THAPAR UNIVERSITY

COURSES SCHEME

&

SYLLABUS

FOR

B.E.

MECHANICAL

(PRODUCTION) ENGINEERING

2014

COURSES SCHEME & SYLLABUS FOR

B.E. MECHANICAL (PRODUCTION) ENGINEERING

SEMESTER – III

SR. NO.	COURSE NO	TITLE	L	T	P	CR
1	UMA032	NUMERICAL ANDSTATISTICAL METHODS	3	1	2	4.5
2	UHU003	HUMAN VALUES, HUMAN RIGHTS & IPR	2	1	0	2.5
3	UEN001	ENVIRONMENTAL STUDIES	3	0	0	3.0
4	UME304	MANUFACTURING TECHNOLOGY	3	0	2	4.0
5	UME501	APPLIED THERMODYNAMICS	3	1	2	4.5
6	UME302	KINEMATICS OF MACHINES	3	1	0	3.5
7	UME305	MACHINE DRAWING	1	4	0	3.0
TOTAL			**18**	**8**	**6**	**25.0**

SEMESTER – IV

SR. NO.	COURSE NO	TITLE	L	T	P	CR
1	UMA031	OPTIMIZATION TECHNIQUES	3	1	0	3.5
2	UHU031	ORGANIZATIONAL BEHAVIOR	3	1	0	3.5
3	UES032	MATERIAL SCIENCE AND ENGINEERING	3	1	2	4.5
4	UME406	COMPUTER AIDED GEOMETRIC MODELING AND ANALYSIS	2	4	0	4.0
5	UME402	DYNAMICS OF MACHINES	3	1	0	3.5
6	UME407	INSPECTION AND QUALITY CONTROL	3	1	2	4.5
7	UME404	MECHANICS OF DEFORMABLE BODIES	3	1	0	3.5
TOTAL			**20**	**10**	**4**	**27.0**

SEMESTER – V

SR. NO.	COURSE NO	TITLE	L	T	P	CR
1	UME507	INDUSTRIAL ENGINEERING	3	1	0	3.5
2	UME503	INDUSTRIAL METALLURGY AND MATERIALS	3	1	0	3.5
3	UME508	MACHINE DESIGN	3	1	0	3.5
4	UME705	MACHINING SCIENCE	3	1	2	4.5
5	UME836	OPERATIONS MANAGEMENT	3	1	0	3.5
6	UPE701	METAL CASTING AND JOINING	3	0	2	4.0
7	UME510	INDUSTRIAL AUTOMATION	3	1	0	3.5
8		~~DESIGN PROJECT (WITH 8 SELF HOURS)~~	~~0~~	~~0~~	~~2~~	~~5.0~~
TOTAL			**21**	**6**	**4**	**26.0**

SEMESTER – VI

SR. NO.	COURSE NO	TITLE	L	T	P	CR
1	UME691	PROJECT SEMESTER*				~~12.0~~ 16
TOTAL						**16.0**

OR

SR. NO.	COURSE NO	TITLE	L	T	P	CR
1	UME692	PROJECT				~~2.0~~ 06
2		PRODUCT DESIGN AND DEVELOPMENT	3	1	0	3.5
3	UME602	PRODUCTION AND INVENTORY CONTROL	3	1	0	3.5
4		ELECTIVE II	3	0	0	3.0
TOTAL			**9**	**2**	**0**	**~~12.0~~ 16**

* TO BE CARRIED OUT IN INDUSTRY/RESEARCH INSTITUTION.

SEMESTER – VII

SR. NO.	COURSE NO	TITLE	L	T	P	CR
1	UME502	AUTOMOBILE ENGINEERING	3	0	2	4.0
2	UME702	COMPUTER AIDED MANUFACTURING	3	0	2	4.0
3	UME709	JIGS AND FIXTURES	3	0	0	3.0
4	UPE703	METAL FORMING	3	1	0	3.5
5	UME710	MODERN MANUFACTURING PROCESSES	3	1	2	4.5
6	UHU081	ENGINEERING ECONOMICS	3	1	0	3.5
7	UME791	CAPSTONE PROJECT PART-I (START)	0	0	4	0
TOTAL			**18**	**3**	**10**	**22.5**

SEMESTER – VIII

SR. NO.	COURSE NO	TITLE	L	T	P	CR
1		RAPID PROTOTYPING	3	1	0	3.5
2		MACHINE TOOL DESIGN	3	1	0	3.5
3	UME	ROBOTICS ENGINEERING	3	1	0	3.5
4		MECHATRONICS	3	0	2	4.0
5		ELECTIVE III	3	1	0	3.5

6		CAPSTONE PROJECT PART-II CONTINUED	0	0	6	8.0
TOTAL			**15**	**4**	**8**	**26.0**

ELECTIVE-II

SR. NO.	COURSE NO	TITLE	L	T	P	CR
1		WORK STUDY AND METHODS ENGINEERING	3	0	0	3.0
2		LEAN MANUFACTURING	3	0	0	3.0
3		FACILITY PLANNING	3	0	0	3.0
4		ERGONOMICS ENGINEERING	3	0	0	3.0

ELECTIVE-III

SR. NO.	COURSE NO	TITLE	L	T	P	CR
1		SUPPLY CHAIN MANAGEMENT	3	1	0	3.5
2		MANAGEMENT INFORMATION SYSTEMS	3	1	0	3.5
3		PROJECT MANAGEMENT	3	1	0	3.5
4		DESIGN OF EXPERIMENTATION AND ANALYSIS	3	1	0	3.5
5		PROCESSING OF POLYMERS AND COMPOSITES	3	1	0	3.5
6		MODERN AUTOMOBILE ENGINEERING	3	1	0	3.5
7		FINITE ELEMENT METHODS	3	1	0	3.5

UMA032 NUMERICAL AND STATISTICAL METHODS

L	T	P	Cr
3	1	2	4.5

Course Objective: The main objective of this course is to motivate the students to understand and learn various numerical and statistical techniques to solve mathematical problems representing various engineering, physical and real life problems.

Floating-Point Numbers: Floating-point representation, Rounding, Chopping, Error analysis, Condition and instability.

Non-Linear Equations: Bisection, Secant, Fixed-point iteration and Newton-Raphson methods, Order of convergence.

Linear Systems and Eigen-Values: Gauss elimination method (using Pivoting strategies), Gauss-Seidel iteration method and its convergence, Rayleigh's power method for eigen values and eigen vectors.

Interpolation: Newton form of polynomials, Finite differences, Newton's forward, Lagrange and Newton's divided difference interpolation formula with error analysis.

Numerical Integration: Newton cotes quadrature formulae (with error) and Gauss - Legendre quadrature formulae.

Differential Equations: Solution of initial value problems using Taylor series, Euler's and Runge Kutta (up to fourth order) methods.

Random Variables: Basic concepts of probability, Discrete and continuous random variables, Probability mass/density functions, Cumulative distribution functions, Mathematical expectation, Variance and covariance.

Probability Distributions: Introduction to binomial and poisson distribution, Geometric, Uniform, Normal and exponential distribution.

Linear Regression and Correlation: Linear regression, Least square principle and the fitted model, Correlation and regression (two variables only).

Sampling Distribution: Sampling distribution of mean and variance, Chi square distribution and F distribution.

Hypothesis Testing: General concepts, Testing a statistical hypothesis.

Laboratory Work:

Laboratory experiments will be set in consonance with the materials covered in theory.

Course Learning Outcomes (CLO):

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

1. understand error, source of error and its affect on any numerical computation and also analyzing the efficiency of any numerical algorithm.
2. learn how to obtain numerical solution of nonlinear equations using Bisection, Newton – Raphson and fixed-point iteration methods.
3. solve system of linear equations numerically using direct and iterative methods.
4. understand the methods to construct interpolating polynomials with practical exposure and also the various approaches dealing with the data using theory of probability.
5. analyze the different samples of data at different level of significance using various hypothesis testing.

Text Books:

1. *Conte, S.D. and Boor, C.D., Elementary Numerical Analysis: An Algorithmic approach, (Third Edition), Tata McGraw Hill, New York (2006).*
2. *Jain, M.K., Iyengar, S. R. K. and Jain, R. K., Numerical Methods for Scientific and Engineering Computation, New Age International Publishers (2008).*

3. *Johnson, R.A., Miller and Freund's Probability and Statistics for Engineers, Pearson Education (2006).*
4. *Meyer P.L., Introduction to Probability and Statistical Applications, Oxford & IBH (2007).*

Reference Books:

1. *Atkinson, A.E., An Introduction to Numerical Analysis, Wiley Publication, Second Edition (2011).*
2. *Chapra, S.C. and Caule, R.P., Numerical Methods for Engineers, McGraw-Hill, (1989).*
3. *Walpole E Ronald, Myers H. Raymond, Myers L. Sharon, Keying Ye, Probability and Statistics for Engineers and Scientists, Pearson Education (2005).*

UHU003: HUMAN VALUES, HUMAN RIGHTS AND IPR

L	T	P	Cr.
2	1	0	2.5

Course Objectives: The course has been designed to enable students to understand the concept of values and different types of values, and to establish the theoretical foundation for the study of important values and their major dimensions. It will also help in understanding the meaning of moral and ethical values and need for ethics in professional life.The course also covers the concept and classification of human rights and their significance in the modern-day world. The course will also enable them to understand the nature and character of IPRs and their role in economic development.

Values: Concept, Types, Rokeach Value Survey.

Different Kinds of Values: Individual, Societal, Material, Psychological, Cultural, Moral And Ethical, Spiritual; The Burgeoning Crises at Each of these levels.

Modern Approach to the Study of Values: Analyzing Individual Human Values such as Creativity, Freedom, Wisdom and Love; Value Spectrum for a Good Life; The Indian Concept of Values, Comparison of eastern and western concept of values.

Ethics: Values, Morals and Ethics; Need for Ethics in Professional Life; Kohlberg's Theory of Moral Development and Its Applicability to Engineers.

Professional Ethics: Values in Work Life; Professional Ethics and Ethos; Codes of Conduct, Whistle-Blowing, Corporate Social Responsibility, Case Studies on Ethics in Business.

Human Rights: Meaning and concept of Human Rights; Notion and Classification of Rights: Natural, Moral and Legal Rights; Three Generations of Human Rights; Civil and Political Rights; Economic, Social and Cultural Rights; Collective/Solidarity Rights.

Introduction to IPR: Nature and Enforcement, International Character of IPRs, Role of IPRs in Economic Development.

Patents: Introduction To Patents, Object of Patent Law, Inventions not Patentable, Obtaining Patents, Rights and Obligations of a Patentee.

Copyrights: Introduction to Copyrights, Subject-Matters of Copyright, Rights Conferred by Copyright, Infringement, Assignment and Licensing Of Copyrights, Copyright Societies, International Copyright, Performers' Rights.

Trademarks: Functions, Significance and Types of Trademarks, Distinctiveness and Deceptive Similarity, Registration Procedure, Trademark Registry, Grounds for Refusal of Registration of Trademarks, Concurrent Use, Character Merchandising.

Trade Secrets: Meaning, Types of Trade Secrets, Statutory Position of Trade Secrets in India, Proofs Required in Trade Secret Litigation Case.

Some Other Types of Intellectual Properties: Role and Significance, Current Status of GIs as Intellectual Property Rights, Nature and Significance of Industrial designs.

Course Learning Outcomes (CLO):

The students after studying this course will be able to appreciate the significance of values and ethics in both personal and professional life, and to be able to respect and uphold human rights. Additionally, they will be able toappreciate the significance of Intellectual Property as a very important driver of growth and development in today's world and be able to statutorily acquire and use different types of intellectual property in their professional life.

Text Books:

1. *Narayanan, P., Intellectual Property Law, Eastern Law House (2007).*
2. *Tripathi A.N., Human Values, New Age International (P) Ltd (2008).*
3. *Rhona K. M. Smith: Textbook on International Human Rights: Oxford University Press (2011).*

Reference Books/Journals:

1. *Robbins, S.P., Organizational Behavior, Prentice Hall of India (2007).*
2. *Journal of Intellectual Property Rights, published by National Institute of Science Communication, CSIR.*

UEN001 ENVIRONMENTAL STUDIES

L	T	P	Cr
3	0	0	3.0

Definition and Scope: Importance, Public awareness and education.

Natural Resources: Introduction, Renewable and non-renewable, Forest, water, mineral, food, energy and land resources, Individual and conservation of resources, equitable use of resources.

Ecosystems: Concept, Structure, Function, Energy flow, Ecological succession, Forest, grassland, desert and aquatic ecosystems - Introduction, characteristic features, structure and function.

Biodiversity: Genetic, Species and ecological diversity, Bio-geographical classification of India, Value and hot spots, Biodiversity at global, national and local levels, India as mega-biodiversity nation, Threats to biodiversity, Endangered and endemic species of India, Conservation of Biodiversity, Endangered and endemic species, Conservation of biodiversity.

Pollution: Definition, Causes, effects and control measures of the pollution – Air, soil, Noise, Water, Marine and Thermal and Nuclear Pollution, Solid waste management, Role of Individual in Prevention of Pollution, Pollution case studies, Disaster management.

Social Issues: Sustainable development, Water conservation, Environmental ethics, Climatic change, Wasteland reclamation, Environmental protection acts and issues.

Human Population and the Environment: Population growth, Environment and human health, Human rights, HIV/AIDS, Value education, Women and child welfare, IT in human health and environment, Case studies.

Text Books:

1. *Bharucha, E., Textbook of Environmental Studies for undergraduate courses, Universities Press (2005).*
2. *Chapman, J.L. and Reiss, M.J., Ecology - Principles and Application, Cambridge University Press (LPE) (1999).*
3. *Joseph, B., Environmental Studies, Tata McGraw Hill (2005).*

Reference Books:

1. *Miller, G.T., Environmental Science - Working with the Earth, Thomson (2006).*
2. *Wright, R.T., Environmental Science -Towards a sustainable Future, Prentice Hall of India (2008).*

MANUFACTURING TECHNOLOGY

L	T	P	Cr
3	0	2	4.0

Course Objectives: To expose the students to the principles of the metal joining methods with principle of operations and power sources for different welding techniques, process parameters and their effects on joint quality, joint quality checking, weld ability issues. To impart the knowledge on metal cutting mechanics, cutting force, stress, strain etc, effect of process parameters, grinding and abrasive machining techniques. To study metal forming techniques, extrusion, rolling, drawing, and sheet metal forming and shearing operations, some design aspects and knowledge about process behavior.

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 and 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; Industrial visit.

Course Learning Outcomes (CLO):

The students will be able to:

1. apply the knowledge of metal casting for different requirements, quality; calculation of charge constituents, designing of gating and riser systems, casting solidification and quality of casting.
2. understand the basic principle of metal cutting and forming operations.
3. understand the processing of non-metallic materials, preparation and processing of plastics for different applications, Powder metallurgy and Rapid prototyping and tooling.

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).*

APPLIED THERMODYNAMICS

L	T	P	Cr
3	1	2	4.5

Course Objectives: To introduce the principles of the conversion of fossil fuel energy to useful power. To introduce fundamental thermodynamic operating principles and phenomena of IC engines.

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, fluidized bed boilers, alternate fuels for fossil fuel based power plants, IGCC.

I. C.Engines: Review of air cycles(Otto, diesel and dual), 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, emissions from IC and SI engines

Laboratory Work:

Study of Nestler Boiler, Lancashire Boiler, Babcock and Wilcox boiler, Locomotive boiler, mountings and accessories of a boiler, Petrol/ Diesel Engine (Both two stroke and Four Stroke), Two Stroke Krimo Engine, Multi cylinder petrol engine, Dual fuel engine test rig, Industrial visit to thermal power plant.

Course Learning Outcomes (CLO):
The students will be able to:

1. apply the first and second laws of thermodynamics for the complete thermal analysis of vapor power cycle.
2. study the performance parameters of IC engines. Fuel injection, combustion, lubrication, cooling, heat transfer, friction and other factors affecting engine power, efficiency and emission.
3. Derive and analyze Otto, Diesel, Dual cycle thermal efficiencies.

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 *Heywood, J. B., Internal Combustion 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).*

KINEMATICS OF MACHINES

L	T	P	Cr
3	1	0	3.5

Course Objectives: To learn actual mechanisms and their kinematic characteristics (displacement, velocity and acceleration) used in the analysis, design and development of machines and to study existing machines for better understanding.

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, Types of Profiles, 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.

Course Learning Outcomes (CLO):
The students will be able to:

1. Select appropriate combination of mechanism to analyze and design new machines and to study existing machines for improvements.

Text Books:

1. *Rattan, S. S., Theory of Machines, Tata McGraw Hill (2009).*
2. *Bevan, T., Theory of Machines, CBS Publisher (2005).*

Reference Books:

1. *Ghosh, A. and Malik, A.K., Theory of Mechanism and Machines, East West Press (2009).*
2. *Shigley, J. E., Kinematics Analysis of Mechanism, McGraw-Hill (1995).*
3. *Myszka, D. S., Machines & Mechanisms: Applied Kinematic Analysis, Pearson Education (2004).*

MACHINE DRAWING

L	T	P	Cr
1	4	0	3.0

Course Objectives: Introduction to Mechanical drawing standards, symbols, conventions and rules. Introduce standards, types, working, uses and design variations of components and assemblies used in machines. Impart knowledge related to principles, methods and techniques used in Manual Drafting and Computer Aided Drafting tools for use in communication of mechanical engineering design for manufacture. Assemble components given only component drawings and make sectioned views of the mechanical system assembly and interpret its working.

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.

Course Learning Outcomes (CLO):
The students will be able to:

1. Use standards used in machine drawing of machine components and assemblies.
2. Create and read production drawings for mechanical components and systems and deduce their functions.
3. Use manual drafting or CAD tools for making drawings of machine components and assemblies.
4. Assemble components given only component drawings and make sectioned views of the mechanical system assembly and interpret its working.

Text Books:

1. *Gill, P.S., Machine Drawing, S.K.Kataria and Sons (2013).*
2. *Bhatt, N.D., Machine Drawing, Charotar Publishing House (2008).*

Reference Books:

1. *Pohit, G., Machine Drawing with AutoCAD, Pearson Education Asia (2007).*
2. *French, T. E. and Vierck, C. J., Graphic Science and Design, McGraw Hill (2000).*
3. *Dhawan, R.K., Machine Drawing, S.Chand & Company Limited (2003).*
4. *Narayana, K.L., Kannaiah P. and Reddy, K.V., Machine Drawing, New Age International Publishers (2002).*

UMA031 OPTIMIZATION TECHNIQUES

L	T	P	Cr
3	1	0	3.5

Course Objective: The main objective of the course is to formulate mathematical models and to understand solution methods for real life optimal decision problems. The emphasis will be on basic study of linear programming problem, Integer programming problem, Transportation problem, Two person zero sum games with economic applications and project management techniques using PERT and CPM.

Scope of Operations Research: Introduction to linear and non-linear programming formulation of different models.

Linear Programming: Geometry of linear programming, Graphical method, Linear programming (LP) in standard form, Solution of LP by simplex method, Exceptional cases in LP, Duality theory, Dual simplex method, Sensitivity analysis, Parametric linear programming.

Integer Programming: Branch and bound technique.

Transportation and Assignment Problem: Initial basic feasible solutions of balanced and unbalanced transportation/assignment problems, Optimal solutions.

Network Analysis: Shortest path problem, Dijkastra's algorithm, Minimum spanning tree problem, Maximum flow problem.

Project Management: Construction of networks, Network computations, Floats (free floats and total floats), Red flagging rule, Critical path method (CPM), Crashing.

Nonlinear Programming: Concept of convexity and concavity, Maxima and minima of functions of n-variables, Lagrange multipliers, Kuhn-Tucker conditions for constrained optimization, One dimensional search methods, Fibonacci, Gradient methods for unconstrained problems.

Course Learning Outcomes (CLO):

After Completion of this course, the students would be able to:

1. Formulate and solve linear programming problems.
2. Solve the problems on networks models such as Transportation, Assignment, Shortest path, minimal spanning tree, and Maximal flow.
3. Solve the problems of Project Management using CPM.

Text Books:

1. *Chandra, S., Jayadeva, Mehra, A., Numerical Optimization and Applications, Narosa Publishing House, (2013).*
2. *Taha H.A., Operations Research-An Introduction, PHI (2007).*

Recommended Books:

1. *Bazaarra Mokhtar S., Jarvis John J. and Shirali Hanif D., Linear Programming and Network flows, John Wiley and Sons (1990).*
2. *Swarup, K., Gupta, P. K., Mammohan, Operations Research, Sultan Chand & Sons, (2010).*
3. *Pant J. C., Introduction to optimization: Operations Research, Jain Brothers (2004).*

UHU 031-ORGANIZATIONAL BEHAVIOR

L	T	P	Cr
3	1	0	3.5

Course Objective: To understand the complexity of human behavior and factors affecting individual differences and their relevance in the global world**.** To learn the dynamics of leadership and motivation for effective functioning in the organization.

Introduction to Organizational Behavior, Today's Organizations, Contemporary Challenges, Foundations of Organizational Behavior, and Individual Behavior: Personality, Values, Attitudes, and Motivation Theories. Employees Motivation in Organization. Management by Objectives, Learning Processes, Reward and Punishment, Shaping Behavior.

Foundations of Group Behavior: Group Development Process, Group Decision Making Techniques, Leadership, Power & Politics, Conflict Process, Negotiations, Inter- Group Relations, Team Working, and Stress Management.

A Macro perspective of Organizational Behavior, Organizational Structure: Key Elements, Types and Basic Models, Work Designs, Organizational Change and Learning Organizations.

Organizational Behavior: Future Challenges, Gender Diversity at Work Place, Changing World Scenario, Role of external Environment.

Achieving Competitive Advantage Management of change, International issues in Organizational Behavior.

Current issues in Organizational Behavior: Techno-stress, Combating stress, Role of Positive Psychology.

Course Learning Outcomes (CLO):
After completing the course, the students will be able to:

1. Understand the basics of Organizational Behavior as an interdisciplinary Course.
2. Understand the different levels of analysis: Individual, Group, Organization.
3. Understand the effect of personality, Learning, Attitudes of an individual in an Organization.
4. Understand the role of Motivation and Leadership in an organization and how an individual as a leader can motivate his/her employees and utilize Group dynamics in Organization.
5. Understand the concept of Power and Politics, and Conflict management and its relevance.
6. Understand how organization functions as whole, Organizational Culture, Organizational Design, and Organizational Change.

Text Books:

1. *Robbins, S.P. Organizational Behavior, PHI, New Delhi.*
2. *Luthans, F. Organizational Behavior, Irwin McGraw Hill.*
3. *Susan Nolen-Hoeksema,S; Geoffrey Loftus ,G,& Wagenaar,W Atkinson & Hilgard's Introduction to Psychology Wadsworth Cengage learning.*

UES032: MATERIALS SCIENCE AND ENGINEERING

L	T	P	Cr
3	1	2	4.5

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.

ModernMaterials: 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., Principles of Materials Science and Engineering: An Introduction, Tata Mc-Graw Hill (2008).*
2. *Raghavan, V., Introduction to Materials Science and Engineering, PHI, Delhi (2005).*
3. *Callister, W.D., Materials Science and Engineering, John Wiley & Sons, Singapore (2002).*

Reference Books:

1. *Kasap, S. O., Principles of Electronic Engineering Materials, Tata-Mc-Graw Hill (2007).*
2. *Van Vlack, L H., Elements of Material Science and Engineering, Thomas Press, India(1998).*

COMPUTER AIDED GEOMETRIC MODELING AND ANALYSIS

L	T	P	Cr
2	4	0	4.0

Course Objectives: Exposure to CAD tools for use in mechanical engineering design conceptualization, Geometric modelling, communication, analysis and optimization. Impart knowledge related to principles, methods and techniques of 3D modelling in parametric CAD software. Design evaluation and optimization using CAD, CAE software. Use of CAD models for further use in CAM and CAE uses in mechanical engineering.

Fundamentals of CAD: Introduction, Application of computers in stages of the design process, Benefits of CAD.

Use of CAD Software like Creo/Pro-Engineer: Techniques and functions used for parametric solid modeling, Surface modeling, Assembly modeling, Drawing creation and detailing, Use of CAD data for CAM and CAE.

Geometric Modeling: Parametric sketching, Constrained model dimensioning, Material addition and removal for extruded, Revolved, Swept and Blended features, Construction features of points, Axis, Curves, Planes, Surfaces. Feature and its parent-child relationships, References. Parametric modeling, User defined parameters, Relations. Advanced features for non-parallel blends, Helical sweep, Swept blend, Variable section sweeps, and surface boundary blend. Top-down vs. bottom-up design. Assembly modeling. Flexible component assembly. Automatic production drawing creation and detailing. File formats for data transfer.

Software Productivity Enhancement Tools: Cosmetic features, Chamfers, Rounds, Standard holes and sketched holes, Draft, Ribs, Shell. Feature patterns, Duplication, Grouping, Suppression. Part family table for Group Technology. Software automation and customization tools. Coloring and rendering. Simplified views. Assembly animation.

Geometric Model Based Analysis: Model measures, Evaluation and analysis. Mass property analysis, Assembly analysis. Design of customized analysis features. Design parameter sensitivity analysis, Feasibility and optimization studies. Mechanism design and assembly for kinematic and dynamic analysis. Linear elastic mechanical stress analysis using software like Pro-Mechanica for industrial design.

Course Learning Outcomes (CLO):

The students will be able to:

1. Translate production drawings to 3D CAD models.
2. Use parametric CAD software for Geometric Modeling of Mechanical Designs.
3. Evaluate and optimize the design using CAD, CAE software.
4. Use 2D / 3D CAD in future courses like Project Semester, Mechanical System Design - project work, CAM, etc.

Text Books:

1. *Gill, P.S., Machine Drawing, S.K.Kataria Publishers (2013).*
2. *Dhawan, R. K., Machine Drawing, S. Chand & Company Limited (2003).*

Reference Books:

1. *Creo / Pro-E Software Manuals, Training materials and literature provided by supplier.*
2. *Shyam Tikku and Prabhakar Singh, Pro/Engineer (Creo Parametric 2.0) for Engineers and Designers, Dreamtech Press (2013)*
3. *Kelley, D. S., Pro/Engineer Wildfire 3.0 Instructor, Tata McGraw Hill (2008).*
4. *Groover, M. P. and Zimmer, E. W., CAD/CAM, Pearson Education Asia (2008).*

DYNAMICS OF MACHINES

L	T	P	Cr
3	1	0	3.5

Course Objectives: To learn different parameters and principles needed to calculate forces and torques in friction devices (belts, pulleys, bearings, brakes, clutches), balancing of rotating and reciprocating masses, and some important devices like gyroscope, gears and gear trains etc. in totality.

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.

Governors: Function, Types, Force analysis and their Characteristics.

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

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.

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

Gears: Interference, Minimum number of teeth on gear and pinion to avoid interference, Path of contact and arc of contact.

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

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

Course Learning Outcomes (CLO):
The students will be able to:

1. Integrate kinematics with dynamics to study, analyze and design new machines, and performance enhancement of existing machines.

Text Books:

1. *Rattan, S. S., Theory of Machines, Tata McGraw Hill (2009).*
2. *Bevan, T., Theory of Machines, CBS Publisher (2005).*

Reference Books:

1. *Ghosh, A. and Malik, A.K., Theory of Mechanism and Machines, East West Press (2009).*
2. *Shigley, J. E., Kinematics Analysis of Mechanism, McGraw Hill (1995).*

INSPECTION AND QUALITY CONTROL

L	T	P	Cr
3	1	2	4.5

Course Objectives: Understand the objectives, functions, and economic aspects of industrial inspection. Understand the essential components/ economics for building quality and study the evolution of the concepts/ tools of quality engineering. Study the basics and applications of various statistical quality control techniques and also process capability analysis. Study and understand the concepts of quality improvement process and the associated quality tools. Understand the scope and significance of engineering metrology

Inspection, Quality, Process and Control: The basic concepts, Objectives and functions of inspection in industry, 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, Quality Circles, Quality system economics, Hidden quality costs, Economic models of quality costs, Quality loss function.

Statistical Process Control: Understanding the process, Process data collection and presentation, Process variability, Process control, Variable control charts ($\overline{X}-R, \overline{X}-S$ etc.), Attribute control charts(p, np, c, μ) , Cumsum charts, Acceptance sampling.

Process Capability Analysis: Need and significance, Process capability for variable data, Process capability indices, Interpreting the indices, Use of control chart and process capability data.

Process Improvement: Quality improvement process, Quality tools for process improvement viz. Pareto Charts, C & E analysis, Scatter Diagrams, Stratification.

Six Sigma Process Quality: Introduction, DMAIC process, role of design of experimentation, Parametric design.

Engineering Metrology: Scope of engineering metrology, Types of measurement methods, Characteristics of a measurement system (Range/span, Precision/Accuracy, Hysteresis, Dead Zone, Drift, Sensitivity), Calibration process, Line measurement and end measurement, Importance of surface texture, Gauge R & R, Radius and Curvature measurement, Angle measurement, Thread and Gear measurement.

Course Learning Outcomes (CLO):
The students will be able to:

1. Understand the importance of quality and the role of industrial inspection in achieving it.
2. Understand the phases and components for building quality and to learn about quality system economics.
3. Apply various SPC and quality tools for the purpose of overall quality improvement.
4. Learn the basic concepts involved in the working of instruments for line and angle measurements.

Text Books:

1. Oakland, J. S., Statistical Process Control, Butterworth and Heinemann, New York (2008).

2. Gupta, I. C., Engineering Metrology, Dhanpat Rai and Sons, New Delhi (2007).

Reference Books:

1. *Grant, E. L. and Leavenworth, R.S., Statistical Quality Control, McGraw Hill International, New York (2008).*
2. *Besterfield, D.H., Total Quality Management, Pearson Education Asia, New Delhi (2003).*
3. *Juran, J. M. and Gryna, F. M., Quality Planning & Analysis, Tata McGraw Hill, New Delhi (1995).*

MECHANICS OF DEFORMABLE BODIES

L	T	P	Cr
3	1	0	3.5

Course Objectives: To perform three dimensional stress and deformation analyses for structures exposed to axial, torsional, shear, bending loads, when acting either independently or in combination. To use the concepts of principal stresses and strains to calculate maximum stresses and strains and determine the critical loads for failure of a structure under static loads. Use linear elastic relationships between stress and strain to predict deformations of a structure or determine stresses from strain measurements. Methods for solving complex problems involving analysis of structures like bending of curved beams, unsymmetrical bending of beams and determining shear centre, critical loads for columns, stresses in pressure vessels.

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.

Thick and Thin Cylinders: 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.

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.

Course Learning Outcomes (CLO):
The students will be able to:

1. Carry out three dimensional stresses and strain analysis in loaded elastic members.
2. Develop governing equations and their solutions for analysis of structures.

Text Books:

1. *Srinath, L.S., Advanced Mechanics of Solids, Tata Mc-Graw Hill (2008).*
2. *Shames, I.H., Mechanics of Deformable Solids, Prentice Hall of India (2000).*

Reference Books:

1. *Popov, E.P., Engineering Mechanics of Solids, Prentice Hall of India (2006).*
2. *Ryder, G.H., Strength of Materials, B.I. Publishers (2005).*
3. *Kumar K. and Ghai, R. C., Advanced Mechanics of Materials, Khanna Publishers (1986).*

INDUSTRIAL ENGINEERING

L	T	P	Cr
3	1	0	3.5

Course Objectives: To equip the students to objectively study business functions in order to critically evaluate the effectiveness and efficiency of processes, tools and equipment manpower utilization, machinery, workplace layout, environment, methods of working, through a structured analysis approach. To cultivate working knowledge in the area of Inventory Management using conventional and contemporary techniques of inventory management in manufacturing environment. To develop knowledge and skills in product design for its proper value analysis and engineering. To develop improved techniques/methods commensurate with the existing conditions and ensuring smooth embedding of the new improved methods in any manufacturing and business organization

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 design considerations, Product development, Detailing, Value Engineering and its role in product design and cost rationalization.

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.

Course Learning Outcomes (CLO):
The students will be able to:

1. Evaluate and improve the business process for effective utilization of all the industrial resources.
2. Manage and plan the general inventory in industry.
3. Develop better methods for workplace improvement and new products.

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, McGraw Hill (2005).*
2. *Sanders, M. and McCormic, E., Human factors in Engineering, McGraw Hill (1993).*
3. *Work Study, ILO, Geneva (1992).*
4. *Curie, R., Introduction to Work Study, McGraw Hill (1992).*

INDUSTRIAL METALLURGY AND MATERIALS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To identify and understand the variables which affect the mechanical properties of alloys. To study the role of equilibrium diagrams in controlling the microstructure of materials especially iron-carbon systems.

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.

Introduction to composite materials.

Exposure to different metallurgical equipment; Industrial visits.

Course Learning Outcomes (CLO):

The students will be able to:

1. understand the kinetics of formation and decomposition of austenite and the various heat treatment processes.
2. study the composition, properties, applications of alloy steels to understand their commercial utility.
3. identify, analyze, and solve problems related to concepts of industrial metallurgy.

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 *Callister, W.D., Materials Science and Engineering: An Introduction, John Wiley and Sons Inc., US (2007).*

2 *Hill, R.E.R., Physical Metallurgy Principles, Affiliated East-West Press, New Delhi (2008).*

3 *Rajan, T.V., Sharma, C.P and Sharma, A., Heat Treatment: Principles & Techniques, Prentice Hall of India, New Delhi (2006).*

4 *Lakhtin, Y., Engineering Physical Metallurgy, CBS Publishers and Distributors, New Delhi (2005).*

MACHINE DESIGN

L	T	P	Cr
3	1	0	3.5

Course Objectives: Topresent the basic knowledge of design procedure for simple components like keys, cotters, shafts, pipe joints, pulleys, seals and gaskets under static and fatigue loading.

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, tolerance, type of fits, selection of fits, limits.

Design of Shaft: Shafts subject to combined loading; subjected to fatigue loading.

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

Couplings: Rigid and Flexible types.

Design of other Mechanical Components: Power screws, pipe joints: circular, oval and square flanged pipe joints, seals and gaskets, pulleys and flywheels.

Assignments related to design and drawings of the above components.
Machine Design data issued by Mechanical Engineering Department is only to be used.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the principles, process and requirements for design of machine elements.
2. select the suitable materials.
3. design simple components like fasteners, shafts, couplings etc.

Text Books:

1. *Bhandari, V. B., Design of Machine Elements, Tata McGraw Hill, New Delhi (2007).*
2. *Shigley, J., Mechanical Engineering Design, McGraw Hill Book Company Inc., New York (2003).*

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 *Norton, R.L., Machine Design: An Integrated Approach, Pearson Education, New Delhi (2006).*
4 *Sharma, C. S. and Purohil, K., Design of Machine Elements, Prentice Hall, New Delhi (2003).*

MACHINING SCIENCE

L	T	P	Cr
3	1	2	4.5

Course Objectives: To provide in-depth knowledge of conventional and advanced machining processes.

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 milling and grinding, grinding process and its specific features, mechanics of grinding operation.

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.

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); Abrasive flow machining process (AFM); 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; Abrasive Blaster setup.

Course Learning Outcomes (CLO):

The students will be able to:

1. understand the principles of machining using Merchant's circle theory as well as frictional and thermal aspects of machining.
2. design the conditions for the maximum tool life and factors influencing surface quality, dimensional accuracy and material removal rate in machining.
3. develop the models for determining the MRR, SR and tool design for different NTMM like EDM, ECM, USM, EBM, LBM, AJM, WJM etc.

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).*

OPERATIONS MANAGEMENT

L	T	P	Cr
3	1	0	3.5

Course Objectives: To understand the various broad functions under production and operations management. Develop an understanding about the various techniques of demand forecasting and their application in management and managerial decision making. Develop knowledge regarding use of various production planning tools like master production scheduling and materials requirements planning. Gain insight into the various inventory management and control tools.

General: Operations Management: meaning and scope; Significance of operations management in increasing productivity of firms; Types of production systems, scope; characteristic features, and applications.

Forecasting Analysis: Need and benefits; Internal and external factors affecting demand; Types of forecasting models based on time horizon; Types of forecasting based on techniques (causal, time series and judgemental methods); Error analysis.

Production Planning: Aggregate production planning; Function and scope; Pure and mixed aggregate planning strategies; Aggressive and reactive strategies.

Master production scheduling; Function and scope; Inputs for master production scheduling; Types of master production schedules.

Material requirements planning; Function and scope; Inputs for Materials requirement planning; MRP explosions; Manufacturing resource planning.

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

Course Learning Outcomes (CLO):
The students will be able to:

1. Understand the various broad functions under production and operations management.
2. Develop an understanding about the various techniques of demand forecasting and their application in management and managerial decision making.
3. Use of various production planning tools like master production scheduling and materials requirements planning for increasing effectiveness of shop floor functions.
4. Understand the reasons for keeping inventory and will gain insight into various inventory management and control tools.

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).*

METAL CASTING AND JOINING

L	T	P	Cr
3	0	2	4.0

Course Objectives: To inculcate the principle, thermal and metallurgical aspects during solidification of metal and alloys. To impart knowledge about principles/methods of casting with detail design of gating/riser system needed for casting, defects in cast objects and requirements for achieving sound casting. To impart knowledge about welding behavior of machine and process during welding, analysis of common and newer welding techniques and metallurgical and weldability aspects of different common engineering materials.

Casting Technology & problems, Survey and scope, Interfacial Heat Transfer, Thermodynamics & metallurgical aspects in solidification of pure metals and alloys, Solidification of actual castings, Homogeneous and heterogeneous nucleation, Codification for pure metals and alloys. Grain refinement techniques,

Moulds Design: Risering curves, NRL, Caine method, Feeding distance, Rising of complex castings, Gating systems and their characteristics. Type of gates and design consideration, Chills, pattern design consideration, Sand testing, Advanced metal casting processes, Casting defects, Their causes & redressal, Heat treatment of castings, Gases in metals.

Metal Joining: Classification – Welding power source, Arc and arc characteristics, Behavior of arc with variation in current and voltage, Welding electrodes, ISI specification of electrodes, Electrode selection, Newer welding process- such as plasma arc, Laser beam, Electron beam, Ultrasonic welding, Joining by braking, Soldering and adhesive bonding.

Welding Metallurgy: Heat flow is welding metallurgical transformation, Implication of cooling rate, HAZ, Weldability of plain carbon steels, SS, CI, Al and its alloys, Design of elements, Residual stresses and distorting, Welding defects, Testing-destructive and NDT.

Laboratory Work:
Joint preparation through various welding processes like Gas Metal Arc Welding, Gas Tungsten Arc Welding, Submerged Arc welding, Shielded Metal Arc Welding, Defect analysis through various non destructive testing, Resistance Spot Welding, Seam Welding, Green Sand Casting, Molasses Sand Casting, Core Making, Sand Casting Defects Analysis, High Pressure Cooled Chamber Die Casting.

Course Learning Outcomes (CLO):
The students will be able to :

1. Analyze the thermal, metallurgical aspects during solidification in casting and welding and their role on quality of cast or weld objects.
2. Design the gating and riser system needed for casting and requirements to achieve defect free casting.
3. Analyze the welding process behavior for common and newer welding techniques and requirements to achieve sound welded joint while welding different similar and dissimilar engineering materials.

Text Books:

1. *Ramana Rao, T. V., Metal Casting – Principles and Practice, New Age International Pvt. Ltd. (2003).*
2. *Rao, P. N., Manufacturing Technology, McGraw Hill (2008).*

Reference Books:

1. *Campbell, J., Castings, Butter Worth – Heinemann Publishers (2003).*
2. *Nadkari, S. V., Modern Arc Welding Technology, Oxford & India Book House Pvt. Ltd. (2005).*

INDUSTRIAL AUTOMATION

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce the need, evolution, and motivation for Industrial Automation. Familiarization with basic concepts and different automation strategies being used in practice worldwide.

Introduction to Factory Automation and Integration: Basic concepts and scope of industrial automation, socio-economic considerations, modern developments in automation in manufacturing and its effect on global competitiveness. Need and implications of automation in manufacturing. Different types of production systems and automation. Hard/fixed automation.

Introduction to Hydraulics/Pneumatics: Basic elements of hydraulics/pneumatics, electro-pneumatic controls and devices, electro-pneumatic systems, fluid power control elements and standard graphical symbols for them, construction and performance of fluid power generators, hydraulic and pneumatic actuators, their design and control devices. Sequence operation of hydraulic /pneumatic actuators. Applications in manufacturing. Hydraulic & pneumatic valves for pressure, flow & direction control, servo valves and simple servo systems with mechanical feedback, solenoid. Different sensors for hydraulic, pneumatic & electro-pneumatic systems.

Design of Pneumatic and Electro-pneumatic Logic Circuits: Logic circuits to be designedfor a given time displacement diagram or sequence of operation. Pneumatic safety and control circuits and their applications to clamping, traversing and releasing operations.

Programmable Logic Controllers (PLC): PLC for design demonstration, programming and interface the hardware with software for modern manufacturing applications.

Automatic Transfer Machines: Classifications, analysis of automated transfer lines, without and with buffer storage, group technology and flexible manufacturing system.

Assembly Automation: Types of assembly systems, assembly line balancing, performance and economics of assembly system.

Course Learning Outcomes (CLO):
The students will be able to:

1. measure the output of any physical system with the help of various sensors and transducers and able to evaluate the performance of any physical system.
2. understand the various components of Hydraulics/Pneumatics Electro-pneumatic systems and methods to design, construct and evaluate such systems.
3. study the design of pneumatic logic circuits for a given time displacement diagram for pneumatic safety and remote control circuits

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).

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).*

PRODUCT DESIGN AND DEVELOPMENT

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce the basis of product design along with the requirements of a good product design.

General: Product design objectives, concept, terminology, principles, requirements of a good product design, product types and design considerations for engineering, product life cycle, product specification and range, safety, liability and warranty aspects, patents and copyrights.

Product Development – Technical and Business Concerns: Technology forecasting and technology S-Curve (Technology Stage), mission statement and technical questioning, economic analysis of product, customer needs and satisfaction, customer population and market segmentation, customer needs-types and models, gathering customer needs information, analysis of gathered information.

Designing for Specific Requirements: Design features and requirements with regard to manufacturing and assembly, safety, ergonomics, energy conservation, storage, transportation and maintence, quality and reliability as a factor in product design, quality v/s cost, packaging design, role of national and international standards.

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

Product Detailing: Need and objectives, considerations affecting detailing decisions, illustration of detailing.

Product Development: Concepts and objectives, information sources, role of innovation in product development and competitiveness, part approval process, advanced product quality planning, design failure mode and effect analysis, use of computers in product design and development, introduction to reverse engineering and rapid prototype development, the CAD-CAM link.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the basic product design objectives and requirements.
2. understand the different design principles like designing for manufacturing and assembly, maintenance, storage, transportation etc.
3. understand the visual design with respect to form, function, material, process, colour etc.

Text Books:

1. *Neibel and Draper, Product Design and Process, McGraw Hill, New York (2004).*
2. *Mayal, Industrial Design, McGraw Hill, New York (1999).*
3. *Trott, Innovation Management and New Product Development, Pearson Education Asia, New Delhi (2007).*

Reference Books:

1. *Asimov, M., Fundamentals of Engineering Design, PHI, New Delhi (2000).*
2. *Chitale and Gupta, Product Design and Manufacturing, PHI, New Delhi (2007).*

PRODUCTION AND INVENTORY CONTROL

L	T	P	Cr
3	1	0	3.5

Course Objectives: To expose the students to the various broad functions under production planning and control. To study the role of process planning especially routing, scheduling functions etc. in effective operations management.

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.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the necessity and functions under production control.
2. understand the role of inventory management and control.

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).*

AUTOMOBILE ENGINEERING

L	T	P	Cr
3	0	2	4.0

Course Objectives: To deliver basic knowledge of different components of automobiles.

Introduction: Conventional motor vehicle, vehicle classification, frame and frameless construction, vehicle dimensions, power requirements, vehicle performance, gear ratio for maximum acceleration, stability of two wheel drive and four wheel drive vehicles.
Clutch and Transmission: Single-Plate clutch, multi-plate clutch, dry clutch, wet clutch, centrifugal, semi-centrifugal clutch, servo clutch mechanism,requirements for manual and automatic transmission, their type and constructional detail.
Steering and Suspension: Steering mechanisms and steering system including power steering, steering geometry, suspension principle, rigid axle suspension and independent suspension, suspension system elements, hydraulic suspension, pneumatic suspension, leaf spring, Mc-pherson strut.
Drive Line: Propeller shaft, universal joint, constant velocity joint, slip joint, differential, axle and hub.
Braking System: Introduction to braking system and their types, ABS, brake compensation.
Wheel and Tyres: Disc pressed wheels, alloy wheels, multi-piece wheels, tyre description, types and manufacturing, tubed and tubeless tyres, radial tyres , tyre specifications and coding, tread pattern, aqua-planing.
Emission control devices: Catalytic convertor and its types, EGR.
Vehicle Electronics: Electrical and electronic systems in automobiles, starting motor drives,
automotive accessories and safety features in automobile.
Trouble shooting in various components.
Trends in automobile sector: Hybrid, solar powered vehicles.

Laboratory Work:
Study of vehicle chassis and construction, 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, components of suspension system of automobile (2 wheel, 4 wheel), steering system of an automobile, electric system, starting system, braking system of an automobile, study of radiator, study of turbocharger and supercharger, study of differential, axles, study of propeller shaft, universal joints and slip joint, study of catalytic convertor; Visit to automobile service station for troubleshooting exercises; Group assignments on above topics.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the performance parameters and power requirements of a vehicle.
2. understand the concept of manual and automatic working of different components of automobiles.
3. understand the fundamental knowledge of mechanisms used to transfer energy from engine to the wheels.

Text Books:

1 *Hiller, V. A. W., Fundamentals of Motor Vehicle Technology, Nelson Thornes, UK (2012).*
2 *Giri, N. K., Automobile Mechanics, Khanna Publishers, New Delhi (2011).*

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 *Crouse, W. and Anglin, D., Automotive Mechanics, Tata McGraw Hill, New Delhi (2006).*
5 *Heinz, H, Engine and Vehicle Technology, Arnold Publishers, Butterworth-Heinemann, London (2002).*

COMPUTER AIDED MANUFACTURING

L	T	P	Cr
3	0	2	4.0

Course Objectives: To expose the students to the basics of NC, CNC, DNC machines. To make them understand the concept of writing the manual part program on CNC milling and lathe machines. To introduce the students to the different components of Computer Integrated Manufacturing systems.

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.

Computer Integrated Manufacturing Systems & Integrated CAD/CAM System: Components of CIMS, types of CIMS, CAD/CAM integration, FMS and CIMS, 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, grooving, central drilling and threading. Milling- Complete machining of a part with: Taper, concave and convex arc, pocketing and drilling, radius compensation. Robot programming: Programs for pick place, welding path, manufacturing, and assembly operations. Practical setup and programming exercise using CNC milling, CNC lathe and robotic arm. Practical on the machines to be conducted as per lab instructions and guidance of the teacher incharge of practical.

Course Learning Outcomes (CLO):
The students will be able to:

1. write a manual part program for a given component on CNC milling and lathe machine.
2. understand the basics of CNC machines and robotic arm.
3. understand the use of computers in group technology, process planning, manufacturing, inventory, shop floor control, quality control, material handling and storage system.

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 *Koren, Y. and Joseph, B. U., Numerical Control of Machine Tools, Khanna Publishers , New Delhi (1999).*

3 *Kundra, T. K., Rao, P. N. and Tewari, N. K., Numerical Control and Computer Aided Manufacture, Tata McGraw Hill, New Delhi (2003).*

JIGS AND FIXTURES

L	T	P	Cr
3	0	0	3

Course Objectives: To understand the principles, functions and design practices of Jigs and Fixtures. To understand the principles of jigs and fixtures design, locating principles, locating elements and clamping devices. To gain proficiency in the development of jigs and fixtures required for different metal cutting and metal joining processes.

Introduction: Definition of jigs and fixtures, Difference between jigs and fixtures, Function and advantages, Materials used for jigs and fixtures, Steps for design.

Locating and Clamping Devices: Principle of Location, Degree of freedom, 3-2-1 principles, Choice of location, Redundant location, Diamond pin calculation, Locating methods and chip control, Locating devices, Surface location, Rest blocks, pins, V-blocks, Equalizers, Profile locators.
Clamping: Basic principles, Cutting forces for different metal cutting forces, Rigid clamping, wedge clamping, Cam clamping, quick action clamps, Toggle clamps, Simultaneously acting clamps, Mechanical, pneumatic and hydraulic actuation for clamping.

Design and Development of Jigs and Fixtures: Types of Jigs, Post, Turnover, Channel, Latch, Plate, Box, Pot, Angular post jigs, Indexing jigs, Typical design of drill jig, Drilling and reaming jigs, Jig bushes, Standards, Setting gauges, Automatic drill jigs: rack and pinion operated, air operated jigs components.
General principles of turning, milling, grinding, boring, broaching fixtures, Universal jigs and fixtures, Welding fixtures, Assembly fixtures, Concepts of Modular fixturing systems and quick change fixtures.

Course Learning Outcomes (CLO):
The students will be able to:

1. design and use different types of locating and clamping devices for different manufacturing processes,
2. design or select suitable jigs for different kinds of machining, joining and assembly purposes,
3. propose different types of fixtures for different manufacturing processes under different requirements,
4. decide and plan for the best suited jigs or fixtures for productivity, cost or time for different production or assembly operations.

Text Books:

1. *Joshi, P.H., Jigs and Fixtures, Second Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi (2004).*
2. *Grant, H.E., Jigs and Fixture, Tata McGraw Hill Publishing Co. Ltd., New Delhi(2003)*

Reference Books:

1. *Hoffman, Jigs and Fixture Design, Thomson Delmar Learning, Singapore(2004).*
2. *Venkataraman, K., Design of Jigs Fixtures & Press Tools, Tata McGraw Hill Publishing Co. Ltd., New Delhi (2005).*

METAL FORMING

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce the material behavior and deformation criteria as happens in all metal forming processes, elementary theory of plasticity. To analyze different metal forming processes such as rolling, wire and strip drawing, extrusion, forging, and High Energy Rate Forming process. To apply mathematical concepts to solve problems related to an industrial/technical environment. To determine the forces ivolved in different metal forming operations.

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).

Course Learning Outcomes (CLO):
The students will be able to :

1. Understand the basics of various metal forming processes and elementary theory of plasticity.
2. Understand the justification of need of various metal forming processes and their comparison to other manufacturing processes.
3. Analyze the mechanics of various metal forming processes including the forces and pressure involved in the processes.
4. Gain the basic knowledge on principle, Process parameters, Equipment, Mechanics and applications of HERF methods.

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).*

MODERN MANUFACTURING PROCESSES

L	T	P	Cr
3	1	2	4.5

Course Objectives: To inculcate specialized knowledge and skill in modern manufacturing processes using the principles and methods of engineering analysis and design. To cultivate the ability to develop and implement new improved manufacturing processes resulting in creation and distribution of value in engineering applications. To impart knowledge about the significance of controlling process parameters for the optimal performance for newly developed engineering materials used in industries and research organizations.

Non Traditional Manufacturing Processes: A comparative study of various Non-traditional machining processes, Development and classification, Considerations in processes selection, Mechanics of material removal, Tool design, Effect of process parameters on MRR, Accuracy, Surface finish and applications of the various non-conventional machining processes like, Ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive flow machining (AFM),Electro chemical machining (ECM), Electro chemical grinding (ECG), Chemical machining (CHM), Electric discharge machining (EDM), Electron beam machining (EBM), Plasma arc machining (PAM), Laser beam machining (LBM) and Ion beam machining (IBM) processes. Micro and Nano fabrication, Microwave processing,

Term project to be assigned as per the above topics.

Laboratory Work:

Determination of MRR, TWR of the machined surface for USM, EDM, LBM, Processes, Use of dynamometer, Surface finish measurement tests, Industry visits.

Course Learning Outcomes (CLO):

The students will be able to:

1. Understand the mechanism of material removal in various modern manufacturing processes
2. Analyze the processes and evaluate the role of each process parameter during machining of various advanced materials.
3. Design of tools for the given profiles to be imparted on the work specimens.
4. Optimize the process parameters involved based on the requirements.

Text Books:

1. *Ghosh, A. and Mullick, S., Manufacturing Science, New Age International (2001).*
2. *Pandey, P.C. and Shan H.S., Modern Machining Processes, McGraw Hill (2004).*

Reference Books:

1. *Mishra, P.K., Non Conventional Machining, Narosa (2006).*
2. *Hofy, H.E., Advanced Manufacturing Process, B and H Publication (1998).*
3. *Bhattacharya, A., New Technology, Institution of Engineers (I) (1995).*
4. *Jain, S.K. andSchmid, S.R., Manufacturing Engg. & Technology, Addison Wesley(2000).*

UHU-081: ENGINEERING ECONOMICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: The objective of the course is to help students to understand the concepts of Economics, get awareness about the economic environment and possess an understanding of market competition and their pricing strategies. The course will enable them to know about Financial Markets, PNational Income Accounting, Inflation and Deflation. It will prepare Engineering students to analyze Cost/Revenue data and carry out economic analyses for decision making.

Engineering Economics: Definitions**,** Scope and Significance
Demand and Supply: Meaning of Demand and supply, Determinants of demand and Supply
Demand Forecasting: Purpose of Forecasting Demand, Determinants of demand forecasting, Methods of Demand Forecasting, Criteria for the good forecasting method.
Cost of Production: Explicit and Implicit costs, Marginal, Incremental and Sunk costs, Opportunity cost, Short-run cost function, Total Average and Marginal costs, Long-run costs, Break-even analysis.
Theory of Production: Law of Variable Proportions and Laws of returns to scale.
Markets Structures and Pricing Theory: Pricing in Different Markets: Perfect competition, Monopoly, Monopolistic competition and Oligopoly.
Investment Decision: Capital Budgeting, Methods of Project Appraisal (Payback Period, IRR, NPV, BCR).

National Accounting: Meaning, Methods and Current Trends.

Inflation &Deflation: Meaning, Measures and Impact on Indian economy.

Globalization and Foreign Direct Investment :Meaning, Recent Indian Policy Towards FDI and Globalization, Impact of FDI & Globalization on Indian Economy.

Exchange Rate: Meaning, Determinants of exchange rate, Measurement of Exchange Rate.

Overview of Financial Markets: Capital Market & Money Market.

Course Learning Outcomes (CLO):
The students after studying this course will:
1. Possess a deep understanding of the concepts and principles of Economics.
2. Be able to develop analytical skills essential for engineers to help to take decisions.
3. Better understand the markets and their pricing strategies
4. Possess an understanding of the pre-requisites of investing and will be able to carry out and evaluate benefit/cost, breakeven analyses on one or more economic alternatives.
5. Acquire an in-depth knowledge about Financial markets, Foreign Exchange Market, National Income Accounting, Inflation and Deflation.

Text Books:

1. *Salvatore, D. and Srivastav, R., Managerial Economics: Principles and Worldwide Applications,Oxford University Press, Sixth Edition (2008).*
2. *Peterson, H. Craig, Lewis, W. Chis. and Jain, Sudhir K. Managerial Economics, Prentice Hall of India (2006).*
3. *Robert Pindyck and Daniel Rubinfeld Microeconomics, Prentice Hall (2009).*

Reference Books:

1. *Pandey, I.M. Financial Management, Vikas Publication (2010).*
2. *Kishore, Ravi, M. Financial Management, Taxmann Publication (2009).*
3. *Dutt, R. and Sundaram, K.P.M., Indian Economy, S. Chand & Company Ltd. (2012).*

RAPID PROTOTYPING

L	T	P	Cr
3	1	0	3.5

Course Objectives: The objective of this course is to provide the students with an understanding of the basic fundamentals of rapid prototyping followed by study of various rapid prototyping, rapid tooling, and reverse engineering technologies. The understanding and knowledge will be used to select appropriate technologies for product development purposes.

1. **Introduction**: Introduction to rapid prototyping (RP), Need of RP in context of modern production methods.
2. **Review of solid modelling techniques**: product design by curves, surfaces and solids.
3. **Basic Principles**: Basic Principles of RP, Steps in RP, Process chain in RP, RP integrated CAD-CAM environment, Advantages of RP.
4. **Classification of RP processes**:Based on raw material, Based on energy sources
5. **Rapid Prototyping Systems**: Sterolithography, Solid Ground Curing, Ballistic particle manufacture, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, 3D Printing, Laser Engineered Net Shaping etc.,
6. **Process planning for rapid prototyping**: STL file generation, Defects in STL files and repairing algorithms, Slicing and various slicing procedures.
7. **Problem areas of Rapid Prototyping**: Accuracy issues in RP, Strength issues of RP Parts, Surface roughness problem in RP, Part deposition orientation issues of RP Parts and other issues like build time, support structure, cost etc.,
8. **Rapid tooling techniques**: RTV Silicone Rubber Mold, Spray Metal Tooling, Vacuum Casting, Cast Resin Tooling, Electroforming, Direct AIM Tooling, Direct Metal Laser Sintering, Laminated Tooling,Laser Engineered Net Shaping.
9. **Reverse Engineering**: Introduction to reverse engineering and its integration with rapid prototyping.

Course Learning Outcomes (CLO):

The students will be able to:

1. understand the principle and philosophy of rapid prototyping.
2. understand the modern rapid prototyping techniques, how the different processes work and strengths as well as weaknesses of each technology.
3. understand the importance of Rapid Prototyping Technology over the existing traditional methods in present competitive scenario in terms of product development cycle and cost.
4. understand how the different rapid tooling processes work
5. understand the concept of reverse engineering and its integration with rapid prototyping.

Text Books:

1. *Chua, C.K., Leong, K.F., Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley and Sons Inc., (2000).*
2. *Pham, D.T., Demov, S.S., Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer-Verlag London Limited, (2001).*
3. *Noorani, R., Rapid Prototyping: Principles and Applications, John Wiley & Sons, Inc., New Jersey, (2006).*
4. *Zeid, I., Mastering CAD/CAM, Tata McCraw Hill, (2006).*

Reference Books:

1. *Patri, K. V., Weiyin, Ma, Rapid Prototyping - Laser-based and Other Technologies, Kluwer Academic Publishers, U.S.A., (2003).*
2. *Hague, R.J.M., Reeves, P.E.,Rapid Prototyping, Tooling and Manufacturing, iSmithers Rapra Publishing, (2000).*
3. *Saxena, A., Sahay, B., Computer Aided Engineering Design, Anamaya Publishers, New Dehi, (2005).*
4. *Hopkinson, N., Hague, R.J.M., Dickens, P.M., Rapid Manufacturing- An Industrial Revolution for the Digital Age, John Wiley & Sons Ltd., U.K., (2006).*

MACHINE TOOL DESIGN

L	T	P	Cr
3	1	0	3.5

Course Objectives: To explore various design aspects of machine tools elements like transmissions, structures, materials, kinematics, dynamics and construction of machine tools, etc. To understand concepts related to design of Die and Punch.

Introduction: General requirement of machine tool design, techno-economic pre-requisites.

Machine Tools: Kinematics structure & mechanical, hydraulic and electrical drives, design of hydrostatic, hydrodynamic and antifriction guideways, design of spindles, design of speed box and feed box, stepped and step less regulations of speed and feed diagram, ray diagram, layout of spindles drive and feed drive in machine tools, machine tool structures, design of bed, heard stock, spindle supports and power screws, machine tool dynamics.

Jigs and Fixtures Design: Applications in manufacturing, principle of location & clamping, types of locators and clamps, design of jigs and fixtures, selection of materials.

Die and Punch Design: Applications in manufacturing, design of various type of dies, selection of materials for casting and forging dies.

Course Learning Outcomes (CLO):
The students will be able to:

1. develop the conceptual design, manufacturing framework and systematic analysis of design problems on the machine tools.
2. apply the design procedures for different types of design problems such as gear box design, guide way design, shaft loading and its associated parts, rolling bearings, die design and jigs and fixtures and so on.
3. design, develop, and evaluate cutting tools and work holders for a manufactured product.

Text Books:

1 Mehta, N. K., Machine Tool Design & Numerical Control, McGraw Hill, New Delhi (2004).
2 Sen, G.C. and Bhattacharya, A., Machine Tools, Central Book Agency, New Delhi (1989).

Reference Books:

1 Pandey, P.C. and Singh, C.K., Production Engineering Sciences, Standard Publishers, New Delhi (2003).
2 Basu, S. K. and Palo, D.K., Design of Machine Tools, Allied Publishers, New Delhi (2008).
3 Acherkhan, N.S., Machine Tool Design, Mir Publishers, New Delhi (1983).

UME ROBOTICS ENGINEERING

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce the students to the basic terminologies, applications, design specifications, and mechanical design aspects both kinematics and dynamics of industrial robotics/ manipulators, sensors, actuators and image processing for robotic work cell control.

Introduction: Definition of a robot, types of robotic joints and motions, classifications of robot based on: Physical configurations, actuators and motion control; Terminologies used for robotics specification and selection for industrial applications; Types of end effectors; Applications of robotics.

Robot Kinematics: Homogeneous co-ordinates and co-ordinate transformations, kinematic parameters, use of Denavit-Hartenberg representation for finding arm equation of robotic arms, forward and inverse kinematics for basic industrial robotic configurations viz. Cartesian coordinate robot, SCARA configurations, and 5-axis and 6-axis articulated industrial robotic configurations.

Robot Dynamics: Introduction to Robot Dynamics.

Robot in Work Place: Work cell organization in robotics environment, function of work cell controller, robotic work cell design and control, introduction to robot trajectory planning.

Introduction to Robot Vision: Sensing and digitization of vision data, image processing: image data reduction, segmentation, feature extraction, object recognition, and training of vision system.

Methods of Robot Programming: Robot programing methods, introduction to basic robot programming languages, and various on-line and off-line robot programming methods.

Course Learning Outcomes (CLO):

The students will be able to:

1. understand the robot kinematics and trajectory planning.
2. work individually and/or with an interdisciplinary team for the purpose of manipulator design for a specific need using mechanical kinematic structure along with the understanding of requirements from robotic work cell controller and its programming, for enabling robotic manipulator to work in an integrated automated industrial environment.

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 and Gonzalez, Robotics: Control, Sensing, Vision, and Intelligence, McGraw Hill, New York (1990).*

Reference Books:

1 *Asada, H. and 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).*

MECHATRONICS

L	T	P	Cr
3	0	2	4.0

Course Objectives: To impart interdisciplinary knowledge to study modern products like household appliances, digital cameras, mobiles etc., which falls under the mechatronics domain. the aim of this course to make a bridge between mechanical, electronics, instrumentation, computer and controls field.

Introduction: Evolution of mechatronics, integrated mixed systems. integration of mechanical engineering, electronics & control engineering and computer science, design process, measurement system, control system, basic elements of open loop and closed loop control system, block diagram representation of mechatronics system, programmable logic controllers, analogue and digital control system, sequential controllers, examples of various mechatronics systems.

Sensors and Transducers: Performance terminology, static and dynamic characteristics, displacement, position and proximity sensors, velocity and motion sensors, stress, strain and force measurements using strain gauges, force, fluid pressure, liquid flow and liquid level sensors, light sensors, temperature sensors.

Signal Conditioning and Digital Signals: Basic conditioning process, operational amplifiers, filtering, pulse modulation, digital signal, AD and DA conversion, Shannon's sampling theorem, Nyquist criterion, review of logic circuits.

Electrical Actuators: Relay, direct current motors, stepper motors, piezoelectric actuators.

Control Systems: Performance specifications, transfer functions, block diagram reduction techniques, signal flow graphs, sensitivity analysis, frequency response. stability, controller types and their design using frequency domain and Laplace domain method, PID control.

Dynamic Systems Modeling: Equations of motion of mechanical, hydraulic, thermal, electric and pneumatic systems, transforming physical model to mathematical model, linearization of the dynamic model.

Data Processing and Control: Introduction to microprocessors, microcontrollers, PLC and their processing.

Laboratory Work:

Demonstration of Lego kits, Tetrix kits, microcontroller kit, PLC trainer and different sensors, Projects on all the mentioned kits.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the basic elements of any Mechatronic device.
2. develop the mathematical model of any physical model from any engineering domain.
3. understand the key inputs and outputs of any physical device, different sensors and transducers to measure the outputs, interfacing of the sensors and actuators to the computers.
4. study and design different controllers to obtain the desired performance from the system.

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).*

WORK STUDY AND METHOD ENGINEERING

L	T	P	Cr
3	0	0	3.0

Course Objectives: To impart knowledge about the concept of productivity, basic work content, excess work content and total work content. To inculcate knowledge about method study, tools used for recording processes, path of movement and work place, procedure for critical examination of operations with the objective of developing a new method. To impart knowledge about work measurement techniques, equipment and its application in shop floor operations for productivity improvement. To educate the use of pre-determined motion time systems and standard data for pro-actively determining time standard of operations

Introduction: Definition, Scope, Historical review and areas of application of work study in industries, Inter-relation between method study and work measurement, Human aspects, Reaction of management and labor, Role in improving plant productivity and safety.

Method Study: Objectives and step-wise procedure for method analysis, Recording & evaluation techniques, Micro-motion and macro motion study, Therbligs and simo-charts, Principle of motion economy, Normal work areas and design of work places, Principles of work design, Multiple activity chart, Flow process chart, String diagram, Travel charts, Layout Design.

Work Measurement: Work measurement objectives, Techniques & criteria for selection of technique, Stop watch time study, Systems of performance ratings, Calculation of standard time, Introduction to allowances, Production study, Work sampling, MTM& work factor system, Standard data usage, Engineered time standard, Computers in work study, Predetermined motion time system (PMTS). Job evaluation & merit rating Wage payment plans, Incentive schemes.

Course Learning Outcomes (CLO):

The student will be able to:

1. Develop a case for productivity improvement in any manufacturing or service industry scenario
2. Independently conduct a method study in any organization with the objective of improving a process, material movement system or design of a work place
3. Develop time standards for operations, identify production bottlenecks and improvise operations
4. Develop methods of working and corresponding time standards for new operations.

Text Books:

1. *Niebel, B.W., Motion & Time Study, McGraw Hill Higher education (1992).*
2. *Kanawaty, G., Work Study, ILO, Geneva, (1992).*

Reference Books:

1. *Mundel, M., and Danner, D. L., Motion & Time Study, Englewood Cliffs, NJ, Prentice Hall, (1994).*
2. *Curie, R., Introduction to Work Study, McGraw Hill (1992).*
3. *Barnes, R. M., Motion & Time Study, John Wiley & Sons (1980).*

LEAN MANUFACTURING

L	T	P	Cr
3	0	0	3.0

Course Objectives: To introduce the philosophy behind 'Lean Manufacturing' by giving a background of the Toyota Production System. Discussion of different 'lean' tools and their significance in improving the workplace. Highlighting the importance of employee involvement, training and culture.

Lean Production: Introduction, background, and lean thinking, importance of philosophy, strategy, culture, alignment, focus and systems view. Discussion of Toyota Production System.

Lean Production Preparation: System assessment, process and Value-stream mapping, sources of waste.

Lean Production Processes, Approaches and Techniques: importance of focusing upon flow. Tools include: Workplace organization – 5S, Stability, Just-In-Time – One piece flow – Pull, Cellular systems, Quick change and set-up reduction methods, Total productive maintenance, Poka-Yoke– mistake proofing, quality improvement, Standards, Leveling and Visual management, Six Sigma.

SMED:Single minute exchange of dies – theory and practice of the SMED system, the structure of production, Set-up operations, Fundamentals of SMED, Techniques for applying SMED, Basic examples of SMED.

Employee Involvement: Teams, Training, Supporting and encouraging involvement – Involving people in the change process; communication; importance of culture.

Concurrent Engineering: Obeya in Toyota's new product development process, cross-functional teams, use of computer technology, information management for simultaneous engineering.

Course Learning Outcomes (CLO):
The students will be able to

1. Identify and understand the key requirements and concepts in lean manufacturing to initiate a continuous improvement change program in a manufacturing organisation.
2. Apply the tools in lean manufacturing to analyse a manufacturing system and plan for its improvements.

Text Books:

1. *Liker, J, The Toyota Way, McGraw-Hill (2004).*
2. *Liker, J and Meier, D., The Toyota Way Fieldbook, McGraw-Hill (2006).*

Reference Books:

1. *Womack, J and Jones, D, Lean Thinking, Free Press (2003).*
2. *Womack, J and Jones, D and Roos, D., The Machine that Changed the World, Rawson Associates (1990).*
3. *Dennis, P., Lean Production Simplified, Productivity Press (2007).*
4. *Shingo, S., A Revolution in Manufacturing: The SMED System, Productivity Press (1985).*

FACILITIES PLANNING

L	T	P	Cr
3	0	0	3.0

Course objectives: Provide students with the ability to apply plant layout design procedure to design a new facility and ability to select a suitable location for new facility with the use of different techniques.

Facilities Planning: Need for facilities planning, Importance of plant layout in plant design, Classifications of production process structures, 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, Characteristic features suitability and applications of different types of layout 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, different forms and sizes of materials, Characteristic features of key material handling equipment, Concept of unit load, safety aspects in material handling system.

Course Learning Outcomes (CLO):
The student will be able to:

1. To select a suitable location amongst the available locations for setting up a new facility
2. To decide about the particular production process flow strategy
3. To design a layout for the new facility to suit the company's production process structure
4. To select proper type of equipment for storage and movement of material

Text Books:

1. *Tompkins, J. A., White, J. A., Bozer, Y.A. and Tanchoco, J.M.A., Facilities Planning, John Wiley (2003).*
2. *Muther, R., Practical Plant Layout, McGraw Hill Book Company (1995).*

Reference Books:

1. *Sheth, V., Facilities Planning and Materials Handling, Marcel Decker (1995).*
2. *Agarwal, G.K., Plant Layout and Material Handling, Jain Publishers (1997).*

ERGONOMICS ENGINEERING

L	T	P	Cr
3	0	0	3.0

Course Objectives: Thiscourse is dedicated to making the students understand theergonomic principles in workplace design and work organisation. It is aimed at enabling the students to identify and evaluate the impact of various human factors to design of safe workplace environment.

General: Man in industrial work environments, Ergonomics as multidisciplinary fields, Importance and justification and ergonomics problems, Man-machine-environment system.

Anthropometry: Significance of human body measurement in design of equipment, Facilities, Work place and operation, Static and dynamic anthropometry, Anthropometric data.

Task Analysis: Task description, Posture measurement, RULA & REBA analysis and evaluation, Lifting & lowering tasks, Lifting index, Lifting & carrying tasks, NIOSH lifting equation.

Biomechanics: Introduction to levers of Human Body, Ligaments & Tendons, Joints. Kinetics to include forces producing motion.

Man-Environment Interface: Environmental factors of temperature, Humidity, Lighting and noise in industry, Effect of environmental factors on human performance, Measurement and mitigation of physical and mental fatigue, Basics of environment design for improved efficiency.

Design of Display and Control: Need for information display, Elements of information theory, Reaction time, Methods and types of displays, Design of audio and visual displays, Design of hand and foot operated control device, Design of human-computer interface.

Course Learning Outcomes (CLO):

The students will be able to:

1. identify, explain and evaluate the impact of various personal attributes (anatomical, physiological and anthropometric) on proper, safe working practice.
2. assess the effect of physical environment factors on comfort and performance.
3. apply principles of good ergonomic design to work areas and equipment.
4. apply various task analysis tools to posture measurement, lifting, lowering and carrying tasks.
5. comprehend the need for information display and the ergonomic design of different display and control devices.

Text Books:

1. *Bridger, R.S., Introduction to Ergonomics, McGraw Hill (2008).*
2. *Sanders, M. and McCormick E., Human Factors in Engineering & Design, McGraw Hill (1993).*

Reference Books:

1. *Maynard, H. B., Industrial Engineering Hand Book, McGraw Hill (1992).*
2. *David, A., Practice & Management of Industrial Ergonomics, Prentice Hall (1986).*
3. *Singleton, W. T., Introduction to Ergonomics, WHO, Geneva (1972).*

SUPPLY CHAIN MANAGEMENT

L	T	P
3	1	0

Course Objective: To educates students about the concepts of and the role supply chain management. To stimulate critical thinking on the topics of competitive performance, network design, planning for inventories in supply chain and opportunities for growth. To evaluate current trends, growth opportunities and niche markets, within the area of Logistics.

Understanding the Supply Chain, Process view, Decision phases and importance of supply chain, Supply chain management and logistics, supply chain and the value chain, Competitive advantage, supply chain and competitive performance, changing competitive environment, Supply Chain drivers and obstacle:

Matching supply and demand The lead-time gap, Improving the visibility of demand, supply chain fulcrum, Forecast for capacity, execute against demand, Demand management and aggregate planning, Collaborative planning, forecasting and replenishment.

Creating the responsive supply chain Product 'push' versus demand 'pull' The Japanese philosophy, Foundations of agility, Route map to responsiveness.

Strategic lead-time management: Time-based competition, Lead-time concepts, Logistics pipeline management.

Planning and managing inventories in a supply chain: managing economies of scale in supply chain cycle inventory, managing uncertainty in supply chain, determining optimal level of product availability.

Transportation, Network Design and Information Technology in a supply chain: transportation, facility design network design in a supply chain, extended enterprise and the virtual supply chain, role of information and information technology in the supply chain, Laying the foundations for synchronization, 'Quick response' logistics, Production strategies for quick response, Logistics systems dynamics.

Managing risk in the supply chain: Vulnerability in supply chains, Understanding the supply chain risk profile, Managing supply chain risk, Achieving supply chain resilience.

Overcoming the barriers to supply chain integration: Creating the logistics vision, Problems with conventional organizations, Developing the logistics organization, Logistics as the vehicle for change, Benchmarking.

Case Studies

Course Learning Outcomes (CLO):
The students will be able to:

1. Explore opportunities for cost reduction through Supply Chain efficiency,
2. Understand how optimization can improve revenue streams.

Text Books:

1. *Chopra, S. and Meindl, P. Supply Chain Management,Prentice Hall, (2010).*
2. *Christopher, M. Logistics & Supply Chain Management, FT Prentice Hall, (2011).*

Reference Books:

1. *John T. Mentzer, J. T. Supply Chain Management, illustrated edition, SAGE Publications(2001).*
2. *Michael H. Hugos, M. H. Essentials of Supply Chain Management, John Wiley, (2011).*
3. *Simchi-Levi, D.,Kaminsky, P., Simchi-Levi, E. Designing and Managing the Supply Chain, McGraw Hill Higher Education. (2011).*

MANAGEMENT INFORMATION SYSTEMS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To introduce basic concepts of information systems used in industry and in service sector. To identify inadequacies in the work systems, analyze problems, and design information systems related to business processes both in the manufacturing and service industry. To acquire basic operational skills in analysis and design of information systems. To identify issues related to implementation and choosing the strategies of smooth implementation of new information systems

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, process of Information System Planning, Strategic Alignment of Business and IT, Information System Architecture

System Analysis &Design: Principle-based Systems Analysis Method, Measuring Work System Performance, Process Modelling, tools for process modelling Process Characteristics, Evaluating Business Process Performance, Communication and Decision-Making Concepts, Data Modelling and database management**,** Phases of an Information System, Alternative Approaches for Building Information Systems

Information Systems Security and Control: Threat of Accidents and Malfunctions, Methods for Minimizing Risks

Strategic CBIS: Business information systems, ERP.

Course Learning Outcomes (CLO):
The students will be able to:

1. Explore opportunities analysing and designing secure information systems to improve business process effectiveness and efficiency.
2. Understanding how to integrate business processes through the use of information systems and improve revenue stream.

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 (2013).*

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).*

PROJECT MANAGEMENT

L	T	P	Cr
3	1	0	3.5

Course Objectives: To develop an understanding of the need, concept, objectives and characteristics of project management approach in the industrial context. To develop working knowledge of the technical and financial aspects of project management decisions. To explore the basic concepts in appraisal criteria and learn to handle the problems in appraisal risk analysis. To acquire working knowledge of the tools and techniques for project planning and control.

Introduction Concept and objectives of projects, Techno-managerial characteristics of project, Project life cycle, Identification of investment opportunities, Industrial policy, Scouting for project ideas and preliminary screening, Selection of project, Incentive schemes, and Project preparation.

Technical Analysis of Projects Product mix decisions, Choice of technology, Plant capacity, Site location, Selecting machinery and equipment, Structure and civil works, Materials and other inputs, Project charts and layouts, Work schedule.

Financial Aspects Planning the capital structure of a new company, Difficulties in raising finances, Cost of different sources of finance, Cost of production, Methods of testing and variance analysis, Profitability, Tax planning, Financial projections, Social Cost –Benefit Analysis (SBAC)

Appraisal Criteria Need, objectives and criteria of appraisal, Payback period, Methods of appraisal, Practical problems in appraisal risk analysis, Concept and measures of risk.

Project Planning Objectives and functions, Work breakdown structure, Project planning tool logistic & safety considerations, Computer aided process planning

Project Control Project control, Performance analysis, Network techniques for project management, Variability of project duration and probability of completion at a specified time, Management reporting and information systems, and Project implementation.

Course Learning Outcomes (CLO):
The students will be able to:

1. Develop an understanding of the importance and main features of project management approach in the industry context.
2. Obtain knowledge about the technical and financial aspects of project management decisions.
3. Explore the basic concepts in appraisal criteria and shall learn to handle the problems in appraisal risk analysis.
4. Use the tools and techniques for project planning and control.

Text Books:

1. *Prasanna, C; Projects: Preparation, Appraisal, Budgeting & Implementation, Tata Mc-Graw Hill, New Delhi, (1987).*
2. *Maylor, H; Project Management, Pearson Education Asia, New Delhi, (2009).*

Reference Books:

1. *Cleland, D;Project Management, Tata Mc-GrawHill, New Delhi, (2007).*
2. *Chase, R.B., Aqulino, N.J. and Jacob, F.R., Production and Operations Management:manufacturing and services, Tata McGraw Hill, New Delhi (1999).*

DESIGN OF EXPERIMENTS AND ANALYSIS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain objective conclusions. To learn both design and statistical analysis issues related to all phases of industrial processes including new product design and development, process development, and manufacturing process improvement.

Design of Experiments: Overview and basic concepts of Design of Experiments, blocking, randomization, replication, and interaction; Full factorial design, 2-level full and fractional factorial design, 3-level fractional factorial design, mixed level designs, central composite method, Box-Behnken and other design, complete and incomplete block designs; Special designs: dummy treatment, nested designs, repeated measures. Some practical aspects of planning experiments

Statistical Analysis: Introduction to statistics, sampling distributions, Hypothesis testing, t-test and confidence intervals, introduction to the analysis of variance (ANOVA) for individual factor, study of interaction effect, one way, two way, three way and multiple ANOVA, multiple comparisons, residuals and model adequacy checking, ANOVA for data obtained from special design, ANOVA of attribute data, random factors in experiments, Signal-to-Noise ratio analysis, Optimal design. Simple linear regression, non-linear regression analysis, response surface methodology of analysis.

Course Learning Outcomes (CLO):
The students will be able to :

1. plan well-designed experiment leading to reduced development lead time for new processes and products, improved manufacturing process performance, and products that have superior function and reliability,
2. design special experimental design based on suitability and need,
3. analyze the experimental data to obtain the influence of factors and their interaction,
4. decide the parametric combinations that leads to optimized solution for better process control.

Text Books:

1 *Montgomery, D. C., Design and Analysis of Experiments, Wiley, NY (2012).*
2 *Ross, P. J., Taguchi Techniques for Quality Engineering, Tata McGraw Hill, New Delhi (1995).*

Reference Books:

1 *Antony,J., Design of Experiments for Engineers and Scientists, Butterworth-Heinemann, UK (2003).*
2 *Panneerselvam, R. , Design and Analysis of Experiments, PHI, New Delhi (2010).*

PROCESSING OF POLYMERS AND COMPOSITES

L	T	P	Cr
3	1	0	3.5

Course Objectives: To impart overview of the basic nature of different polymers, ceramics and manufacturing processes associated thereof. To decide and select use of polymers and composites for different engineering applications.

Properties and Processing of Polymers: Structure and mechanical properties of plastics, thermoplastics and thermosets, common thermoplastics and thermosets for engineering application and their properties, additives in polymers: dispersion aids, UV stabilizers, antioxidants and antiozonents, processing/flow modifiers, different fillers.
Extrusion using single and twin screw extruders, injection moulding, thermoforming, compression moulding, transfer moulding, general behavior of polymer melts, machining of polymers, processing of rubbers, testing of polymers, applications of polymer composites in automotive, marine and aerospace; Recycling of plastics.

Properties and Processing of Composites: Classification of composite materials, properties of composites, processing methods of polymeric matrix composites: Hand lay-up, autoclaving, filament winding, pultrusion, compression molding, pre-pegging, sheet molding compounds etc.,
ceramic matrix composites, mechanical properties of ceramic matrix composites, different processing techniques for ceramic matrix composites, process capability and applications of various techniques.
Secondary processing of composite materials, need of secondary operations, different type of secondary operations, machining, drilling, joining of composites.

Course Learning Outcomes (CLO):
The students will be able to:

1. analyze the behavior of polymers, their properties to select suitability for engineering applications
2. understand the behavior during processing of polymers
3. analyze the behavior and properties of ceramics, and their applications
4. know different processing techniques of ceramics.

Text Books:

1 Strong, A.B., Plastic Materials and Processing, Prentice Hall, New Delhi (1999).
2 Middleman, S., Fundamentals of Polymer Processing, Houghton Mifflin Company, UK(1997).

Reference Books:

1 Chawala, K.K., Composite materials, Springer-Verlag, New York (1987).
2 Tadmor, Z. and Gogos, C.G., Principles of Polymer Processing, John Wiley, US (2006).

MODERN AUTOMOBILE ENGINEERING

L	T	P	Cr
3	1	0	3.5

Course Objectives: To prepare the students to critically evaluate the challenges and identify the role of electronics and software systems in a modern automobile. Students are taught basic automotive systems, underlying principles of construction and working, limitations of the conventional systems, the needs for electronic controls to improve the performance, safety and meet regulatory requirements. Also, they are motivated to explore potential new functions and applications by studying the physical systems, interacting with experts and users.

Body Aerodynamics and Modern Chassis: Uni-body construction, carbon fiber construction, monocoque construction, viscous air flow fundamentals, aerodynamics drag, after flow wake, aerodynamic lift, car body drag reduction, body panel shapes and taper, aerodynamic lift control, underbody air dams, rear end spoiler.

Automotive Electronics: Introduction to body computers, body computer module, electronic control units, microprocessors, high-side drivers, low-side drivers.

Advanced Automotive Lighting: Computer controlled headlight systems, automatic on/off with time delay, automatic headlight dimming, headlight leveling, adaptive headlights, daytime running lamps, adaptive Brake Lights, instrument panel dimming, fiber optics, lamp outage indicators, high intensity discharge headlamps, projector headlamps, LED lamps, cornering lights.

Driver Assistance System: Digital instrument cluster, travel information system, head-up display, night vision system, global positioning navigation system, lane change warning system, warning programs, traffic management system, hand's free communication and operation.

Automatic Transmission and Driveline: Drive by wire system, electronic shift transmission, direct shift gearbox, S-Tronic gearbox, paddle shift control, constantly variable transmission, cruise control, limited slip differential, differential lock, hill ascent function.

Modern Suspension and Steering: Active suspension system, magnetic fluid suspension, height adjustable suspension system, load sensing suspension, hydrogen suspension, variable gear ratio steering, speed sensitive steering, collapsible steering column.

Advance Safety and Passive Restraint System: Introduction, primary restraint system, secondary restraint system, passive seat belt systems, air bag systems, air bag deployment, passenger-side air bags, hybrid air bag, multistage air bag deployment, side-impact air bags, seat belt pre-tensioners, inflatable knee blockers, occupant classification systems, anti-whiplash headrest restraint system, NCAP crash test ratings.

New Generation Accessories: Climate control air conditioning, dual zone climate control, electronic defoggers, rain sensing wipers, electrochromic mirrors, power seats, electric adjustable memory seats, automatic door locks, keyless entry, anti-theft system, immobilizers, heated windshields.

Vehicles with Alternative Power Sources: Introduction, electric vehicles, hybrid vehicles, 42-volt systems, fuel cells.

Course Learning Outcomes (CLO):

The students will be able to:

1. understand the function of electronic systems in modern automobiles.
2. evaluate the use of modern electronics technology to improve the performance, safety, comfort and related issues.
3. synthesize and specify the addition of new features in existing electronic automotive subsystems for enhanced functionality.

Text Books:

1 Hiller, V. A. W., Fundamentals of Motor Vehicle Technology, Nelson Thornes, UK (2012).

2 Hollembeak, B., Today's Technician: Advanced Automotive Electronic Systems, Cengage Learning, New Delhi (2010).

Reference Books:

1 Heisler, H., Advanced Vehicle Technology, SAE International.

2 Pike , J. A., Automotive Safety, SAE International.

3 Duffy, J.E., Modern Automotive Technology, SAE International.

FINITE ELEMENT METHODS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To expose the students to the basic mathematical formulation of Finite Element Methods.

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 conduction Problems.

Course Learning Outcomes (CLO):
The students will be able to:

1. understand the basic steps involved to solve a structural, thermal problem using Finite Element Methods.
2. derive the element stiffness matrices for 1D spring, 1D bar, 2D truss, 2D and 3D beam problems using direct, Galerkin and potential energy approach.
3. solve a problem using triangle, axisymmetric, quadrilateral, tetrahedral, hexahedral and isoparametric elements.
4. understand and develop the shape functions for 1D, 2D and 3D 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).*