FACULTY OF ENGINEERING

Syllabus for the

M.E. (Production Engineering)
(Manufacturing & Automation)

(w.e.f 2008-2009)

UNIVERSITY OF PUNE

THE SYLLABUS IS PREPARED BY:

BOS- Production & Industrial Engineering,
University of Pune

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UNIVERSITY OF PUNE
COURSE STRUCTURE FOR
ME (Production Engineering) (2008 Course)

SEMESTER- I

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME					CREDITS
		Lect.	Pr.	Paper	TW	Oral	Pr	Total	
511101	Mathematics & Statistics	3		100	-	-	-	100	3
511102	CAD/CAM/CIM	3		100	-	-	-	100	3
511103	Advance Manufacturing Processes	3		100	-	-	-	100	3
511104	Elective I	3		100	-	-	-	100	3
511105	Elective II	3		100	-	-	-	100	3
511106	Lab Practice I	-	6	-	50	-	-	50	3
511107	Seminar I	-	4	-	50	-	-	50	2
Total of First Term		**15**	**10**	**500**	**100**	**-**	**-**	**600**	**20**

SEMESTER- II

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME					CREDITS
		Lect.	Pr.	Paper	TW	Oral	Pr	Total	
511108	Material Technology	3		100	-	-	-	100	3
511109	Manufacturing Management	3		100	-	-	-	100	3
511110	Industrial Automation	3		100	-	-	-	100	3
511111	Elective III	3		100	-	-	-	100	3
511112	Elective IV (Open)	3		100	-	-	-	100	3
511113	Lab Practice II	-	6	-	50	-	-	50	3
511114	Seminar II	-	4		50	-	-	50	2
Total of Second Term		**15**	**10**	**500**	**100**	**-**	**-**	**600**	**20**

SEMESTER- III

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME					CREDITS
		Lect.	Pr.	Paper	TW	Oral	Pr	Total	
611101	Seminar III	-	4	-	50	-	-	50	2
611102	Project Stage I	-	18	-	50	-	-	50	6
Total of Third Term		**-**	**22**	**-**	**100**	**-**	**-**	**100**	**08**

SEMESTER- IV

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME					CREDITS
		Lect.	Pr.	Paper	TW	Oral	Pr	Total	
611103	Project Stage II	-	18	-	150*	50	-	200	12
Total of Fourth Term		**-**	**18**	**-**	**150**	**50**	**-**	**200**	**12**

* The term-work of project stage II of semester IV should be assessed jointly by the pair of internal and external examiners along with the oral examination of the same.

Note- The contact hours for the calculation of load of teacher:

Seminar- 1 Hr / week /student
Project- 2 Hr / week / student

Elective I
1. Advance Mechatronics
2. Reliability & Failure Analysis
3. Supply Chain Management
4. Advance Machine Tool Design

Elective II
1. Advance Robotics
2. Sheet Metal processing
3. Tool and Die Design
4. Engineering Economics & Accounting

Elective III
1. Plastics Processing
2. Product Life Cycle Management
3. Welding & Joining,
4. Surface Treatment processes

Elective IV
1. Optimization Techniques
2. Research Methodologies
3. Intellectual Property Rights & Product Design
4. Energy management

511101 Mathematics and Statistics

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Theory: 100 Marks
	Duration: 3 hours
	Credits - 3

1. **Complex Variables**
   Analytical functions, conformal mapping, bilinear transformations, complex integration, Cauchy's integral theorem and formula, Taylor's and Laurent's series, Cauchy's residue theorem, Applications to Dirichlet's and Neumann's problems.

2. **Calculus of Variations**
   Introduction, Variational notation, Euler's first order condition with extension to several independent variables, constraints and Lagrange's multipliers, Hamilton's principle, Lagrange's equation in generalized co-ordinates, strum-Liouville's equation with orthogonal character of the solution for different values of physical problems involving differential equations expressed as Variational problems Galerkin's and Raleigh- Ritz method.

3. **Numerical Solution to Partial Differential Equations**
   Difference equations and their types, Solutions of difference equations, finite difference equivalence of solutions of Elliptic Parabolic and hyperbolic equations. Applications to Laplace, Poisson and Cauchy's equations.

4. **Special Functions**
   Differential Equations and its solutions in series, Bessel's and Legendre's differential equations and their series solutions, properties of Bessel's functions and Legendre's polynomials, generating functions, recurrence relations, Fourier Bessel expansion of function and its applications to boundary value problems.

5. **Mathematical Modelling**
   Proportionality Models, fitting models to data, creating simulations, dimentional analysis, probabilistic modeling, optimization (discrete and continuous models), multivariate random number generation, bootstrapping, Monte Carlo simulation, efficiency improvement techniques, simulation output analysis.

6. **Statistics and Probability**
   Random variables, various distributions, sampling theory, Chi- square test, t-tests, elementary Stochastic process's, Markov-chain, Markov process, reliability testing. Control chart (P, np chart etc.)

References

1. Erwin Kreyzig, Advanced Engineering Mathematics, Jhon Wiely & Sons
2. Spiegel, Complex Variables, Schaum's Series
3. B.S.Grewal, Numerical Methods in Engineering and Science, Khanna Publishers New Delhi
4. Mark Meerschaert, Mathematical Modeling, Academic press
5. B. S. Grewal, Advanced Engineering Mathematics, Khanna Publishers, New Delhi

511102 CAD/ CAM/ CIM

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits-3

1. **Computer aided design:**
   Geometric modeling, model structure organization, database creation, wire frame modeling, solid modeling, surface modeling, parametric modeling, variational modeling, hybrid modeling. Types and mathematical representation of curves, surfaces and solids. Geometric transformations, visual realism, computer animation, mechanical assembly, mass property calculations.

2. **Computer aided manufacturing**
   Revision to NC/CNC/DNC and its role in flexible manufacturing systems and CIMS, Elements of CNC systems, CNC part programming, computer assisted part programming, NC program generation from CAD models, tool path generation and verification, recent developments in CNC machine tools.

3. **Computer aided engineering analysis**
   Introduction to finite element analysis, need for finite element analysis in CAD/CAM system, Steps in finite element analysis, second order differential equation in one-dimension applications such as discrete systems, heat transfer, fluid mechanics, plane trusses. Introduction to advance topic in finite element analysis such as three-dimensional problems and non-linear problems. Use of engineering analysis software.

4. **Computer aided process planning**
   Advantages of CAPP, variant type CAPP system, generative approach, hybrid approach, geometric modeling for process planning, computer programming languages for CAPP.

5. **Computer aided shop floor control**
   Computer aided production planning and control, computer aided material requirement planning, factory data collection system, computer process monitoring, computer aided quality control.

6. **Computer Integrated manufacturing**
   Cellular manufacturing system: Introduction to GT, benefits, part families, part classification and coding, product flow analysis, cellular manufacturing systems, virtual cell system, quantitative analysis in cellular manufacturing.
   Flexible manufacturing system: Building blocks of FMS, applications, benefits, FMS layout, FMS planning and implementation issues, quantitative analysis of FMS.
   Computer aided material handling system, computer control system.

References

1. Mikell P. Grover, “Automation, Production Systems and Computer-Integrated Manufacturing”, Pearson Education, New Delhi.
2. P. Radhakrishnan and S. Subramanyan “CAD/CAM/CIM” Willey Eastern Limited, New Delhi.
3. Michael Fitzpatrick, “Machining and CNC Technology”, Tata McGraw Hill.
4. Mikell P. Grover and Enory W. Zimmers Jr. “CAD/CAM”, Pearson Education, New Delhi.
5. Steve Krar, Arthar Gill “CNC Technology and Programming”, McGraw Hill Pub. Company, New Delhi.
6. P.N. Rao N.K. Tewari et al “CAM” Tata Mc Graw Hill Pub. New Delhi.
7. David Bedworth, "Computer Integrated Design and Manufacturing", TMH, New Delhi
8. Zeid Ibrahim, “CAD/CAM Theory and Practices”, McGraw Hill International Edition.

511103 Advance Manufacturing Processes

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits - 3

1. **Principles of Casting**
   Principles of Casting – metals, alloys, eutectics and plastics; Mechanism of melting and solidification, grain growth and structure, shrinkage defects.
   Mold filling – fluidity and turbulence, filling under gravity and pressure; filling defects; gating design, Injection Molding, Simulation of Mold filling and Solidification.

2. **Fundamentals of Fusion Welding**
   Fundamentals of fusion welding processes – analysis of heat source, types of metal transfer, weld pool characteristics, solidification mechanisms in fusion zone, heat affected zone characteristics, types of weld joint, distortion and residual stresses, weld defects, destructive and non-destructive testing of welds.

3. **Non Conventional Machining Processes**
   Introduction and need of Non-conventional machining processes, Principle, Theory of material removal, Process parameters, Advantages, limitations and applications of Ultrasonic machining, Electro discharge machining, Laser beam machining and Electro chemical machining.
   Special processes: Micro machining, Nano-technology, molecular dynamic analysis, dry electro discharge machining, electro discharge chemical machining, vaccum coating, Ballistic machining, unit head machining, hot machining.

4. **Advances in Material Forming**
   Macroscopic plasticity and yield criteria, plastic instability, strain rate and temperature, slab analysis, upper bound analysis, slip line field theory, plastic anisotropy, numerical analysis of material forming processes.

5. **Unconventional forming processes**
   High energy rate forming, electromagnetic forming, explosive forming, high speed hot forging, high velocity extrusion, high speed forming machines, peen forming, study of various process parameters.

6. **Sheet metal forming**
   Formability, bending, cupping, redrawing, ironing, complex stamping, metal spinning, stretch forming, fine blanking, high speed blanking.

References

1. B.H. Amsteal, Philip F. Ostwald and Myron L. Begeman, Manufacturing Processes", John Wiley & Sons, eighth edition.
2. G.F. Benidict "Advanced Manufacturing processes", Marcel Deker Publisher
3. Lancaster,J. F., Metallurgy of welding, brazing and soldering, George Allen & Unwin, London, 1985.

4. Degarmo, “Materials and Processes in Manufacturing”, 9th edition, Wiley Students Edition.
5. P. N. Rao, “Manufacturing Technology”, Tata McGraw Hill.
6. Regis Blondeau, “Metallurgy and Mechatronics of Welding”, ISTE.
7. American Soc. For Metals, Metals Handbook, 10th Edition, Vol 15, on Metal Forming, ASM, Metals Park, Ohio, 1989.
8. Eary, D. F., and Reed, E. A., Techniques of Press working Sheet metal and Engineering,
9. Willium F. Hosfford and Robert Caddell, Metal forming: Mechanics and Metallurgy,
10. Raj, Shankar, Bhandari, “Welding Technology for Engineers”, Narosa Publication House Pvt. Limited.

511104 Advance Mechatronics-Elective-I

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits: 3

1. **Introduction**
   Introduction to Mechatronics - Systems - Mechatronics in Products - Measurement Systems - Control Systems -Traditional design and Mechatronics Design.

2. **Sensors And Transducers**
   Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion – Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing - Servo systems.

3. **Microprocessors in Mechatronics**
   Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters –Applications - Temperature control - Stepper motor control - Traffic light controller.

4. **Process Control Computer Systems**
   Minis, micros, classification by hardware features and software facilities, performance evaluation techniques. Characteristics of Digital Processors: Organization, instruction set, characteristics for process control, input/output arrangements, addressing techniques, memory systems.

5. **Programmable Logic Controllers**
   Introduction - Basic structure - Input / Output processing - Programming -Mnemonics Timers, Internal relays and counters - Data handling - Analog input / output - Selection of PLC.

6. **Design And Mechatronics (Mechatronic Product Design)**
   Designing - Possible design solutions - Case studies of Mechatronics systems.

References

1. Michael B.Histand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 1999.
2. Ramesh. S Gaonkar, “Microprocessor Architecture, Programming and Applications ", Wiley Eastern, 1998.
3. Lawrence J.Kamm, "Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ", Prentice-Hall, 2000.
4. Ghosh, P.K. and Sridhar, P.R., 0000 to 8085, "Introduction to Microprocessors for Engineers and Scientists ", Second Edition, Prentice Hall, 1995.
5. Bolton, “Mechatronics: Electronic Control System in Mechanical and Electrical Engineering”, Pearson Education Ltd.
6. Dr. Appukuttan, “Introduction to Mechatronics”, Oxford University Press.

511104 Reliability & Failure Analysis – Elective I

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits – 3

1. Introduction

Basic Probability-concept and various distributions, Concept of Reliability and analysis of various configurations of assemblies and sub-assemblies. Series, Parallel and other grouping. System reliability, Set theory, optimal Cut Set and Tie Set, 'star-delta' method, matrix method etc.

2. Product Failure Theory

System reliability determination through 'Event Tree' analysis and Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), Failure Modes, Effects and Criticality Analysis (FMECA). R.P.N, Graph theory, etc.

3. Reliability Prediction Models

Series and parallel systems - RBD approach - Standby systems - m/n configuration - Application of Baye's theorem - cut and tie set method - Markov analysis.

Optimal allocation of component reliability to achieve maximum system reliability - various techniques and methods such as Proportional, Conditional, Agree, Arinc, etc.

4. Reliability evaluation

Concept of loading roughness, probability in design including evaluation of safety margin. Reliability of Engineering Design; Mean, Median & K statistics for Reliability evaluation (non parametric, Short Sample).

5. Reliability Management

Reliability testing - Reliability growth monitoring - Non parametric methods - Reliability and life cycle costs - Reliability allocation - Replacement model.

6. **Case Studies**

Diagnostic maintenance through ferrography, Vibration Signature, SOAP and other programme. Case studies done in Indian perspectives using Short Sample, nonparametric reliability

References

1. Gupta AK, Reliability engineering and tero-technology, Macmillan India Ltd, Delhi
2. Srinath LS, Reliability Engineering, Affiliated East-West Press Pvt Ltd, Delhi
3. O'Connor PDT, Practical Reliability Engineering, John Wiley & Sons Ltd, Singapore
4. Modarres, "Reliability and Risk analysis ", Mara Dekker Inc., 1993.
5. John Davidson, The Reliability of Mechanical system, The Institution of Mechanical Engineers, London, 1988.
6. Smith C.O." Introduction to Reliability in Design", McGraw Hill, London.
7. "Reliability Engineering and Risk Analysis", 2nd edition Taylor & Francis.

511104 Supply Chain Management – Elective I

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Theory: 100 Marks
	Duration: 3 hours
	Credits - 3

1. Introduction

Objectives of Supply Chain Management (SCM), key components of supply chain i.e. sourcing, distribution strategy, customer service strategy; supply chain. Management as Integrated logistics, generic activities, architecture of supply chain, future potential of SCM.

2. Supply chain strategies

Evaluation of supply chain strategies, supply chain performance measures, vendor management, JIT, Link to supply chain, evaluation of SCM strategies, customer focus in SCM, inventory and logistic management, vendor management, Just-in- Time (JIT). Supply chain design considerations.

3. Logistic Management

Logistical operation, integration, network design, logistical performance cycle, customer service global logistic, logistical resources, logistic planning.

4. Warehouse and transport management

Concept of strategic storage, warehouse functionality, warehouse operating principles, developing warehouse resources, material handling and packaging in warehouse, transportation management, transport functionality and principles, transport infrastructure, transport economics and pricing, transport decision making.

5. Inventory management

Cost associated with inventory decisions, selective control, economic order quantity, safety stock and service level, P and Q system, probabilistic models. Recent Trends in SCM:

6. Recent Trends in SCM

Tierisation of supplies, Reverse logistics, JIT II, Milk Round System (MRS), bar coding, Hub and Spoke Concept and other latest concepts. IT – enabled supply chain: Electronic data interchange, enterprise resource planning (ERP), Application of IT, Scope of emerging distributed cooperative tele-manufacturing over internet.

References

1. Chopra, “Supply Chain Management”, Pearson Education Asia, New Delhi
2. Christopher, “Logistics and Supply Chain Management”, Pearson Education Asia, New Delhi
3. Taylor and Brunt, “Manufacturing Operations and Supply Chain Management (The Lean Approach)”, Business Press Thomson Learning, NY.
4. Arjan J. Van Weele, “Purchasing and Supply Chain Management (Analysis Planning and Practice)”, Engineering, Business Press, Thomson Learning NY.
5. Donald B., “Logistic Management - The Integrated Supply Chain process”, McGraw Hill, NY

511104 Advance Machine Tool Design-Elective I

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits - 3

1. **Introduction**
   Introduction to Metal Cutting Machine tools, Kinematics, Basic Principles of Machine tool design, estimation of drive power. Design requirements of machine tools. A design approach for machine tools. Identification and quantification of objectives and constraints in machine tool design.

2. **Design of Structural Components**
   Design of Machine tool spindle and bearings, Design of power Screws - Static deformation of various machine tool structures - thin walled box structures with open and compliant cross sections - correction coefficients - design of beds, columns, tables and supports. Dynamics of cutting forces - tool chatter - design of sideways.

3. **Design of Drives**
   Design considerations of electrical, mechanical and Hydraulic drives in machine tool, stepped and stepless arrangements and systems.
   Design of control mechanisms - selection of standard components - Dynamic measurement of forces and vibrations in machine tools - Stability against chatter - use of vibration dampers.

4. **Design of CNC Machine Tools**
   CNC machine - block diagram showing memory, CPO, I/O, post processor etc, Machining center, Auto tool changers, uses of Composites in machine tool. DNC and Local Area Network, machines with Adaptive Control. Design of slides with reinforced PTEE, Ball screw all design, methods of calculation of load, Reliability based design. Static and dynamic rigidity and stability analysis.

5. **Testing of Machine Tools**
   Vibration study of machine tool structures – micro-displacement and error analysis of machine tools with reference to transmission system and positional displacement (stick-slip). Acceptance tests and standardization of machine tools- machine tools reconditioning.

6. **Ergonomics applied to machine tool**
   Concepts of aesthetics and ergonomics applied to machine tools, latest trends in Machine Tool Design, Introduction to CAD techniques

References:

1. Mehta N. K.,"Machine Tool design and Numerical Control",Tata McGraw Hill, 1989
2. Koenisberger F., "Design Principles of Metal cutting Machine Tools",Pergamon Press,
3. Acherkan N., "Machine Tool Design",Vol.3and 4,MIR Publishers, Moscow
4. Sen.G. and Bhattacharya,A., "Principles of Machine Tools",Vol.2,NCB.Calcutta, 1973

511105 Advanced Robotics – Elective II

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits - 3

1. **Introduction**
   Basic concepts - Robot anatomy - Robot configurations - Basic robot motions –Types of robots- Types of drives - Applications - Material handling - processing -Assembly and Inspection - safety considerations.

2. **Transformations And Kinematics**
   Vector operations - Translational transformations and Rotational transformations - Properties of transformation matrices-Homogeneous transformations and Manipulator - Forward solution - Inverse solution.

3. **Controls And End Effectors**
   Control system concepts - Analysis - control of joints - Adaptive and optimal control - End effectors - Classification - Mechanical - Magnetic -Vacuum - Adhesive - Drive systems - Force analysis and Gripper design.

4. **Robot Programming**
   Methods - Languages -Computer control and Robot Software - VAL system and Language.

5. **Sensory Devices**
   Non optical and optical position sensors - Velocity and Acceleration - Range - Proximity - touch - Slip - Force - Torque - Machine vision - Image components - Representation - Hardware - Picture coding - Object recognition and categorization - Software consideration.

6. **Design of Mechanisms And Manipulators**
   Classification of closed- and open-loop kinematic systems, Definition of mechanisms and manipulators, Kinematic constraints, Degree of freedom (DOF) and Mobility; DH parameters, Coordinate transformations, Matrix methods; Structural analysis and synthesis of mechanisms; Forward kinematics of robot manipulators with examples; Inverse kinematics; Jacobian and singularity; Alternative design solutions of mechanisms and manipulators;

References:

1. Fu K.S., Gonzalez R.C., and Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw-Hill Book Co., 1987.
2. Klafter R.D., Chmielewski T.A. and Negin M., " Robot Engineering An Integrated approach", Prentice Hall of India, New Delhi, 1994.
3. Deb S.R., "Robotics Technology and Flexible Automation ", Tata McGraw-Hill Publishing Co., Ltd., 1994.
4. Craig J.J., "Introduction to Robotics Mechanics and Control ", Addison-Wesley,
5. Groover M.P., "Industrial robotics Technology, programming and applications ", McGraw-Hill Book Co., 1995.
6. Mittal and Nagrath, "Robotics & Control", Tata McGraw-Hill.
7. Ashitava Ghoshal, "Robotics Fundamental Concepts & Analysis", Oxford University Press.

511105 Sheet Metal Processing – Elective II

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Theory: 100 Marks Duration: 3 hours Credits - 3

1. Introduction:
Introduction to sheet metal forming lines, sheet- tool-machine tool as a system, properties and grades of sheet metal available, their applications, manufacturing and testing procedure.

2. Product design for sheet metal
Products manufacturable using sheet metals, formability, analytical prediction of forming limits, strain path, strain distribution, product design for sheet metal forming.

3. Sheet metal processes
Separating processes like shearing, fine blanking, plasma cutting and bending, laser cutting and bending, bending and springback calculations, bend sequencing, drawing of sheets, draw ratio, LDR, process analysis, process analysis of axysymmetric deep drawn parts.

4. Special sheet forming processes
Super plastic forming and diffusion bonding processes, sheet joining processes, deformation and weld contours, TWB forming, warm forming, sheet and tube hydro forming, roll forming.

5. Equipment selection:
Different types of presses press structures, drives, safety devices, part handling, multiple point blank holding, press brakes, counter pressure bending devices, transfer presses.

6. Computer applications in sheet metal design:
Process modeling and analysis, scope of CAD/CAM in sheet metal forming, numerical analysis of forming processes.

References:

1. American Soc. For Metals, Metals Handbook, 10th Edition, Vol 15, on Metal Forming, ASM, Metals Park, Ohio, 1989.
2. David, A., Smith (Editor), Die Design Handbook, SME publications, Michigan, 1990.
3. Lange, K., Handbook of Metal Forming McGraw Hill, 1985.
4. Eary, D. F., and Reed, E. A., Techniques of Pressworking Sheet metal and Engineering,
5. Willium F. Hosfford and Robert Caddell,Metal forming: Mechanics and Metallurgy,
6. SME: Tool and Manufacturing Engineers Handbook, vol.2.
7. Rowe G.W., “Principles of Industrial Metalworking Processes”, Edward Arnold publication.
8. Sadhu Singh, “Theory of Plasticity and Metal forming Processes”, Khanna publishers.
9. Ivana Suchy, “Handbook of Die Design”, 2nd Edition McGraw-Hill.

511105 Tool & Die Design – Elective II

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Theory: 100 Marks
	Duration: 3 hours
	Credits - 3

1. Cutting Tool Design

Fundamentals of Cutting tools design, cutting tools and their principal elements, Tool geometry, system of nomenclatures and their interrelations, setting for the grinding of various basic cutting tool (turning, drilling, milling)

2. Analyses and Design of Jigs and Fixture

Principles of jig and fixture design, Dual cylinder location, diamond pin analysis, V-block analysis, design principles of centralisers, various mechanisms and design of equalizers, analysis for optimum number of clamping forces required and calculation of their magnitudes, concept of modular fixtures, design of fixtures for NC/CNC machines, computer applications in fixture design and analysis.

3. Design of press tools:

Components of die design, design of die blocks, punches and strippers, methods of holding punches, sketches of stock stops, Design procedure for progressive dies, compound dies and combination dies for press tool operation forging die design for drop and machine forging parts. Computer applications in press tool design.

4. Design of forging dies:

Grain flow considerations, parting line selection, draft, design problems involving ribs, bosses and fillets. Flash and flash control, determination of number of impressions required and their sequence, design steps and analysis of forging dies, detail calculations, shrinkage, cavity shapes, heat transfer considerations, cooling and ejection systems, automation in forging operations, computer aided design and analysis.

5. Design of injection molds

Principles of melt processing, product considerations, determination of economical number of cavities, temperature control of injection molds, calculation of mold opening force and ejection force. Detail design of cooling system, ejection system and gating system. Moldability features, mold flow analysis.

6. Die casting die design

Metals for die casting, specific details of die construction, casting ejectors, side cores, loose die pieces, slides, types of cores, directional solidification, types of feeders, die venting, water cooling, design aspects of die casting dies, defects.

References

1. Cole: “Tool Design”
2. Donaldson: “Tool Design”, Tata McGraw Hill.
3. ASTEM: “Fundamentals of Tool Design”

4. P.C.Sharma: “A Textbook of Production Engineering”., S.Chand Publication, N.Delhi
5. Ivana Suchy, “Handbook of Die Design”, 2nd edition McGraw Hill.
6. Ventatraman, “Design of Jigs, Fixtures and Press Tools”, Ascent Series Tata McGraw Hill.
7. Deshpande D. L., “Basic Tools”, 2nd edition University Press.

511105 Engineering Economics and Accounting-Elective II

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Theory: 100 Marks Duration: 3 hours Credits - 3

1. Introduction

Definition, nature and scope of Managerial Economics, Managerial Economics and Micro-economics – Managerial, Economics and Macro-economics - Applications of Economics.

2. Demand Analysis

Determinants of Market Demand – Law of Demand - Elasticity of Demand - Measurement and its use - Demand Forecasting - Techniques of Demand Forecasting.

3. Pricing and output determination

Pricing decisions under different market forms like perfect competition, monopoly, oligopoly - Pricing Methods - Pricing in Public Sector, Pricing Methods - Pricing in Public Sector undertakings and co-operative societies.

4. Cost Benefit Analysis

Steps in cost benefit analysis - Justification for the use of cost benefit analysis, Private Vs. Public Goods - Government investment, Overall resource allocation.

5. Cost management

Classification of cost, type of costing, absorption and marginal costing, break even analysis, standard cost accounting, cost-volume profit analysis.

6. Investment appraisal methods

Types of investment proposals, project report, methods of appraisal, discounted cash flow, net present value method, internal rate of return, profitability index, depreciation, limitation of appraisal method, forecasting business changes, use of index number and growth analysis.

References:

1. D.Salvatore , “Managerial Economics in a global economy” Tata McGraw Hill
2. Reckie and Crooke., “ Managerial Economics” Prentice Hall; 4 edition.
3. Khan M.Y., Jain P.K , “Management Accounting”, Tata Mc Graw Hill, 1995.
4. 4.Horngren C.T., Datar S.M., Foster G.M., “Cost Accounting : a managerial emphasis”, Pearson Education, 2002.

511106 Lab Practice I

Teaching Scheme	**Examination Scheme**
Practical: 6 hrs/week	Term Work: 50 Marks
	Credits – 3

Each student should write at least two assignments on each subject of Semester I, based on laboratory work.

511107 Seminar I

Teaching Scheme
Practical: 4 hrs/week

Examination Scheme
Term Work: 50 Marks
Credits – 2

Each student is required to deliver a Seminar on state of the art topic of his/her choice relevant to any area of Production Engineering and submit it in the form of short report.

511108 Material Technology

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits - 3

1. Elastic and Plastic Behaviour

Elasticity in metals and polymers - Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals - Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviors - Super plasticity - Deformation of non crystalline material.

2. Fracture Behavior

Griffith's theory, stress intensity factor and fracture toughness - Toughening mechanisms - Ductile, brittle transition in steel - High temperature fracture, creep - Larson-Miller parameter - Deformation and fracture mechanism maps - Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Effect of surface and metallurgical parameters on fatigue - Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

3. Selection of Materials

Motivation for selection, cost basis and service requirements - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

4. Modern Metallic Materials

Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys - Metallic glass - Quasi crystal and nano crystalline materials, bio materials

5. Non Metallic Materials

Plastics, rubber, foams, adhesives and coatings - Structure, properties and applications of engineering polymers - Advanced structural ceramics, WC, TiC, TaC, AI2O3, SiC, Si3N4, CBN and diamond - properties, processing and applications.

6. Composite materials

Reinforced fibers, Particle strengthened and laminar composites-- production techniques of each type, Production of fibers, properties mechanics of composites, manufacturing of metal matrix, Ceramic matrix composite, Carbon-Carbon composite- properties and testing of composite material, areas of application.

References:

1. Thomas H. Courtney, " Mechanical Behavior of Materials ", McGraw-Hill, 2000.
2. Charles J.A., Crane, F.A.A and Furness, J.A.G., “Selection and use of Engineering Materials ", (3rd Edition), Butterworth-Heinemann, 1977.
3. Flinn, R.A. and Trojan, P.K., “Engineering Materials and their Applications ", (4th Edition), Jaico, 1999.
4. George E. Dieter, “Mechanical Metallurgy ", McGraw Hill, 1988.
5. Metals Hand Book, Vol.10, “Failure Analysis and Prevention ", (10th Edition), 1994.
6. Willam D. Callister, Jr., “Material Science and Engineering: An introduction”, John Wiley & Sons, Inc, 2003.
7. Willam F. Smith, “Principles of Materials Science and Engineering”, 3rd edition, McGraw Hill, 2002.

511109 Manufacturing Management

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits - 3

1. **Scope of Manufacturing Management**
   History and development of Manufacturing Management - Contribution of various pioneers beginning from Division of Labor to Quality Revolution and Environmental Control. Manufacturing Management - Nature, Scope, Importance and Functions

2. **Production Planning & Control**
   Functions of Production Planning & Control (PPC), Scheduling techniques - Gantt Charts, analytical techniques, Documentation - Production Work Order. Introduction to PERT/CPM, Network Crashing

3. **Advanced Topics in Production Management**
   Concept of world-class manufacturing, quality management system, manufacturing challenges of information age, lean and agile manufacturing, reconfigurable manufacturing, green production, computerized production management system.

4. **Organizational Behaviour**
   Definition - Importance - Historical Backgrourud, Fundamental Concepts of OB - 21st Century corporate - Different models of OB i.e. autocratic, custodial, supportive, collegial and SOBC
   Personality & Attitudes - Meaning of personality - Development of personality Nature and dimensions of attitude - Job Satisfaction - Organizational Commitment.

5. **Motivation and Leadership**
   Motivation - Motives - Characteristics - Classification of motives - Primary Motive, Secondary motives - Morale - Definition and relationship with productivity – Morale Indicators; Theories of Work Motivation - Maslow's theory of need hierarchy Herzberg's theory of job loading
   Leadership - Definition -Importance - Leadership Styles - Models and Theories of Leadership Styles

6. **Group Dynamics and Team Working**
   Theories of Group Formation - Formal and Informal Groups, their interaction - Importance of teams - Formation of teams - Team Work. Conflict Management - Traditional vis-a-vis Modern view of conflict - Stress management, Conflict Process - Strategies for encouraging constructive conflict - Strategies for resolving destructive conflict

References

1. Fred Luthans, Organizational Behaviour -
2. Saxena, Principles and Practices of Management
3. Krajewski, Operations Management, 5th Ed.
4. Panneerselvam, Production & Operations Management
5. Adam & Ebert, Production & Operations Management

511110 Industrial Automation

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits - 3

1. **Automation of assembly lines**
   Concept of automation, mechanization and automation, Concept of automation in industry, mechanization and automation, classification, balancing of assembly line using available algorithms. Transfer line-monitoring system (TLMS) using Line Status, Line efficiency. Buffer stock Simulation in assembly line.

2. **Automation using hydraulic systems**
   Design aspects of various elements of hydraulic systems such as pumps, valves, filters, reservoirs, accumulators, actuators, intensifiers etc. Selection of hydraulic fluid, practical case studied on hydraulic circuit design and performance analysis. Servo valves, electro hydraulic valves, proportional valves and their applications.

3. **Automation using pneumatic systems**
   Pneumatic fundamentals - control elements, position and pressure sensing -logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods – step counter method - compound circuit design - combination circuit design. Pneumatic equipments - selection of components - design calculations -application - fault finding – hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

4. **Automation using electronic systems**
   Introduction, various sensors, transducers, signal processing, servo systems, programming of microprocessors using 8085 instruction, programmable logic controllers.

5. **Automated work piece handling**
   Working principles and techniques, job orienting and feeding devices. Transfer mechanisms-automated feed cut of components, performance analysis. Uses of various types of handling systems including AGV and its various guiding technologies.

6. **Introduction to robot technology**
   Robot physical configuration and basic robot motions, Types of manipulators- constructional features, servo and non servo manipulators. Feedback systems and sensors- encoders and other feed back systems, vision, ranging systems, tactile sensors. Programming languages-description of VAL and other languages. Artificial intelligence- legged locomotion and expert systems.

References

1. Groover, M.P., CAD/CAM- Prentice Hall
2. Yoram Koren, Robotics for Engineers- McGraw Hill 1992
3. Paul, R.P., Robot Manipulators- MIT Press 1993
4. Pressman R.S, Numerical Control and CAM-. John Wiley 1993 Williams

5. Shearer P., Fluid Power Control John Wiley
6. Antony Espossito, " Fluid power with Applications ", Prentice Hall, 1980.
7. Dudleyt, A.Pease and John J.Pippenger, " Basic Fluid Power ", Prentice Hall, 1987.
8. Andrew Parr, " Hydraulic and Pneumatics ", (HB), Jaico Publishing House, 1999.
9. Bolton. W. " Pneumatic and Hydraulic Systems ", Butterworth - Heineman, 1997.

511111 Plastic Processing – Elective III

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Theory: 100 Marks
	Duration: 3 hours
	Credits - 3

1. **Plastic materials**
   Classification of plastic materials, their physical and mechanical properties, selection of plastics for various applications, advantages and limitations of using plastics.

2. **Melt processing techniques**
   Polymer processing techniques such as extrusion, compression and transfer moulding. Injection moulding, blow moulding, thermoforming, rotational moulding, calendaring, Bag moulding reaction moulding. Classification of polymer processing operations. Simple model flows for analysing processing operations with examples.

3. **Constructional features of mold**
   constructional features of core and cavity plates, mold size and strength, cavity material, and fabrication, mold placement, constructional features and layout of runners and gates.

4. **Product design of moulded products**
   Various considerations such as wall thickness, fillets and radii, ribs, under, cuts, drafts, holes, threads, inserts parting lines, etc. surface treatment mould design for avoiding warpage. Standards for Tolerances on moulded articles.

5. **Design of molds for plastic processing**
   Methodical mold design, determination of economical number of cavities, melt rheology, temperature control of injection molds, calculation of mold opening force and ejection force. Detail design of cooling system, ejection system and gating system. Moulding thermoplastics, thermosets, expandable polysterene, foamed engineering plastics, molds for reaction injection molding.

6. **Computer applications in plastic molding**
   Use of various softwares for mold flow analysis, optimum gate location and defect analysis, design of component for balanced flow, optimization of process parameters of plastic molding.

References

1. A.W. Birley, B. Howarth, Hana, “Mechanics of plastics processing properties”,
2. J.E. Mark, R. West, “Inorganic Polymers”, H.P. Alocock, Prentice Hall, 1992
3. Fried, “Poly. Science and Technology”, Prentice Hall
4. Frados, “Plastic Engg. Hand Book”
5. Pattan , “Plastic Technology”
6. Glanill , “Plastic Engg. Data Book”
7. Charles Harper, “Handbook of Plastics Technologies”, McGraw-Hill.

511111 Product Life Cycle Management-Elective III

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Theory: 100 Marks
	Duration: 3 hours
	Credits - 3

1. **Introduction to PLM**
   Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study, PLM visioning.

2. **PLM Strategies**
   Industrial strategies, strategy elements, its identification, selection and implementation, change management for PLM.

3. **Product Data Management (PDM)**
   PDM systems and importance, reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.

4. **Product Design**
   Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modeling and simulation in product design.

5. **New Product Development**
   Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product.

6. **Technology Forecasting**
   Future mapping, invocating rates of technological change, methods of technology forecasting such as relevance trees, morphological methods and mission flow diagram, combining forecast of different technologies, uses in manufacture alternative.

References

1. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.
2. Robert J. Thomas, NPD: Managing & forecasting for strategic processes.
3. Martins Joseph, Technological Forecasting for decision Making, 2nd edition, North Holland.

511111 Welding & Joining – Elective III

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits - 3

1. Introduction:
Basic classification of welding processes, weldability, weld thermal cycle, metallurgy of fusion welds, solidification mechanism and microstructural products in weld metal, epitaxial, cellular and dendritic solidification, metallurgical changes in weld metal, phase transformation during cooling of weld metal in carbon and low alloy steel, prediction of microstructures and properties of weld metal. Heat affected zone, re-crystallization and grain growth of HAZ, gas metal reaction, effects of alloying elements on welding of ferrous metals.

2. **Welding Arc**:
Arc efficiency, temperature distribution in the arc; arc forces, arc blow, electrical characteristics of an arc, mechanism of arc initiation and maintenance, role of electrode polarity on arc behaviour and arc stability, analysis of the arc.
Coated Electrodes: Electrode coatings, classification of coatings of electrodes for SMAW, SAW fluxes, role of flux ingredients and shielding gases, classification of solid and flux code wires,

3. **Fusion Welding reviews**:
Critical reviews of manual metal arc welding (MMAW) GTAW, GMAW, FCAW and CO welding processes, plasma arc, submerged arc welding, electro gas and electro slag welding, analysis of the process.

4. **Welding power sources**:
Arc welding power sources basic charters tics of power sources for various arc welding processes, duty cycles, AC, DC welding power source, DC rectifiers, thyristor controlled rectifiers, transistorised units, inverter systems. Arc length regulation in mechanised welding processes.

5. **Metal Transfer and Melting Rate**:
Mechanism and types of metal transfer, forces affecting metal transfer, modes of metal transfer, metal transfer in various welding processes, effective of polarity on metal transfer and melting rate.

6. **Solid State welding**:
Theory and mechanism of solid sate welding. Techniques and scope of friction welding, diffusion welding, cold pressure welding and ultrasonic welding. High energy rate welding. Analysis of the Process.
Welding Techniques using Radiation energy: Technique, scope and application of the electron beam and laser welding processes.

References:

1. Dr. R.S.Parmar, “Welding processes and technology”, Khanna Publishers
2. Raj, Shankar, Bhandari, “Welding Technology for Engineers”, Narosa Publication House Pvt. Limited.
3. S.V. Nandkarni, “Modern Arc Welding Technology”, Oxford and IDH publishing Co.
4. L.M. Gourd, “Principles of Welding Technology”, ELBS/ Edward Arnold
5. “The Physics of welding”, Lancaster; Pergaman Press.
6. “Welding Handbook”, Vol. 1 and 2, seventh edition; American welding society.
7. “Metal Handbook”, Vol 6, 73; ASME
8. Richard L. Little, “Welding and Welding Technology”, McGraw Hill.

511111 Surface Treatment processes – Elective III

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	Theory: 100 Marks Duration: 3 hours Credits – 3

1. Introduction of Surface dependent properties

Classification and scope of surface engineering in metals, ceramics, polymers and composites, tailoring of surfaces of advanced materials. Surface protection (Physical);
Surface dependent engineering properties, viz., wear, friction, corrosion, fatigue, reflectivity, emissivity, etc.; common surface initiated engineering failures; mechanism of surface degradation; importance and necessity of surface engineering

2 Various Surface Cleaning Processes

Classification and Selection of Cleaning processes. Acid and Alkaline, Salt bath, Ultrasonic, Mechanical cleaning, Pickling and descaling, etc. Process details of each, applications of each, Environmental concern of each.,

3 Surface modification techniques

classification, principles, methods, and technology used, conventional surface engineering methods: Diffusion coatings like carburising, nitriding, cyaniding, hot dipping, galvanizing, anodizing ,Aluminising, Phosphetising etc.; Diamond and Diamond like Carbon thin films and coatings for engineering surfaces .Electrochemistry and electro-deposition; electro less deposition .Scope and application of conventionally deposited materials.; advantages and limitations of above mentioned processes.

4. Other Surface engineering processes

Influence of manufacturing processes on various surface properties of an engineering component; scope of surface engineering in augmentation of surface properties.
Other processes used in surface engineering – Thermal spray coatings, Physical vapor deposition, Chemical vapour deposition.- Process, applications. Mass production; surface engineering problems related to substrate characteristics. Plasma enhanced Surface engineering, Ion Implantation.

5. Evaluation of engineered properties

control properties, response properties; surface geometry – characterization techniques (conventional and recent trends); coating thickness measurements – laboratory techniques and special techniques for accurate routine thickness measurements; adhesion measurement – conventional methods and recent developments;

6. Recent trends in surface engineering

Measurement of mechanical properties of engineered surface in nano scale; Evaluation of tribological characteristics of engineered surface in macro, micro and nano scale, simulation of actual application environment in tribometer. Use of Laser in Surface Engineering,

References

1. Bharat Bhushan, “Introduction to Tribology”
2. N.J. Persson, “Sliding Friction”
3. Frank Philip Bowden, “The Friction and Lubrication of Solids”, Oxford Classic Texts
4. Gwidon Stachowiak, A W Batchelor, “Engineering Tribology”
5. ASM Hand Book, Vol. 5, “Surface Engineering”.
6. Tool & Manufacturing Engineers Hand book, Vol.3, ‘ Materials Finishing and Coating’

511112 Optimization Techniques - Elective IV

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits - 3

1. **Introduction to optimization**
   Engineering Applications, statement of an optimization problem, classification. Introduction to optimization techniques.

2. **Single variable optimization**
   Fabbonci search methods, golden section search methods, gradient based methods, Newton-Raphson method, secant method.

3. **Multi-variable optimization**
   Direct search methods: Evolutionary optimization method, Powell's conjugate direction method.
   Gradient based methods: Steepest descent method, Newton's method.

4. **Constrained optimization**
   Constraint handling methods, method of feasible directions, generalized reduced gradient method, gradient projection method.

5. **Specialized algorithms:** Integer programming, geometric programming**.**

6. **Non-Traditional Optimization Algorithms**
   Genetic algorithms (GA) - working principle, Differences and Similarities between GA's and traditional methods, GA's for constrained optimization. Simulated Annealing (SA) approach – introduction only.

References

1. Rao S S "Optimization", Wiley Eastern, New Delhi, 1995.
2. Kalyanamoy Deb, "Optimization for engineering design", Prentice Hall of India, New Delhi, 2000.
3. Ravindran, Phillips and Solberg, "Operations Research: Principles and Practice", John Wiley & Sons (Asia), Pvt. Ltd.
4. H. S. Kasana and K. D. Kumar, "Introductory Operations Research: Theory and Applications", Springer International Edition.
5. Belegundu, "Optimization Concepts and Applications in Engineering", Wiley Students Edition.
6. Deb, "Multi Objective Optimization Using Evolutionary Algorithms", Wiley Students Edition.
7. Fletcher, "Practical Methods of Optimization", Wiley Students Edition.

511112 Research Methodologies – Elective IV

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits - 3

1. **Introduction**
   Nature and objectives of research. Methods of Research: historical, descriptive and experimental, research process, research approaches, criteria for good research.

2. **Research Design**
   Meaning of research design, need of research design, features of good design, different research designs, and basic principles of experimental designs, design of experiments.

3. **Data collection**
   Types of data, methods and techniques of data collection, primary and secondary data, meta analysis, historical methods, content analysis, devices used in data collection, pilot study and pretest of tools, choice of data collection methods.

4. **Processing and analysis of data**
   Use of statistics for data analysis, measures of central tendency, dispersion, skewness and relationship. Sampling distributions, sampling theory, determination of sample size, chi-square test, analysis of variance, multiple regression analysis,

5. **Decision making techniques**
   Application of various decision making techniques such as Analytical Hierarchy Process (AHP), TOPSIS, neural networks, graph theory, simulated annealing, genetic algorithms, data envelope analysis (DEA).

6. **Interpretation and report writing:**
   Techniques of interpretation, precautions in interpretation, significance of report writing, different steps in report writing, layout of research report, mechanics of writing research report.

References

1. C.R Kothari, Research Methodology, Wishwa Prakashan
2. P.G Triphati, Research Methodology, Sultan Chand & Sons, N.Delhi
3. Fisher, Design of Experiments, Hafner
4. Stoufferetal, Measurement and Prediction, Wiley, N.York
5. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
6. Donald Cooper, Business Research Methods, Tata McGraw Hill, N.Delhi
7. Bhanwar Lal Garg, Renu Kavdia, Sulochana Agrawal and Umesh Kumar Agrawal, An Introduction to Research Methodology. RBSA Publications,
8. Rao S. S., "Optimization", Wiley Eastern, New Delhi, 1995.
9. Montgomery D.C., "Design and analysis of experiments", Wiley publications.

511112 Intellectual Property Rights & Product Design – Elective IV

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits – 3

1**. Introduction**
Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.

2. **International Scenario**
International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

3. **Patent Rights**
Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

4. **New Developments in IPR**
Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Softwares etc. Traditional knowledge Case Studies, IPR and IITs.

5. **Product Design**
Importance of product design in industry. Principal requirements of good product design. Factors and considerations affecting product design. Ergonomic factor in product design. Product design methodology and techniques. Basic elements and concepts of visual design.

6. **Product Design Standards**
Standards related to Materials, forms, functions, color, graphics, product development and testing. Packaging materials their characteristics and applications. Packaging design considerations

References

1. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007
2. Mayall , “Industrial Design”, Mc Graw Hill
3. Niebel , “Product Design”, Mc Graw Hill
4. Asimov , “Introduction to Design”, Prentice Hall
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”.
6. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand.

511112 Energy Management – Elective IV

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Theory: 100 Marks
Duration: 3 hours
Credits - 3

1. **Introduction**
   Global and Indian energy market, Energy scenario in various sectors and Indian economy. Need and importance of energy conservation and management. Payback period. Return on Investment (ROI). Life Cycle Cost. Sankey Diagrams. Specific Energy consumption. Load Management.

2. **Energy Auditing**-
   Methodology, analysis and reporting. Portable and on-line instruments, costing of utilities like steam, compressed air, electricity and water.

3. **Steam and Condensate Systems**.
   Boilers (including packaged boilers), efficiency, testing, excess air and flue gas monitoring. Steam distribution. Steam traps. Condensate and flashsteam utilization. Thermal insulation. Economic Thickness of Insulation (ETI).

4. **Electrical systems**:
   Demand control, power factor improvement, benefits and ways of improvement. Load scheduling. Electric motors, losses, efficiency, energy- efficient motors, motor speed control, variable speed drive.Lighting: Illumination levels, fixtures, timers, energy-efficient illumination.

5. **Energy conservation**
   Energy conservation in compressed air systems, refrigeration and air-conditioning systems and water systems. Elementary coverage of energy conservation in pumps and fans. Opportunities in Process Industries for Energy conservation.

6. **Cogeneration**
   Concept, options (steam/gas turbine/DCT -based). Selection criteria. Application in various industries

References

1. P. H. Henderson: India-The Energy Sector, Oxford university Press.
2. D. A. Ray: Industrial Energy Conservation. Pergamon Press.
3. IGC Dryden, editor: The efficient use of Energy (Butterworths).
4. W. C. Turner, editor: Energy Management handbook (Wiley).
5. Patrick Steven R., Patric Dale R., Fordo Stephen: Energy Conservation Guide book, The Fairmont Press Inc.
6. Frank Keith, Yogi Goswami, “Energy Management and End Use Efficiency Handbook”, Taylor & Francis.

511113 Lab Practice II

Teaching Scheme	**Examination Scheme**
Practical: 6 hrs/week	Term Work: 50 Marks
	Credits – 3

Each student should write at least two assignments on each subject studied in Semester II based on laboratory work.

511114 Seminar II

Teaching Scheme
Practical: 4 hrs/week

Examination Scheme
Term Work: 50 Marks
Credits – 2

Each student is required to review the literature related to proposed dissertation work to be done. He/she is required to deliver the seminar and submit it in the form of short report.

611101 Seminar III

Teaching Scheme
Practical: 4 hrs/week

Examination Scheme
Term Work: 50 Marks
Credits – 2

Each student is required deliver a seminar based on proposed dissertation work to be done and submit it in the form of short report. The report should include analytical treatment and mathematical formulation of the problem identified for the dissertation work.

611102 Project Stage I

Teaching Scheme
Practical: 18 hrs/week

Examination Scheme
Term Work: 50 Marks
Credits – 2

Student has to submit a report based upon the following:

- Objective of the Project
- Progress Achieved
- Difficulties encountered
- Experimental set up preparation
- Future plan of action

611103 Project Stage II

Teaching Scheme
Practical: 18 hrs/week

Examination Scheme
Term Work: 50 Marks
Credits – 2

Student has to submit a report based upon the following:
1. Objectives of work
2. Review of literature
3. Devepoment of methodology
4. Experimental and numerical analysis.
5. Results obtained.
6. Comparison of results with previous work done
7. Conclusions.