maintenance management systems, banking systems, production scheduling systems, hospital management systems, logistics systems, financial systems, HRIS, Marketing information systems.

Text Books

1 *Alter, S., Information Systems: Foundation of E-Business, Pearson Education, New Delhi (2002).*
2 *Laudon, K. and Laudon, J., Management Information Systems, Pearson Education, New Delhi (2009).*

Reference Books

1 *Brien, O., Management Information Systems, Galgotia Publishers, New Delhi (2010).*
2 *Yourdon, E., Structured Analysis, Yourdon Press, New York (1988).*
3 *Schultheis, R and Sumner, M., Management Information Systems, Tata McGraw Hill, New Delhi (1999).*
4 *Gupta, U. G., Management Information Systems: A Managerial Perspective, Galgotia Publishers, New Delhi (1996).*
5 *Davis, G and Olson, M.H., Management Information Systems, McGraw Hill, International, New York (1984).*

UME624 WASTE HEAT RECOVERY SYSTEMS

L	T	P	Cr
2	2	0	3.0

Introduction: Waste Heat, Sources of waste heat, high temperature heat recovery applications, waste heat recovery calculations.

Recuperators: Gas to gas heat exchangers, recuperators, rotary regenerator, air pre-heaters, Heat pipe exchangers.

Regenerators: Gas or liquid to liquid Regenerators, Finned tube heat exchangers, shell and tube heat exchangers, waste heat boiler, Heat pumps.

Economics: Waste Heat recovery economics general concepts, case studies, examples.

Case Studies: Cast studies of some industrial problems.

Text Books

1 *Ready, D.A., Industrial Energy Conservation, Pergamon Press, New York (1979).*
2 *Olszewski, M., Utilization of Reject Heat, Marcel and Dekker Inc., New York (1980).*

Reference Books

1 *Peterson, G.P., An Introduction to Heat Pipes, John Wiley and Sons, New York (1994).*
2 *Collie, M. J., Heat Pump Technology, Noyes Data Corporation, New Jersey (1979).*
3 Goldstick, R. J., Waste Heat Recovery, Fairmont Press, Georgia (1986).

UME701 ADVANCED MACHINE DESIGN

L	T	P	Cr
3	2	0	4.0

Spur Helical, Bevel, Worm and Worm Wheel gears: Introduction to types, force analysis and application; Gear tooth failure, Beam strength and wear strength of gear tooth, Materials and manufacture.

Brakes and Clutches: Introduction to types, construction, application and force analysis, Band brakes, Block brakes, Expanding shoe brakes, Disk brakes, Single and multiple plate clutches.

Flat and V- belts, selection of chains and wire ropes: Introduction to types, construction, application and force analysis; Design considerations, recommendations and characteristics; Selection from manufacturer's catalogue, Designation.

Sliding and selection of rolling element bearings: Hydrodynamic and hydrostatic lubrication, Raimondi and Boyd method of solution to Reynold's equation; Bearing design-selection of parameters and materials; Selection of rolling element bearings from manufacturer's catalogue.

Close-coiled and leaf springs: Introduction to types and applications, compression and extension helical closed coil springs, concentric springs; Design of helical springs and multi-leaf (semi elliptic) springs, spring materials.

Text Books

1 *Bhandari, V. B., Design of Machine Elements, Tata McGraw Hill, New Delhi (2007).*
2 *Norton, R. L., Machine Design: An Integrated Approach, Pearson Education, New Delhi (2006).*

Reference Books

1 *Spotts, M. F. and Shoup, T. E., Design of Machine Elements, Pearson Education, New Delhi (2003).*
2 *Juvinall, R. C. and Marshek, K. M., Fundamental of Machine Component Design, John Wiley & Sons, New York (2005).*
3 *Shigley, J., Mechanical Engineering Design, McGraw Hill Book Company Inc., New York (2003).*
4 *Bathe, K. J., Finite Element Procedures, Printice Hall of India, New Delhi (1996).*

UME702 COMPUTER AIDED MANUFACTURING

L	T	P	Cr
3	0	2	4.0

Fundamentals of CAM: Programmable automation, Automation and CAM. Numerical control of machine tools. Adaptive control of machine tools, Industrial robots, programming methods, applications. CNC design features to improve accuracy and productivity. Manual part programming.

Computer Aided Part Programming: Introduction and demonstration of use of Pro/E CAM Software or equivalent in; Computer Aided Part Programming, machining simulation, process planning, route sheet development and Post processing. Die manufacture.

Computer Integrated Manufacturing Systems & Integrated CAD/CAM System: Components of CIMS. Types of CIMS. CAD/CAM integration. FMS and CIMS. Introduction to Rapid Prototyping and Rapid Tooling. Group Technology.

Automated Material Handling & Storage: AGVs, ASRS, Carousel.

Computer Aided Manufacturing Planning Systems: CAPP, Computer Aided Production Management, Inventory Management, MRP-I and MRP-II, shop floor control, computer aided process monitoring and control, computer aided quality control and inspection.

Laboratory Work: Exercises on manual part programming of CNC machines: Lathe- Complete machining of a part with: Taper, concave and convex arc, and threading. Milling- Complete machining of a part with: Taper, concave and convex arc, Pocket and PCD cycles, Radius compensation. Robot programming: Programs for pick place, welding path, manufacturing, and assembly operations. Study and sequence programming of a FMS / CIMS virtual setup on VR-CIMS s/w. Practical setup and programming exercise to form a FMS using MIRAC, XL-MILL and RVM2 robot. Practicals in the machines to be conducted as per lab instructions and guidance of the teacher incharge of practical.

Text Books

1 *Groover, M. P., Automation, Production Systems, and Computer Integrated Manufacturing, Pearson Education Asia, New Delhi (2008).*
2 *Koren, Y., Computer Control of Manufacturing Systems, McGraw Hill, New York (2005).*

Reference Books

1 *Groover, M. P. and Zimmers, E. W., CAD/CAM, Pearson Education Asia, New Delhi (2005).*
2 *Besant, C. B. and Lui, C. W. K., CAD/CAM, Tata McGraw Hill, New Delhi (2005).*
3 *Koren, Y. and Joseph, B. U., Numerical Control of Machine Tools, Khanna Publishers , New Delhi (1999).*
4 *Kundra, T. K., Rao, P. N. and Tewari, N. K., Numerical Control and Computer Aided Manufacture, Tata McGraw Hill, New Delhi (2003).*

UME703 FLUID MACHINERY

L	T	P	Cr
3	1	2	4.5

Viscous Flow: Momentum Equation, Navier Stokes Equation and its derivation, Boundary Layer Theory, Similarity solution and approximate solution, Aerofoil theory, Lift and Drag.

Principles of Hydraulic machines, Impulse momentum equation, Euler's equation for energy transfer, Impact of jets.

Hydraulic Turbines: Classification, head losses, efficiencies, hydropower plant, various elements, impulse and reaction turbines, components, selection of design parameters, size calculations, work, efficiency, governing, Similarity relations and unit quantities, specific speed, cavitation.

Hydraulic Pumps: classification, selection, installation, centrifugal pumps, head, vane shape, pressure rise, velocity vector diagrams, work, efficiency, design parameters, multistaging, operation in series and parallel, submersible pumps, NPSH, specific speed.

Reciprocating Pumps: indicator diagram, work, efficiency, effect of acceleration and friction, air vessels.

Other Hydraulic Devices: Hydraulic ram, airlift pump, jet pump, centrifugal jet-pump, fluid coupling, torque converter.

Laboratory Work: Impact of jet on stationary vanes, Performance of Pelton Wheels, Francis turbine, Kaplan turbine, Centrifugal pump, Reciprocating pump, Hydraulic Ram, Study of Hydraulic pump models.

Text Books

1 *White, F. M., Viscous Fluid Flow, McGraw Hill, New York (2006).*
2 *Wright, T., Fluid Machinery, CRC Press, USA (2009).*

Reference Books

1 *Douglas J. F., Gasiorek, J. M. and J. A. Swaffield, Fluid Mechanics, Addison-Wesley Longman Inc., Edinburgh, U.K (1995).*
2 *Rattan, S.S., Fluid Machines and Hydraulic Machines, Khanna Publishers, New Delhi (2004).*
3 *Panton, R.L., Incompressible Fluid Flow, John Wiley & Sons, New Jersey (2005).*

UME704 HEAT AND MASS TRANSFER

L	T	P	Cr
3	1	2	4.5

Heat Conduction: General heat conduction equation in rectangular, polar and spherical co-ordinates, one dimensional heat conduction, variable thermal conductivity, composite walls, critical insulation thickness, unsteady heat conduction, heat transfer from extended surfaces.

Heat Convection: Dimensional analysis, momentum and energy equation for boundary layers over a flat plate, empirical equations for plates, pipes and spheres; Boiling and condensation heat transfer; Thermal boundary layer (in heat convection).

Thermal Radiation: Laws of radiation, radiating surfaces, heat transfer between surfaces, radiating surfaces, shape factor, electrical network method and radiation shields.

Heat Exchangers: Classification, LMTD and effectiveness-NTU methods, design criteria, fouling factors and standards.

Mass Transfer: Fick's Law, equimolal diffusion, isothermal evaporation, mass transfer coefficients, humidification operations.

Laboratory Work: Thermal conductivity of insulating powder, Heat transfer through composite wall, Thermal conductivity of lagging material on pipe / metal rod, Thermal conductivity by two slab guarded hot plate method, Heat Transfer coefficient in Natural convection, Forced Convection heat transfer from a heated pipe, Forced convection heat transfer through pin-finance, Emmisivity of a test plate, Critical Heat flux in pool boiling, Verification of Stefan Boltzmann's law of radiation, Study the phenomenon of drop wise and film wise condensation, Study the working of two phase heat transfer unit, Performance of parallel flow and counter flow heat exchanger, Super thermal conducting heat pipe and comparison with the best conductor.

Text Books

1 *Holman, J.P., Heat Transfer, McGraw-Hill Book Company, Singapore (2008).*
2 *Krieth, F and Bohn, M., Principles of Heat Transfer, Thomson Learning, Australia (2002).*

Reference Books

1 *Cengel, Y., Heat Transfer- A practical approach, Tata McGraw Hill, New Delhi (2007).*
2 *Long, C., Essential Heat Transfer, Pearson Education Asia, New Delhi (1999).*
3 *Incropera, F.P. and DeWitt, D.P., Fundamentals of Heat and Mass Transfer, John Wiley and Sons, Singapore (2006).*

UME705 MACHINING SCIENCE

L	T	P	Cr
3	1	2	4.5

Machining with Single Point Cutting Tool: Mechanism of chip formation, orthogonal and oblique cutting, type of chips, machining parameters, cutting force and power requirement in single point turning process, Merchant's circle theory, shear angle relationships, specific cutting pressure, friction and thermal aspects of machining.

Machining with Multi-Point Cutting Tools: Nature of cutting with multi-point cutting tools, mechanism of chip formation in drilling and milling, grinding process and its specific features, specification of grinding wheel.

Tool Wear: Tool life, definition & factors affecting tool life, Taylor's tool life equation, cutting fluids, their, characteristics & applications, factors affecting machinability, factors influencing surface quality, dimensional accuracy and material removal rate in machining, calculation of economic cutting speed, high efficiency zone.

Jigs and Fixtures: Definition and importance of jigs and fixtures in production, principles of location and clamping, essential requirements of jigs/fixtures, types of jigs and fixtures, drill jigs, milling.

Modern Machining Methods: Comparison of non-conventional and conventional methods of machining, process parameters, material removal rate and application of electric-discharge machining (EDM), electro-chemical machining (ECM), ultra-sonic machining (USM), electron beam machining (EBM) & laser beam machining (LBM), Abrasive Jet Machining (AJM); Water Jet Machining (WJM); Plasma Arc Machining.

Laboratory Work: Experiments relating to Tool Makers Microscope, Cutting angles of a single point turning tool, Point angle of a twist drill; Machining of metallic materials; chip reduction coefficient and shear angle; calibration of two component Strain Gauge Type Force dynamometer; Cutting forces in turning; Tool Flank Wear; Effect of Speed, Feed and Depth of cut on power consumption; Tool-Tip Temperature; Alignment Tests; Electro Discharge Machine; Laser Beam Machining; Spark test.

Text Books

1 *Pandey, P. C. and Singh, C. K., Production Engineering Sciences, Standard Publishers, New Delhi (2004).*
2 *Ghosh, A. and Bhattacharya, Manufacturing Science, Tata McGraw Hill, New Delhi (2003).*

Reference Books

1 *Shaw, M.C., Metal Cutting, Tata McGraw Hill, New Delhi (1997).*
2 *Venkatesh, V.C., Techniques in Metal Cutting, Prentice Hall of India, New Delhi (1997).*
3 *Juneja, B. L. and Sekhon, G. S., Metal Cutting, New Age International, New Delhi (2003).*
4 *Mehta, N. K., Machine Tools, Tata McGraw Hill, New Delhi (2002).*

UME706 MECHANICAL VIBRATIONS

L	T	P	Cr
3	2	0	4.0

Fundamentals of Vibration: Simple Harmonic motion, Natural frequencies and resonance.

Free and Forced Vibrations of Single Degree of Freedom system: Newton's Second Law, D'Alembert's Principle, Lagrange's equation, Springs in combinations, types of damping, Logarithmic decrement, equivalent viscous damping, support excitation, vibration isolation and transmissibility, vibration measuring instruments.

Two Degree of Freedom Systems: Free and Forced vibrations with and without damping, principal and normal modes, vibration absorbers.

Multi Degree of Freedom Systems: Various methods of analysis of multi degree freedom systems, influence coefficients, coupling of modes, numerical methods, Rayleigh's method, Dunkerley's equation, Holzer's method, Application to torsional vibrations.

Vibration of Continous Systems: Wave equation, Transverse vibration of strings, Longitudinal vibration of bars, Lateral vibrations of beam.

Whirling of Shafts: Critical speed and effect of damping.

Introduction to Non-Linear Vibrations.

Introduction to Condition Monitoring of Machinery.

Text Books

1 *Grover, G. K., Mechanical Vibrations, Nem Chand and Bros, Roorkee (2009).*
2 *Ambekar, A. G., Mechanical Vibrations and Noise Engineering, Prentice Hall of India, New Delhi (2006).*

Reference Books

1 *Rao, S. S., Mechanical Vibrations, Addison Wesley Publishing Company, New York (1995).*
2 *Kelly, S. G., Mechanical Vibrations, Schaum's Outlines, Tata McGraw Hill, New Delhi (2007).*
3 *Rao, J. S. and Gupta, K., Introductory Course on Theory and Practice of Mechanical Vibrations, New Age International Publication, New Delhi (1996).*
4 *Srinivasan, P., Mechanical Vibration Analysis, Tata McGraw Hill, New Delhi (1995).*

UME801 MECHANICAL SYSTEM DESIGN

L	T	P	Cr
1	0	6	4.0

A project based course to teach Integrated approach to the design of mechanical systems using concepts of mechanism, dynamics of machines, and mechanical design courses studied in the previous semesters. The mechanical systems are to be designed satisfying requirements of reliability, fatigue loading, optimized design, manufacturing, assembly, installation, maintenance, cost and transportation-to-site aspects. Lectures are to introduce / review the concepts detailed above and the use of a system design approach using various courses already studied by the students and guide in the use of software tools specific to the selected project.

Each student either individually or in a group, will be assigned a mechanical system design project involving problem definition, mechanism selection, analysis, synthesis, optimization and drafting. Assembly and detailed production drawings will be prepared for the presentation of the design along with a printed report, PPT presentation and soft copy submission of CAD and CAE work for final evaluation by a committee. CAE softwares like ProEngineer, ProMechanica, SolidWorks, Cosmos, ANSYS along with a spread sheet may be used for the design modeling, synthesis, optimization, analysis and preparing production drawings.

UME802 MECHATRONICS

L	T	P	Cr
3	2	0	4.0

Introduction: Integrated Mixed Systems. Integration of Mechanical Engineering, Electronics & Control Engg. And Computer Science.

Dynamic Systems Modeling and Simulation: Equations of motion, transforming, physical model to Math. Model, linearization, Frequency response.

Control Systems: Performance specifications, Transfer functions, Stability, Controller types and their design using frequency domain and Laplace domain method, PID control. Digital Control – z-transforms, problems in analogue to digital conversion-Nyquist frequency, Digital controller design.

Sensors and Actuators: Temperature Sensors, Stress, Strain and Force measurements using strain gauges, Piezoelectric sensors and Accelerometers. Analog / Digital Position Measurements, Velocity Measurements. Direct Current Motors, Stepper Motors, Piezoelectric Actuators.

Electronics: Review of logic circuits, Op Amps, AD and DA converters, Microcontrollers, Digital signal processing, introduction to PLC.

Study of Some Mechatronics Devices: Hard disk drive, Dot matrix printer, optical sensing and control mechanism in NC machine tools etc.

Text Books

1 *Bolton, W., Mechatronics: A Multidisciplinary Approach, Pearson Education, New Delhi (2008).*
2 *Kamm, M.L.J., Mechatronics, Prentice Hall of India, New Delhi (2007).*

Reference Books

1 *Auslander, D. M. and Kempf, C. J., Mechatronics: Mechanical System Interfacing, Prentice Hall, New Jersy (1996).*
2 *Necsulescu, D., Mechatronics, Pearson Education, New Delhi (2002).*
3 *Alciatore, D. G. and Histand, M. B., Introduction to Mechatronics and Measurement System, McGraw Hill, New Delhi (2005).*

UME803 REFRIGERATION AND AIR CONDITIONING

L	T	P	Cr
3	1	2	4.5

Vapour Compression and Air Cycle Refrigeration: Reversed Carnot cycle, air refrigeration cycle, aircraft refrigeration cycle, vapour compression refrigeration cycle, actual vapour compression cycle. Advanced Vapour Compression refrigeration systems, Compound compression and multi load systems; Cryogenics refrigeration, cascade system.

Vapour Absorption Refrigeration: Water Vapour refrigeration systems, Steam jet refrigeration; Vapour absorption refrigeration systems, single effect and double effect vapour absorption systems.

Refrigerants: Desirable properties of common refrigerants, Alternative Refrigerants, Refrigerator retrofitting procedure. Impact on environment by traditional refrigerants, refrigeration & associated equipment, concept of ozone depletion and global warming.

Refrigeration System Components: Compressors, expansion devices, condensers, evaporators

Air Conditioning: Psychometric properties of air, psychometric processes, comfort charts, air conditioning load calculations, Types of air conditioning systems. Demonstration of HVAC softwares related to psychometric processes & HVAC systems.

Laboratory Work: Experiments relating to measurement of performance parameters related to Refrigeration Bench, Air Conditioning Test Rig; Cold Storage Plant; Heat Pump Characteristics; Experimental Ice Plant; Cascade Refrigeration System; Rail Coach Air Conditioning Unit; Study of safety devices, cutting, flaring of tubes, hermetically sealed compressor unit etc.

Text Books

1 *Arora, C. P., Refrigeration & Air Conditioning, Tata McGraw Hill, New Delhi (2000).*
2 *Stoecker, W. F. and Jones J. W., Refrigeration and Air Conditioning, McGraw Hill, New York (1982).*

Reference Books

1 *Dossat, R. J., Principles Of Refrigeration, Pearson Education, Singapore (2004).*
2 *Ameen, A., Refrigeration and Air Conditioning, Prentice Hall of India, New Delhi (2004).*

UME804 TURBOMACHINES

L	T	P	Cr
3	1	0	3.5

Principle of Turbomachines, Impulse Momentum Equation, Euler's equation for energy transfer.

Compressible Flow: Stagnation Properties, Speed of sound and Mach Number, one dimensional isentropic flow, isentropic flow through nozzles, shock waves and expansion waves, Fanno line Rayleigh line flow, air flow and steam flow through nozzles.

Steam Turbines: Steam nozzles, isentropic flow, critical pressure ratio, maximum discharge, throat and exit areas, effect of friction, supersaturated flow. Stream Turbines, types, impulse turbine, velocity and pressure compounding, reaction turbine, degree of reaction, reheat & regenerative cycles for turbines, losses, partial admission factor, overall efficiency, governing.

Compressors: Positive displacement and non-positive displacement; reciprocating, centrifugal and axial flow type; characteristic curves of compressors.

Steam Condensers: Classification and types, jet condensers- parallel flow, counter flow and ejector type, Edwards's air pump, shell and tube, shell and coil etc, cooling towers- natural draught, induced draught and forced draught.

Gas Turbines: Brayton cycle, Ericsson cycle, effect of intercooling, reheating and regeneration, open and closed gas turbine cycle, jet propulsion, turbo jet, ram jet, turbo- prop.

Text Books

1 *Cohen, H., Sarvnamattoo, H. I. H., and Rogers, G. F., Gas Turbine Theory, Pearson Education, New Delhi (1996).*
2 *Vasandani, V. P. and Kumar, D. S., Heat Engineering, Metropolitan Books, New Delhi (2003).*

Reference Books

1 *Kearton, W. J., Steam Turbine Theory and Practice, CBS Publishers and Distributors, New Delhi (1990).*
2 *Joel, R., Basic Engineering Thermodynamics, Pearson Education, New Delhi (1996).*
3 *Yahya, S. M., Turbines, Compressors & Fans, Tata McGraw Hill, New Delhi (2005).*
4 *Dixon, S. L., Fluid Mechanics and Thermodynamics of Turbomachinery, Butterworth-Heinemann, London (2005).*

UME831 COMPUTATIONAL FLUID DYNAMICS

L	T	P	Cr
3	1	0	3.5

Introduction: Motivation and role of computational fluid dynamics; concept of modeling and simulation.

Governing Equations: Continuity equation; momentum equation; energy equation; various simplifications; dimensionless equations and parameters; convective and conservation forms; incompressible inviscid flows Basic flows; source panel method; vortex panel method.

Nature of Equations: Classification of PDE, general behavior of parabolic, elliptic and hyperbolic equations; boundary and initial conditions.

Finite Difference Method: Discretization; various methods of finite differencing; stability; method of solutions.

Incompressible Viscous Flows: Stream function-vorficity formulation; primitive variable formulation; solution for pressure; applications to internal flows and boundary layer flows.

Finite Element Method: Introduction; variational and weighted residual formulations; different types of elements; shape functions; local and global formulations; applications to single flow problems.

Text Books

1 *Roache, P. J., Computational Fluid Dynamics, Hermosa Publishers, New Mexico (1982)*
2 *Wendt, J. F., Computational Fluid Dynamics: An Introduction, Springer, New York (2009)*

Reference Books

1 *Muralidhar, K and Sundararajan, T., Computational Fluid Flow and Heat Transfer, Narosa, New Delhi (1995).*
2 *Jaluria, Y and Torrance, K.E., Computational Heat Transfer, Hemisphere Publishing Company, New York (1986)*
3 *Patankar, S. V., Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Company, New York (1980)*

UME832 FINITE ELEMENT METHODS

L	T	P	Cr
3	1	0	3.5

Introduction: Finite element methods, history and range of applications.

Finite Elements: definition and properties, assembly rules and general assembly procedure, features of assembled matrix, boundary conditions.

Continuum Problems: classification of differential equations, variational formulation approach, Ritz method, generalized definition of an element, element equations from variations. Galerkin's weighted residual approach, energy balance methods.

Element Shapes and Interpolation Functions: Basic element shapes, generalized co-ordinates, polynomials, natural co-ordinates in one-, two- and three-dimensions, Lagrange and Hermite polynomials, two-D and three-D elements for C^o and C^1 problems, Co-ordinate transformation, iso-parametric elements and numerical integration.

Application of Finite Element Methods To Elasticity Problems And Heat Transfer Problems.

Text Books

1 *Chandrupatla, T. R. and Belegundu, A. K., Introduction to Finite Elements in Engineering, Pearson Education, India (2001).*

2 *Huebner, K. H., The Finite Element Method for Engineers, John Wiley, New York (2001).*

Reference Books

1 *Bathe, K.J., Finite Element Procedure in Engineering Analysis, Englewood Cliffs, Prentice Hall, New York (2001).*

2 *Zienkiewicz, O. C., The Finite Element Methods, Tata McGraw Hill, New Delhi (2002).*

3 *Reddy, J. N., An Introduction to Finite Elements Methods, McGraw Hill, New York (2001).*

4 *Stasa, F.L., Applied Finite Element Analysis for Engineers, Holt, Rinehart and Winston, New York (1995).*

UME833 INSPECTION AND QUALITY CONTROL

L	T	P	Cr
3	1	0	3.5

Industrial Inspection: Objectives and functions of inspection in industry, production/ inspection interaction, organization for industrial inspection, inspection procedures, economic aspect of inspection.

Concept of Quality in Engineering: Meaning and significance of quality; essential components of quality; phases or elements for building quality; evolution of the concepts of quality; spiral of progress of quality; changing scope of quality activities; Ishikawa's seven quality tools; Quality Circles; Quality system economics, hidden quality costs; economic models of quality costs.

Quality Control Function: Inspection versus quality control techniques, quality planning activities, organization for quality control. Fundamentals of statistical quality control, Juran's quality trilogy Charts for variables and attributes, application of control charts for averages, range, standard deviation, fraction defectives and number of non conformities per unit, Process capability analysis.

Acceptance Sampling: Elementary concepts, sampling by attributes, single, double and multiple sampling plans, construction and use of operating characteristic curves.

Quality Management Systems: Introduction to various quality standards.

Text Books

1 *Juran, J. M. and Gryna, F. M., Quality Planning & Analysis, Tata McGraw Hill, New Delhi (1995).*

2 *Grant, E. L., Statistical Quality Control, McGraw Hill International, New York (2005).*

Reference Books

1 *Feignbaum, A. V., Total Quality Control, McGraw Hill International, New York (1991).*

2. *Besterfield, D.H., Total Quality Management, Pearson Education Asia, New Delhi (2003).*

UME834 INTERNAL COMBUSTION ENGINES

L	T	P	Cr
3	1	0	3.5

Thermodynamic properties of fuel-air mixture before and after combustion, deviations of actual cycle from Ideal conditions, Analysis using combustion charts.

S.I. Engines: carburation, MPFI, combustion, ignition systems, Combustion chambers in S.I. engines.

C.I. Engines: Fuel injection, combustion, swirl & inlet ports design, Combustion: DI models, Supercharging, turbocharging & matching of turbocharging.

Engine Lubrication: Friction and lubrication, Performance, ISI codes, Emission and its control, Two stroke engine: scavenging, standards.

Recent Trends in I.C. Engines: Duel-fuel engines, multifuel engines, stratified charge engine, Sterling engine, variable compression ratio engine.

Text Books

1 *Ganesan, V., I. C. Engines, Tata McGraw Hill, New Delhi (2007).*
2 *Pulkrabek, W. W., Engineering Fundamentals of the Internal Combustion Engines, Pearson Education, New Delhi (2007).*
3 *Nunny, M. J., Light and Heavy Engine Technology, ButterWorth Hienemann, USA (2005).*

Reference Books

1 *Heisler, H., Advance Engine Technology, ButterWorth Hienemann, USA (2000).*
2 *Heywood, J. B., Internal Combustion Engine Fundamentals, McGraw Hill, New York (1988).*
3 *Stone, R., Introduction to Internal Combustion Engines, Pearson Education, New Delhi (1999).*

UME835 METAL FORMING

L	T	P	Cr
3	1	0	3.5

Classification of Metal Forming Processes: Elementary theory of plasticity, stress/ strain, strain-rate characteristics of materials, yield criteria of metals, formability, Hot forming/ Cold forming.

Mechanics of Forming Process: Rolling, process parameters, pressure distribution and roll separating force, rolling pressure, driving torque and power requirements.

Forging: Determination of forces in strip forging and disc forging, defects in forged components.

Drawing: Drawing stresses, limiting draw ratio, factors affecting drawability determination of force and power in wire drawing, determination of maximum allowable reduction, deep drawing force analysis, defects in drawn components.

Bending: Bendability, determination of work load and spring back.

Extrusion: Process, parameters, determination of work load from stress analysis and energy considerations, power loss, hydrostatic extrusion, pressure required to extrude, variables affecting the process.

Punching & Blanking: Two-dimensional deformation model and fracture analysis, determination of working force.

High Energy Rate Forming: Classification, comparison of conventional and high speed forming, Introduction to High Energy Rate Forming Processes (HERF).

Text Books

1 *Reddy, N.V. and Lal, G.K., Theory of Plasticity, Narosa Publication, New Delhi (2009).*
2 *Avitzur, B., Metal Forming Analysis, McGraw Hill, New York (1968).*

Reference Books

1 *Dixit, P.M. and Dixit, U.S., Modeling of Metal Forming and Machining Processes, Springer-Verlag, London (2008).*
2. *Ghosh, A. and Malik, A. K., Manufacturing Science, Affiliated East-West Press, New Delhi (1985).*
3. *Bruno, E. L., High Velocity Forming of Metals, ASTME, New York (1970).*
4. *Johnson, W and Millore, P.B., Plasticity for Mechanical Engineers, Van Nostrand, London (1962).*
5. *Narayansamy, R., Metal Forming Technology, Ahuja Book Publishers, New Delhi (1995).*
6. *Rowe, J. W., An Introduction to the Principles of Industrial Metal Working, Edward Arnold, London (1968).*

UME836 OPERATIONS MANAGEMENT

L	T	P	Cr
3	1	0	3.5

General: Operations Management: meaning and scope; significance of operations management in increasing productivity of firms; soft variety and hard variety; categories of production systems and layouts.

Forecasting Analysis: Need and benefits, various qualitative and quantitative models, error analysis in quantitative forecasting.

Production Planning: Aggregate production planning, pure and mixed aggregate planning strategies; Master production scheduling; material requirements planning and manufacturing resource planning (MRP I and MRP II); Supply Chain Management.

Inventory Management and Control: Inventory: need and types, deterministic and stochastic models for inventory management.

Text Books

1 *Monks, J. G., Operations Management: Theory and Problems, McGraw Hill, New York (1987).*

2 *Krajewski, L. J., Ritzman, L. P. and Malhotra, M. K., Operations Management, Prentice Hall, New Delhi (2009).*

Reference Books

1 *Ebert and Adams, Production/Operations Management, Prentice Hall of India, New Delhi (2007).*

2 *Chase, R. B., Aquilano, N. J. and Jacob, F. R., Production and Operations Management: manufacturing and services, Tata McGraw Hill, New Delhi (1999).*

UME837 POWER PLANT ENGINEERING

L	T	P	Cr
3	1	0	3.5

Energy sources for generation of electric power, Types of power plant- their special features and applications, Present status and future trends.

Hydroelectric Power Plant: Classifications, Components and their general layout, hydroelectric survey, rainfall run-off, hydrograph, flow duration curve, mass curve storage capacity, site selection.

Thermal Power Plant: General introduction, developing trends, essential features, site selection, coal-its storage, preparation, handling, feeding and burning, ash handling, dust collection.

Gas Turbine Power Plant: Field of use, components, plant layout, comparison with steam power plants, operation of combined steam and gas power plant.

Nuclear Power Plant: Nuclear fuels, nuclear energy, main components of nuclear power plant layout, nuclear reactors- types and applications, radiation shielding, radio-active waste disposal, safety aspects.

Power Plant Economics: load curves, terms and definitions, effect of load on power plant design, methods to meet variable load, prediction of load, cost of electrical energy, selection of types of generation and generating equipment, performance and operating characteristics of power plants, load division among generators and prime movers, Tariff methods of electrical energy.

Non- conventional Power Generation: Geothermal power plants, Tidal power plant, Wind power plant, Solar power plant, Electricity from City refuge, Thermoelectric conversion system, Thermo ionic conversion system, Photo voltaic power system, Fuel cells, Magneto-hydrodynamic system.

Text Books

1 *Nag, P. K., Power Plant Engineering, Tata McGraw-Hill, New Delhi (2005).*
2 *Ei-Wakil, M. M., Power Plant Engineering, McGraw-Hill, New York (1985).*

Reference Books

1 *Drbal, L. F., Boston, P. G. and Westra, K. L., Power Plant Engineering, Springer, New York (1996).*

UME838 PRINCIPLES OF ROBOTICS ENGINEERING

L	T	P	Cr
3	1	0	3.5

Introduction: Economic aspects in robot applications w.r.t. quality and productivity. Robot classifications and applications.

Robot Kinematics: Homogeneous co-ordinates and co-ordinate transformations, Forward and inverse kinematics.

Robot in Work Place: Work cell organization in robotics environment, Work Cell Design and Control.

Robot Dynamics: Introduction to Robot Dynamics.

Sensors and Actuators: Tactile, Proximity and Range sensors in robots; encoders; Velocity sensors, Robot Vision. Introduction to image processing, pneumatic and hydraulic motors, stepper motors, D.C servo motors.

Methods of Robot Programming: Introduction to on-line and off-line Robot programming methods.

Applications of Robots: Welding, parts handling / transfer, assembly operations, parts sorting, parts inspection, future applications.

Text Books

1 *Groover, M. P., Weiss, M., Nagel, R. N. and Odrey, N. G., Industrial Robotics: Technology, Programming and Applications, McGraw Hill, New York (1986).*

2 *Lee, C.S.G., Fu, K.S & Gonzalez, Robotics: Control, Sensing, Vision, and Intelligence, McGraw Hill, New York (1990).*

Reference Books

1 *Asada, H., Slotine, J. E., Robot Analysis and Control, John Wiley & Sons, New York (1986).*

2 *Craig, J. J., Introduction to Robotics Mechanics and Control, Addison - Wesley Publishing Company, New York (1986).*

3 *Schilling, R.J., Fundamentals of Robotics Analysis & Control, Prentice Hall of India, New Delhi (1990).*