COURSES SCHEME

&

SYLLABUS

FOR

M.E.

PRODUCTION ENGINEERING

2015

COURSES SCHEME & SYLLABUS FOR M.E. (PRODUCTION ENGINEERING)

SEMESTER – I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPI313	METAL FORMING	3	1	0	3.5
2	PCD105	COMPUTER AIDED MANUFACTURING	3	0	2	4.0
3	PCD106	GEOMETRIC MODELING AND ANALYSIS	2	4	0	4.0
4	PCD108	MACHINE TOOL DESIGN	3	1	0	3.5
5	PCL105	STATISTICAL METHODS AND ALGORITHMS	3	0	2	4.0
		TOTAL	14	6	4	19.0

SEMESTER – II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPI201	ADVANCED MANUFACTURING PROCESSES	3	1	2	4.5
2	PCD325	RAPID PROTOTYPING	3	1	0	3.5
3	PPI204	OPERATIONS MANAGEMENT	3	1	0	3.5
4	PPI103	QUALITY ENGINEERING	3	1	0	3.5
5		ELECTIVE-I	3	1	0	3.5
6	PPI291	SEMINAR	-	-	-	2.0
		TOTAL	15	5	2	20.5

SEMESTER – III

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPI312	METAL CASTING AND JOINING	3	0	2	4.0
2		ELECTIVE-II	3	1	0	3.5
3	PPI392	MINOR PROJECT	-	-	-	4.0
4		DISSERTATION STARTS	-	-	-	-
		TOTAL	6	1	2	11.5

SEMESTER – IV

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPI491	DISSERTATION	-	-	-	12.0
		TOTAL	-	-	-	12.0

LIST OF ELECTIVES-I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PCD206	COMPUTER INTEGRATED MANUFACTURING SYSTEMS	3	1	0	3.5
2	PCD316	APPLIED OPTIMIZATION IN ENGINEERING DESIGN	3	1	0	3.5
3	PPI323	PRODUCT DESIGN AND DEVELOPMENT	3	1	0	3.5

LIST OF ELECTIVES-II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPI315	WORKSTUDY AND METHOD ENGINEERING	3	1	0	3.5
2	PCD204	INDUSTRIAL AUTOMATION	3	1	0	3.5
3	PCD103	MECHATRONICS	3	1	0	3.5
4	PPI325	ADVANCED MATERIALS TECHNOLOGY	3	1	0	3.5

TOTAL NUMBER OF CREDITS: 63.0

PPI313: METAL FORMING
L T P Cr
3 1 0 3.5

Course Objectives: To impart knowledge about principles and criteria of yielding during forming of metals, analysis of different bulk metal forming processes following different analysis approach. To understand the process mechanics with role of different controlling process parameters.

Elementary Theory of Plasticity: Stress / strain / strain-rate characteristics, Von-Mises and Tresca Yield Criteria, Levy Mises and Prandtl – Reuss stress-strain relationship, Experimental investigation, Plastic potential theory and plastic work, Kinematically admissible velocity field, Upper bound solution, Slab method, Slip line field theory.

Drawing: Analysis of 2D frictionless drawing, Analysis of wire and sheet drawing process by Slab method, Upper bound and Slip line field theory.

Rolling: Analysis of cold rolling by Slab method, Rolling pressure, torque and power requirements.

Forging: Determination of forces in disc forging considering sticking and slipping, Forging defects.

Extrusion: Analysis of direct cold extrusion process through conical dies by Slab method, Upper bound and Slip line field.

Research Assignment:
Assignment containing the full analysis with appropriate boundary conditions (and coding to solve equations, if needed) for bulk or sheet metal forming processes to obtain the variations of force, torque, power etc. with process parameters. Students may refer recent journal publications to borrow the idea for the problem and analysis approach. Student should submit individual report with derivations of equations and results of parametric analysis.

Course Learning Outcomes (CLO):
The students will be able to:
1. Decide yielding of a material according to different yield theory for a given state of stress,
2. Develop the kinematically admissible velocity field for different forming processes.
3. Analyze the different bulk metal forming process mechanics using different analysis approach and calculate the force, power requirements etc.
4. Evaluate the effect of process parameters on the process mechanics during bulk metal forming.

Recommended Books:

1. *Rowe, G.W., Principles of Industrial Metal Working Process, CBS Publishers (2004).*
2. *Avitzur, B., Metal Forming Analysis, McGraw Hill (1998).*
3. *ASTME, High Velocity Forming of Metals, Prentice Hall (1995).*
4. *Ghosh, A. and Malik, S., Manufacturing Science, Affiliated East-West Press (2001).*
5. *Johnson, W. and Mellore, P.B., Plasticity for Mechanical Engineers, Van Nostrand (1995).*

6. *Narayan, S.R., Metal Forming Technology, Ahuja Book Publishers (2001).*
7 *Haffmann, O., Introduction to the Theory of Plasticity-Metal Forming Applications, McGraw Hill (1995).*

Evaluation Scheme:

S. No.	Evaluation	Weightage (%)
1	MST	30
2	EST	45
3	Sessional (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

PCD105: COMPUTER AIDED MANUFACTURING

	L	T	P	Cr
	3	0	2	4.0

Course Objective: To Introduce the students to the standard terminologies, conventions, processes, operations, design and operational characteristics of key hardware components, programming techniques, applications, merits and demerits of Computer Numerical Controlled (CNC) machines.

Introduction: Need of Nc Technology, Fundamental Concepts In Numeric Control: structure and functions of NC System, advantages of NC technology over conventional manufacturing.

NC Machine Tools: Types, Definition and designation of control axes,Special constructional and design characteristics of NC machine tools, Standard tooling used for NC turning and milling centres.

NC Part Programming: Work holding and tool setting procedure for NC turning and milling centres, Tool zero presetting, Block formats and introduction to ISO based G & M codes for NC part programming, Concepts of tool length and radius compensation, Standard canned cycles used in CNC turning and milling centres, Introduction to automatic NC part program generation from CAD models using standard CAD/CAM software for machining of surfaces, moulds and dies etc.

Computer Numerical Control of Machine Tools: Types and functions of computer numeric control (CNC), Types and functions of direct numeric control (DNC), Need of adaptive control types, functions and types of adaptive control, its uses & benefits, Advantages of combined CNC/DNC systems.

System Devices: Drives, Feedback devices, Interpolator systems, Control loop circuit elements in point to point (PTP) and contouring system, Interpolation schemes for linear and circular interpolations.

Laboratory Work:
Exercises in tool presetting and workpiece referencing on CNC machine tools, manual part programming for CNC turning and milling centres, Use of software for simulation of turned and milled parts and simple surfaces, Automatic Cutter location data generation from CAD Models in APT format and post-processing for machining on CNC machines using standard CAD/CAM software.

Minor Project:
Each student will submit a research assignment in terms of a short report and a small presentation on topic related to either design/selection criteria for critical CNC machine elements, CNC interpolation algorithms, need and design of special control features in CNC controller, or design of CNC toolpath algorithms in consultation with the course instructor. The evaluation of the assignment will be on the basis of understanding of student about the state of the art in the area of CAM particularly related to areas like CNC machining processes, CNC control systems or the advancement in the design of CNC machine tools, literature survey, and design methodology required (if any), report and a presentation about the findings from the study undertaken.

Course Learning Outcomes (COL):
1. The students will be able to:
2. Apply the concepts of machining for the purpose of selection of appropriate machining centers, machining parameters, select appropriate cutting tools for CNC milling and turning equipment, set-up, program, and operate CNC milling and turning equipment.
3. Create and validate NC part program data using manual data input (MDI) and automatically using standard commercial CAM package for manufacturing of required component using CNC milling or turning applications.
4. Produce an industrial component by interpreting 3D part model/ part drawings using Computer Aided Manufacturing technology through programming, setup, and ensuring safe operation of Computer Numerical Control (CNC) machine tools.
5. Create and demonstrate the technical documentation for design/ selection of suitable drive technologies, precision components and an overall CNC machine tool system for automation of machining operations using appropriate multi-axis CNC technology.

Recommended Books:

1. *Koren, Y., Computer Control of Manufacturing systems, McGraw Hill (2009).*
2. *Suh Suk-Hwan, Kang Seong-Kyoon, Chung Dae-Hyuk, Stroud Ian., Theory and Design of CNC Systems(2008).*
3. *Smith Peter, CNC programming handbook (2003) Industrial Press Inc.*
4. *Groover, M. P. and Zimmers, E. W., CAD/CAM:Computer Aided Design & Manufacturing, 2006, Pearson Education India*
5. *Hood-Daniel P., and Kelly J.F., Build Your Own CNC Machine (2009) Springer-Verlag New York*
6. *Manuals of CAD/CAM Software Package on CAM Module and CNC Machines.*

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (Including assignments/ Minor Projects / Quizes etc.)	25

PCD106: GEOMETRIC MODELING AND ANALYSIS

	L	T	P	Cr
	2	4	0	4.0

Course Objective: Exposure to CAD tools for use in mechanical engineering design conceptualization, geometric modelling, communication, analysis and optimization, further use in CAD, CAM, CAE. Impart knowledge related to principles, methods and techniques of 3D modelling in parametric CAD software. Undertake project works in use of CAD geometric modeling software for design analysis, evaluation and optimization of mass properties, static-stresses, thermal deformations, etc. using professional software. To provide an experiential learning environment, while applying CAD, CAE tools to design of simple parts, assemblies, mechanisms and structures.

CAD Overview: Introduction to use of computer in Product Life Cycle, Software for mechanical engineering CAD/CAM/CAE.

Geometric Modeling: Parametric sketching, Constrained model dimensioning, Material addition and removal for extruded, Revolved, Swept and blended features, References and construction features of points, Axis, Curves, Planes, Surfaces and customized analysis features, feature and sequence of feature editing. Cosmetic features, Chamfers, Rounds, Standard holes, File formats for data transfer. Feature patterns, Duplication, Grouping, Suppression, Assembly modeling, Assembly analysis tools. Top-down vs. bottom-up design, Parametric relations and design optimization parameters creation, Mass property analysis, Automatic production drawing creation and detailing, Software automation and customization tools, Colors, Advanced features for non parallel blend, Helical sweep, Swept blend, Variable section sweep, Draft, Ribs, Sketched holes, Mechanism design and assembly.

Mechanical Design Analysis and Optimization: Design analysis for mass properties, Stress, Thermal stress, using CAD/CAE packages, Optimum design of machine components using multivariable non linear optimization techniques using iterative CAD/CAE software tools.

Research Assignments: Individual research assignments will be based on use of standard CAD and CAE packages for modeling of mechanical elements, Assembly and Automated Drawing. Project involving assembly, position, kinematic and dynamic analysis of a mechanism. Interference analysis in motion. Optimization of mechanical system design using CAD/CAE software tools, Project on mechanical systems design and analysis. Make a prototype for design validation.

Course Learning Outcome (COL):
The students will be able to:
1. Use parametric 3D CAD software tools in the correct manner for making geometric part models, assemblies and automated drawings of mechanical components and assemblies.
2. Use CAD software tools for assembly of mechanism from schematic or component drawing and conduct position/ path/ kinematic / dynamic analysis of a mechanism in motion.
3. Evaluate design, analyze and optimize using commercial CAD, CAE software as black box for required mass properties/ stress, deflection / temperature distribution etc. Under realistic loading and constraining conditions.

4. Redesign in CAD and evaluate a mechanical product by making components in the mechanical workshop for design validation, using measured relevant materials properties.

Recommended Books:
1. *Manuals & Tutorials on CAD/CAE packages like Pro/Engineer, Pro/Mechanica, ANSYS, etc latest available in the lab.*
2. *Kelley David S., Pro/ENGINEER Wildfire 5.0 Instructor, Tata McGraw Hill (2011).*
3. *Shih Randy H., Introduction to Finite Element Analysis Using Creo Simulate 1.0, SDC Publications, USA (2011, ISBN: 978-1-58503-670-7, ISBN (Book + Software on Disk): 978-1-58503-731-5*
4. *Toogood Roger Ph.D., P. Eng., Zecher Jack P.E., Creo Parametric 1.0 Tutorial and MultiMedia DVD, SDC Publications, USA (2012), ISBN: 978-1-58503-692-9, ISBN (Book + Software on Disk): 978-1-58503-730-8*
5. *Shih Randy H., Parametric Modeling with Creo Parametric 1.0-An Introduction to Creo Parametric 1.0,SDC Publications, USA (2011) ISBN: 978-1-58503-661-5, ISBN (Book + Software on Disk): 978-1-58503-729-2*
6. *Sidheswar, N., Kannaiah, P. and Sastry, V. V. S., Machine Drawing, McGraw Hill (2001).*
7. *Shigley, J. E., Mechanical Engg. Design, McGraw Hill (2008).*
8. *Spotts, M. F. and Shoup, T. E., Design of Machine Elements, Dolly Kindersley (2006).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST (Formal Test on Software)	25
2.	EST (Formal Test on Software)	35
3.	Sessionals Research Projects (Presentation of CAD CAE, Prototype, Technical Report)	40

PCD108: MACHINE TOOL DESIGN

L	T	P	Cr
3	1	0	3.5

Course Objective: To impart the fundamental notions of the machine tools including the different types, construction, applications and their technological capabilities. To provide exposure to the systematic methods for solving the problems of designing machine tools and their components by exploring the various design aspects of machine tools elements like transmissions, structures, materials, kinematics, dynamics and construction of machine tools, etc.

Introduction: Classification of Machine Tools and their technological capabilities, General requirement of machine tool design.

Machine Tool Drives: Introduction to kinematics of machine tools, Mechanical, hydraulic and electrical drives, Stepped and step less regulations of speed and feed; Layout of spindles drive and feed drive in machine tools; Structural diagram, Ray diagram; Design of speed box and feed box.

Design Of Machine Tool Structures: Function & Requirement of Machine Tool Structure, Design Criteria from Strength & Stiffness considerations. Role of Static & Dynamic Stiffness in the design, Factors affecting stiffness of machine tool structures & methods of improving it, Basic Design procedure of machine tool structures, Design of bed, head stock, etc. Dynamics of machine tools.

Design of Guideways: Function and Types, Design of hydrostatic, hydrodynamic and antifriction guideways.

Design of Spindles and Spindle Supports: Function & Requirements of Spindle Units, their Materials, Design of Spindle, Requirements of Spindle Supports, Selection of sliding and antifriction bearings.

Research Assignment:
Students in a group of 3/4 will submit a research assignment based on the design and analysis of a machine tool/ machine tool component. Assessment of the assignment will be done based on the literature review, design, analysis and optimization of the selected machine tool / component along with the presentation and submission of the technical report.

Course Learning Outcomes (COL):
The students will be able to:
1. Analyze constructions and kinematic schemata of different types of machine tools.
2. Construct ray diagrams and speed spectrum diagrams for speed and feed box.
3. Develop the conceptual design, manufacturing framework and systematic analysis of design problems on the machine tools.
4. Apply the design procedures on different types of machine tool and/or machine tool components.

Recommended Books:

1. *Mehta, N. M., Machine Tool Design & Numerical Control, McGraw Hill (2012).*
2. *Sen, G.C. and Bhattacharya, A., Machine Tools, Central Book Agency (1989).*
3. *Rao P.N., Manufacturing Technology: Metal cutting and Machine Tools, McGraw Hill (2013).*
4. *Basu, S. K. and Pal, D.K., Design of Machine Tools, Allied Publishers (2008).*
5. *Acherkhan, N.S., Machine Tool Design, University Press of the Pacific, (2000).*
6. *Boothroyd G and Knight Wiston A., Fundamentals of Machining And Machine Tools, CRC Press (2005).*
7. *Sharma, P. C., A Text Book Of Machine Tools & Tool Design, S. Chand Limited,(2005)*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (Assignments /Tutorials/Quizes)	25

PCL105: STATISTICAL METHODS AND ALGORITHMS

	L	T	P	Cr
	3	0	2	4.0

Introduction: Nature and objectives of research, Study and formulation of research problem. Scope and formulation of hypothesis. Preparation and presentation of research proposal using statistical package.

Review of Probability: Appraisal of axiomatic approach of probability, Conditional probability, Baye's rule, Conditional distributions, and conditional expectations.

Markov chains: Basics of markov chains, Finite state space, Markov chains, Transition and stationary markov chains. Continuous time markov process: continuous time branching processes, Kolmogorov, Forward and backward equations, Pure birth, Pure death, Birth and death process.

Analysis of variance: One Way Classification: ANOVA for fixed effect model, ANOVA for Random Effect Model, Two-way Classification (one observation per cell): ANOVA for fixed effect model, ANOVA for Random Effect Model.

Design of Experiments: Completely Randomised Design, Randomised Block Design, Latin Square Design, their statistical analysis and variance of estimates, Analysis of Covariance.

Multivariate Data Analysis: Introduction, multivariate normal distributions, Mean vector, Variance-covariance matrix, Correlation matrix and their estimation for multivariate data., Step wise regression, Selection of best set of variables, Classification and discrimination problems. Factor analysis and principal component analysis. Illustrative examples and Multivariate data analysis using statistical package.

Time Series and forecasting: Components of time series, Analysis of time series, Measurement of trend, Measurement of seasonal variations, Measurement of cyclic variations, Auto-Regression Analysis, Auto-correlation, Random component in time series.

Text Books:
   1. *Medhi, J., Stochastic Processes, New Age International (2005).*
   2. *Montgomery, Introduction to Statistical Quality Control, John Wiley and Sons (2005).*
Reference Books:
   3. *Populis, A., Random Variables and Stochastic Processes, Tata McGraw Hill (2002).*
   4. *Bhuyan, K. C., Multivariate Analysis and Its Applications, New Central Book Agency (2002).*

Laboratory Assignments:
   1. Analysis of variance and covariance of data.
   2. Evaluation of statistical parameters of Multivariate data.
   3. Analysis of time series.
   4. Measurement of trend.
   5. Measurement of seasonal variations.
   6. Measurement of cyclic variations.
   7. Auto-Regression Analysis.
   8. Auto-correlation analysis.
   9. Random component estimation in time series.

PPI201: ADVANCED MANUFACTURING PROCESSES

	L	T	P	Cr
	3	1	2	4.5

Course Objectives: To inculcate specialized knowledge and skill in advanced 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.

Mechanical Processes: Development and classification,Considerations in process selection,Tool design, Mechanism of material removal in: Ultrasonic machining, Abrasive jet machining, Abrasive flow machining, Magnetic abrasive finishing, Parametric analysis: Effect of process parameters on material removal rate, surface finish, Process capabilities, Engineering applications, Development of Hybrid processes.

Thermal Metal Removal Processes: Historical backgroundand classification,Characteristics of process , Mechanism of material removal in: Electric discharge, Wire electric discharge, laser beam, Plasma arc, Electron beam advanced machining processes,Parametric analysis, advantages and limitations, applications

ElectrochemicalMachining and other Processes: Introduction, Mechanics, Tool design, Electrochemistry of ECM process, Kinematics and Dynamics, Effect of heat and H_2 bubble generation,Calculation of material removal rate, Parametric analysis,advantages and limitations, applications, Microwave processing,Explosive forming: Principle, Process parameters, Equipment, Mechanics and applications.

Laboratory Work:

Experimental determination of Material removal rate, Tool wear rate, Ovality of the machined surfaces for the Ultrasonic, Electric discharge,Laser beam machining processes, Determination of impact strength of shot blasted surfaces, Use of dynamometer, Surface finish measurement tests.

Micro Project/ Research assigment:

Students will be divided in groups comprising of 4–5 students. Each group will be assigned with a separate research topic related to parametric analysis and optimization of process parameters involved in various advanced manufacturing processes. Students will be required to go through the topics from sources like reference books, journals etc. in the relevant field. Each group will be required to submit a report (and presentation) containing review of literature, summary, gaps in the existing literature, key findings etc.

Course Learning Outcomes (CLO):
The students will be able to:
1. Model the 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. Solve the various problems for the given profiles to be imparted on the work specimens.
4. Select the best process out of the available various advanced manufacturing processes for the given job assignment.

5. understand requirements to achieve maximum material removal rate and best quality of machined surface while machining various industrial engineering materials.

Recommended Books:

1. *Pandey, P.C. and Shan H.S., Modern Machining Processes, Tata McGraw Hill (2004).*
2. *Mishra, P.K., Non Conventional Machining, Narosa Publications (2006).*
3. *Hofy, H.E., Advanced Manufacturing Process, B and H Publication (1998).*
4. *Jain, V.K., Advanced Machining processes, Allied Publishers Private Limited (2004).*
5. *Ghosh, A. and Mullik, A., Manufacturing Science, East –West private Limited (2010).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	40
3	Sessionals (Projects/Tutorials/Quizzes/Lab Evaluations)	35

PCD325: RAPID PROTOTYPING

	L	T	P	Cr
	3	1	0	3.5

Course Objective: To provide the students with an understanding of the basic fundamentals of rapid prototyping, its fabrication techniques, materials and various areas of defects and improvements in Rapid Prototyping.

Introduction: Classification of manufacturing processes, Different manufacturing systems, Introduction to Rapid Prototyping (RP), Need of RP in context of batch production, FMS and CIM and its application; Basic Principles of RP, Steps in RP, Process chain in RP in integrated CAD-CAM environment, Advantages of RP.

Classifications of Different RP Techniques: Based on raw material, Based on layering technique (2D or 3D) and energy sources.

Process Technology in RP: Comparative study of stereo-lithography (SL) with photo-polymerization, Solid foil polymerization, Selective laser sintering, Selective laser melting, Ballastic particle manufacturing, Fused deposition modeling, Shape melting, Laminated object manufacturing, Solid ground curing, Repetitive masking and deposition, Beam inference solidification, Laser engineered net shaping (LENS), 3D Printing,

CAD Data and Programming Techniques for RP: Transformations, Solid modeling for RP, Surface modeling, STL file generation, Defects in STL files and repairing algorithms, Interface formats, Slicing methods, Design of support structures, Internal hatching and surface skin fills.

Materials for RP: Materials used for different RP processes, Selection criterions for materials for different processes, The advantages and limitations of different types of materials.

Reverse Engineering: Introduction to reverse engineering and its integration with rapid prototyping.

Research Assignment:
The students will be given different assignments to write their codes in MATLAB for constant slicing, adaptive slicing, transformations, parametric curves and surfaces involved in Rapid Prototyping.

Course Learning Outcomes (CLO):
The student will be able to:
1. Apply solid modeling concepts and techniques in RP.
2. Analyze and implement the different algorithms associated with STL file errors.
3. Calculate the layer thickness in different layering techniques and carry out design manipulations for the generation of support structure.
4. Identify, characterize and select the ideal materials for a given Rapid Prototyping system.

Recommended 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. *Patri, K. V., Weiyin, Ma, Rapid Prototyping - Laser-based and Other Technologies, Kluwer Academic Publishers, U.S.A., (2003).*
5. *Saxena, A., Sahay, B., Computer Aided Engineering Design, Anamaya Publishers, New Dehi, (2005).*
6. *Zeid, I., Mastering CAD/CAM, Tata McCraw Hill, (2006).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (Assignments/Quizes/Presentations)	25

PPI204: OPERATIONS MANAGEMENT

	L	T	P	Cr
	3	1	0	3.5

Course Objectives: The objective of this course is to develop understanding of the strategic role of operations management in creating and enhancing a firm's competitive advantages. This will help to apply key concepts and issues of OM in both manufacturing and service organizations. Further, apply analytical skills and problem-solving tools to the analysis of the operations problems like forecast demand, material requirement planning, inventory etc.

Production Systems: Production/ Operations Management: meaning and scope; significance of operations management in increasing productivity of firms; design of different production systems (project, job shop, batch.

Forecasting Analysis: Need, benefits and applications, cost and accuracy of forecasting, factors affecting demand, types of forecast based on methodology, types of forecast based on time horizon (causal methods, time series and qualitative methods); error analysis in quantitative forecasting.

Aggregate Planning: Need of aggregate production planning, inputs for aggregate plan, Reactive aggregate planning strategies, Aggressive aggregate planning strategies, pure and mixed aggregate planning strategies, level and chase strategies, Graphical method to choose aggregate plan.

Master Production Scheduling and MRP: Functions, planning horizon and planning periods for master production schedule, types of master production schedule; Independent Demand versus dependent demand, Functions of material requirements planning and manufacturing resource planning (MRP I and MRP II), inputs for MRP system, performance characteristics of MRP system (planning lead time, lot sizing rules, safety stocks), materials requirement planning explosion

Inventory Management and Control: Objectives and functions of materials management, inventory: need and types, inventory record systems, inventory costs and order quantities, economic order quantity, economic run length.

Minor Project:
Demand forecasting and error analysis of given product manufactured by identified manufacturer**.**

Course Learning Outcomes (CLO):
The student will be able to:
1. Understand the fundamental theory of operations and production management.
2. Solve various kinds of problems or issue faced by service and manufacturing industries like economic consideration, optimum utilization of resources, productivitysolve various kinds of problems or issue faced by service and manufacturing industries
3. solve various kinds of problems or issue faced by service and manufacturing industries for production planning, inventory management and control.
4. Get the solutions for materials requirement planning

Recommended 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).*
3. *Ebert, J and Adams, D.J., Production/Operations Management, Prentice Hall of India, New Delhi (2007).*
4. *Chase, R. B., Aquilano, N. J. and Jacob, F. R., Production and Operations Management: manufacturing and services, Tata McGraw Hill, New Delhi (1999).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (Assignments/Projects/Quizes/Seminar presentation)	25

PPI103 : QUALITY ENGINEERING

	L	T	P	Cr
	3	1	0	3.5

Course Objectives: To impart knowledge about the significance of quality and the various tools/ concepts of building quality into products. To learn the techniques used for quality control and quality improvement. To impart knowledge about plans for acceptance sampling and quality systems.

Introduction: Quality - meaning and significance, Essential components of quality, Phases or elements for building quality, Evolution of the concepts of quality, Spiral of progress of quality, Changing scope of quality activities, Ishikawa's seven quality tools, Quality Circles, Quality system economics, Hidden quality costs, Economic models of quality costs.

Taguchi's Quality Loss Function: System approach for quality management, Juran's quality trilogy, Quality planning activities, Sporadic and chronic quality problems, Causes of variation, General quality control methodology.

Statistical Quality Control: Control charts for variables: X bar-R, X bar-S, median, X-MR charts, Control charts for attributes: p, np, c charts, Product reliability, Process capability analysis.

Acceptance Sampling: Plans and tables for attributes and variables, Sampling methods, Type of plans, Operating characteristic curves, Quality improvement methodology, Just-in-time philosophy.

ISO 9000 Philosophy: Documentation, Implementation and certification process.

Course Learning Outcomes (CLO):
The student will be able to:
1. Apply the tools and techniques of quality to resolve industrial engineering issues.
2. Estimate the obvious and hidden quality costs for a given production system.
3. Apply a system based approach for quality management
4. Prepare and analyze various charts/ methods for quality control and improvement.
5. Use plans for sampling and concepts of quality system management.
6.

Recommended Books:

1. *Juran, J.M. and Gryna, F.M, Quality Planning & Analysis, McGraw Hill (2001).*
2. *Grant, E.L., Statistical Quality Control, McGraw Hill (2008).*
3. *Feignbaum, A.V., Total Quality Control, McGraw Hill (1991).*
4. *Juran, J.M., Juran's Quality Control Handbook, McGraw Hill (1988).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include Research Assignments//Tutorials/Quizes)	25

PPI312: 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 behaviour 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: Interfacial Heat Transfer, Thermodynamics & metallurgical aspects in solidification of pure metals and alloys, Homogeneous and heterogeneous nucleation,

Riser Design: Risering curves, NRL, Caine method, Feeding distance, 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.

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, Electorate, Ultrasonic welding.

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

Laboratory work: Joints preparation, development of welding by SMAW, GMAW, GTAW, Spot and Seam. Demonstration of SAW and flash butt welding, oxy-acetylene gas cutting.

Minor Project:
Development of aluminum alloy casting through sand casting process and investigation of metallurgical and mechanical properties of cast component. The students will develop the defined pattern casting of a given alloy/material. Further, the cut section of cast component will characterize for metallurgical and mechanical property investigation like porosity, cracks, phases, microstructure and microhardness.**Joining and characterization of aluminum alloy through MIG process.**The students will develop joining of aluminum alloy through MIG process and will optimize the process parameters. Further, Students will characterize for metallurgical and mechanical property investigation like porosity, cracks, phases, microstructure and microhardness.

Course Learning Outcomes (CLO):
The student 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
4. understand requirements to achieve sound welded joint while welding different similar and dissimilar engineering materials.

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

Evaluation Scheme:

S. No.	Evaluation Elements	Weightage (%)
1.	MST	25
2.	EST	40
3.	Sessionals (Assignments/Projects/Quizes/Lab Evaluations)	35

PCD206: COMPUTER INTEGRATED MANUFACTURING SYSTEMS

	L	T	P	Cr
	3	1	0	3.5

Course Objective: To impart knowledge about the integration of interdisciplinary fields of computer aided design, computer aided manufacturing, automatic identification system, automatic storage & retrieval system as a whole. To design and analysis various automatic material handling systems and to make the students aware about various techniques of data collection and its availability to automated subsystems.

Introduction: Introduction to Product life cycle management. Need of CAD/CAM integration through computers, Benefits of integration, Types of production systems and their automation, CAD/CAM integration. Concept of FMS and CIMS. DNC based factory management and control, Integrated CAD/CAM system and shared database.

Elements of a General CIM System: Types of CIM systems, CAD-CAM link for CIMS, Benefits of CAM, FMS and CIMS, Automated material handling systems, equipment and their functions. Integration of Robots in CIMS, automated guided vehicle navigation system, Automatic Storage and Retrieval Systems (AS/RS), Carousel storage system, design of automatic material handling system, KWO analysis, work-part transfer mechanisms.

Group Technology: Concept and terminology, Part family formation, Classification and coding systems for components, Group technology machine cells.

Computer Aided Production Planning and Control: Computer aided shop floor control, Computer aided inspection & quality control, Shop floor data collection systems, Sensors used in Automation, Tool management system, Automatic identification systems, Barcode system.

CIM Database and Database Management Systems: Types, Management information system, Manufacturing data preparation.

Research Assignments:
Need analysis and concept design for specifications of systems to be used for automatic transfer lines, automatic storage and retrieval system, data collection system, automated guided vehicles, inspection system, identification system etc.

Course Learning Outcomes (COL) :
The students will be able to:
1. Solve the design problems of different type of transfer mechanism.
2. Perform design and analysis of automatic storage and retrieval system.
3. Evaluate the space requirements of different storage system.
4. Design theworkstation requirement for unattended operations and automated production system.
5. Optimize the number of machines required for machine cell in a given production system.

Recommended Books:

1.   *Groover, M. P. and Zimmers, E. W., CAD/ CAM, Dorling Kingsley (2008).*
2.   *Groover, M. P., Automation, Production systems and Computer Integrated Manufacturing, Pearson Education Asia (2009).*
3.   *Vajpayee, K.S., Principles of Computer Integrated Manufacturing, Prentice Hall (2006).*
4.   *Rao, P. N., Tewari, N. K. and Kundra, T. K., Computer Integrated Manufacturing, McGraw Hill (1998).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (Assignments / Projects / Tutorials / Quizes)	25

PCD316: APPLIED OPTIMIZATION IN ENGINEERING DESIGN

	L	T	P	Cr
	3	1	0	3.5

Course Objective: The main objective of this course is to provide the detailed classification of optimization techniques available in order to address wide range of optimization problems. The course will also highlight different solution strategies and performance criterion for applied optimization problems. Through this course, the students will learn how to formulate an engineering optimization problem. The course will also introduce the basics of evolutionary optimization techniques as compared to classical optimization techniques.

Optimization Studies: Problem formulation, Solution Strategies, Performance Criteria, Classification of Optimization techniques.

One-dimensional Optimization Methods: Optimality Criteria – necessary and sufficient conditions, Bracketing methods, Region-elimination methods, Point estimation method, Gradient based methods, Sensitivity analysis.

Multi-dimensional Optimization Methods: Optimality Criteria, Unidirectional search, Direct search methods, Gradient-based methods. Conjugate-direction methods, Quasi-Newton methods.

Constrained Optimization Methods: Constrained Optimization Criteria, Penalty Methods, Method of Multipliers, Direct search methods, Linearization methods, Feasible Direction method, Generalized Reduced Gradient Method.

Linear programming Methods: Formulation of problems, Analytical and Graphical solutions, Simplex Method, Integer Programming, Interior Point Methods.

Specialized Optimization Techniques: Introduction to Multi-Objective optimization; Global Optimization: Criteria, Introduction to Genetic Algorithms.

Research Assignment: Each team of 3-4 students will submit a realistic case study of an applied optimization problem. The research assignment will constitute collection of literature, formulation of the optimization problem, selection of the appropriate algorithms, and obtaining the optimal solution. Each team has to validate the obtained results with published literature and also using commercially available optimization softwares like MATLAB. Finally, each team has to submit a detailed report along with a presentation.

Course Learning Outcomes (CLO):
The students will be able to:
1. Solve one-dimensional and multi-dimensional engineering optimization problems.
2. Formulate as well as analyze unconstraint and constraint optimization problems.
3. Analyze the progress of any engineering process in terms of achieving local optimum and global optimum.
4. Identify the most critical parameter in any engineering design problem by performing sensitivity analysis.
5. Solve special design problems with discrete solutions using integer programming.

Recommended Books:
1. *Deb, K., Optimization for Engineering Design Algorithms and Examples, Prentice Hall of India Pvt. Ltd., (2005).*
2. *Deb, K., Multi-objective Optimization using Evolutionary Algorithms, John Wiley and Sons, (2009).*
3. *Rao, S.S., Engineering Optimization Theory and Practice, John Wiley and Sons, (2009).*
4. *Belegundu, A.D., Chandrupatla, T.R., Optimization Concepts and Applications in Engineering, Cambridge University Press, (2011).*
5. *Dasgupta, B., Applied Mathematical Methods, Pearson Education India, (2006).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (Assignments/Projects/Tutorials/Quizes)	25

PPI323: PRODUCT DESIGN AND DEVELOPMENT

	L	T	P	Cr
	3	1	0	3.5

Course Objectives: To introduce the objectives of product design and the requirements of a good product design. To expose the students to different design principles like designing for function, production, installation and handling, maintenance, packaging etc. To expose them to the latest CAD/CAM/CAE software for different design and development functions.

The Process of Product Design: Design by evolution, Limitations of evolutionary method in modern design situation, Structure of design process, Morphology of design, Specifications and Standards of performance, Environmental factors, Creativity techniques in design problem.

Strategies for Search of Design Concepts: Physical realizability, Economic and financial feasibility, Designing for function, Designing for production, Tolerance analysis, Use, Maintenance, Designing for handling and installing, Economics of design, Human factors in design, Optimization of design, Reverse engineering of ergonomic shape designs,Visual design

Use of CAD / CAM /CAE: Software for concurrent engineering design. Case studies in design of products for manufacture, Aesthetics, Surface styling and shaping tools in modern CAD software, Exercises in design, Reverse engineering and surface design and review software.

Research Assignments:
Students will be divided in groups comprising of 4–5 students. Each group will be assigned with a separate research topic/ case study in the field of product design and development. Students will be required to go through the topics from sources like reference books, journals etc. in the relevant field. Each group will be required to submit a report (and presentation) containing review of literature, summary, major findings and gaps in the existing literature. The topics may include design morphologies for product design, models for physical realizability of design concept, case studies of products comparing products developed through tradition design approach vs those developed through the modern systemic approach.

Course Learning Outcomes (CLO):
The student will be able to:
1. Apply the principles of product design to modify existing engineering systems or to develop new artifacts.
2. Design a system taking into consideration the concepts of ease of production, maintenance, handling, installation etc.
3. Translate the concepts of economics in design, optimization of design and human factors approach to product design.

Recommended Books:

1. *Gupta, V. and Murthy, P.N., Introduction to Engineering Design Method, McGraw Hill (1980).*
2. *Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, Prentice Hall of India (2004).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include Research Assignments/Tutorials/Quizes/Lab Evaluations)	25

PPI315: WORK STUDY AND METHOD ENGINEERING

	L	T	P	Cr
	3	1	0	3.5

Course Objectives: To inculcate specialized knowledge and skill in production process optimization using the principles and methods of engineering analysis and design. To cultivate the ability to build and implement new improved methods resulting in creation and distribution of value in operations. To cultivate work space design capability. To develop the skill in systems integration by fostering the ability to work with inter-disciplinary groups in professional, industry and research organizations.

Introduction to Productivity: Definition of productivity, Productivity and production, Importance and role of productivity, Factors affecting productivity, Industrial productivity
.
Productivity Evaluation, Measurement Approaches: Need for productivity measurement, Productivity measurement approaches, Total and partial productivity, Productivity measurement models and their comparisons, Work study and productivity.

Productivity Improvement, Implementation Factorsand Techniques: Internal and External, Productivity analysis – productivity appraisal, Approaches to productivity analysis, **Strategy** and structure of productivity improvement, Organizational approaches to productivity improvement, Productivity improvement and implementation techniques.

Introduction to Work Study: Definition, Scope, Inter-relation between method study and work measurement, Human aspects, 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.

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, MTN & Work Factor system, Standard data usage, Engineered time standard, Predetermined motion time system (PMTS), Job evaluation & merit rating.

Laboratory Work (if any):

Minor Project (if any):
Method Study and Time study of an assembly and a dis-assembly operation.

Course Learning Outcomes (CLO):
The student will be able to:
1. Address issues related to productivity assessment and improvement.
2. Analyse the operations and using systematic approach to improving shop floor operations.

3. Use tools for analysis and design of operations.
4. Determine time standards and conditions of work.
5. Redesign layout of a shop floor.
6. Pre-empt assessment and design of methods of operations.

Recommended Books:

1. *Barnes, R. M., Motion and Time Study: Design and Measurement of work, Wiley, (1980).*

2. *Kanawaty, G., Introduction to Work Study, ILO, Geneva (1992).*

3. *Niebel , Methods Standards Work Design, McGraw-Hill Education, (2000),.*

4. *Meyers, F. E., Stewart, J. R., Motion and Time Study for Lean Manufacturing, Prentice Hall, (2002),*

5. *Freivalds, A., Niebel, B.,Niebel's Methods, Standards, and Work Design, McGraw-Hill Higher Education, (2013).*

6. *Mundel, M. E., Motion and Time Study: Principles and Practice, New York: Prentice-Hall, (1950).*

7 *Groover, M. P., Work Systems: The Methods, Measurement and Management of Work, Pearson Prentice Hall, (2007).*

8 *Christopher. W. F., Productivity measurement handbook: how to measure productivity performance for plant operations, administration and services, profit centers and total company, Productivity, Inc., (1985).*

9 *Sumanth, D. J., Productivity engineering and management: productivity measurement, evaluation, planning, and improvement in manufacturing and service organizations, International student edition, McGraw-Hill, (1984).*

10 *Maynard, H. B., Zandin, K., Maynard's Industrial Engineering Handbook, McGraw-Hill Education, (2001).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	25

PCD204: INDUSTRIAL AUTOMATION

<div align="right">

L   T   P   Cr

3   1   0   3.5

</div>

Course Objective: To impart adequate knowledge on automation as well as to provide hands-on knowledge to truly appreciate contemporary automation technologies, their integration and application related concepts.

Introduction to Factory Automation and Integration: Basic Concepts, Types of automation, Automation strategies, Automation Technologies.

Introduction to Hydraulics/Pneumatics/Electro-pneumatic Controls And Devices: Basic elements hydraulics/pneumatics, Electro-pneumatic systems, Fluid power control elements and standard graphical symbols for them, Hydraulic & pneumatic cylinders - construction, design and mounting, Hydraulic & pneumatic valves for pressure, Flow & direction control, Solenoid valves, Different sensors and actuators interfaces in automation with their application criteria for electro-pneumatic system, hydraulic, pneumatic & electro-pneumataic circuits.

Design of Pneumatic and Electro-Pneumatic Logic Circuits: Design of logic circuits for a given time displacement diagram or sequence of operation. Pneumatic safety and their applications to clamping, Traversing and releasing operations, Automatic transfer systems: Automatic transfer, Feeding and orientation devices.

Industrial Control Systems: Industrial control systemswith PLC programming using ladder logic, Human-Machine-Interface design, SCADA, Motion controller, Servo and stepper motors, RFID Technologies & Integration and Machine Vision.

Research Assignment: Students in a group of 4/5 will carry out assignment on design and fabrication of an automatic modular system which can be useful in contemporary automation industries. The methodologies will be followed as first use of virtual simulation fluid SIM software for design and analysis and then fabrication with pneumatic controls, electro-pneumatic controls, PLC and motion controls.

Course Learning Outcomes (CLO):
The students will be able to:
1. Design and simulate a system or process to meet desired needs within realistic constraints and the same can be applied to automate the different processes incontemporary manufacturing systems.
2. Design pneumatic and electro-pneumatic logic circuits.
3. Use the different automation approaches and skills to solve the complex industrial problems necessary forcontemporary engineering practice.

Recommended Books:
1. *Groover, M. P., Automation, Production System & Computer Integrated Manufacturing, Pearson Education Asia (2009).*
2. *Nakra, B. C., Automatic Control, New Age International (2005).*
3. *Morriss, S. B., Automataed Manufacturing Systems, McGraw Hill (2006).*
4. *Majumdar, S. R., Pneumatic Systems, McGraw Hill (2005).*

5. *Esposito, A., Fluid Power with Applications, Prentice Hal of India, New Delhi (2005).*
6. *Auslander, D. M. and Kempf, C. J., Mechatronics: Mechanical System Interfacing, Prentice Hall Inc., New Jersey (1996).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizes)	25

PCD103: MECHATRONICS

	L	T	P	Cr
	3	1	0	3.5

Course Objective: To impart interdisciplinary knowledge to study modern Electro-Mechanical Devices. The aim of this course to make a bridge between Mechanical, Electronics, Instrumentation, Computer and Controls field. To familiarize the students with all the important elements of a Mechatronic device. To understand the importance of each control action and how to choose a proper controller for an engineering problem.

Introduction: Integration of mechanical, electronics, control and computer science engineering, Elements of mechatronics system, Open-loop and closed-loop system.

Physical and Mathematical Modeling of Dynamic Systems: Equations of motion of mechanical, electrical, pneumatic and hydraulic systems, Transforming physical model to mathematical model, Linearization, Frequency response. Modeling of different motors and generators.

Control Systems: Laplace transformations, Block diagram reduction, Signal flow graph, Performance specifications, Transfer functions, Stability, Sensitivity of the open-loop and closed-loop systems, Types of controller, Controller design using frequency domain and Laplace domain methods.

Sensors: Displacement, Position and Proximity sensors, Flow sensors, Pressure and force sensors, Motion sensors, Optical, Mechanical and Thermal sensors.

Actuators in Mechatronics System: Electric actuators, Stepper motors, DC motors, and AC motors.

Electronic Elements in Mechatronic System: Analog to digital and digital to analog converters, Operational amplifiers, Introduction to Microcontrollers and Microprocessors.

Research Assignment:
Each team of 4-5 students will submit a case study of a mechatronics device. The research assignment will constitute collection of literature, CAD model of the device, development of the mathematical model and its controller design for different control tasks. Finally, each team has to submit a detailed report along with a presentation. The team can demonstrate the case study by developing a working model of the mechatronic device using the LEGO or Tetrix kits.

Course Learning Outcomes (CLO):
The students will be able to:
1. Construct the block diagram of any physical mechatronics device used in day-to-day life.
2. Calculate the output to input relation of any physical model in the form of a transfer function.
3. Evaluate the performance of any physical system in terms of its performance parameters.
4. Develop the mathematical model of any physical model from any engineering domain.
5. Interface the sensors and actuators of a mechatronic device to the computer/laptop.

6. Recognize the key features of different type of controllers and develop a suitable controller toobtainthedesiredperformancefromthesystem.

Recommended Books:

1. *Bolton, W., Mechatronics,PearsonEducation Asia (2004).*
2. *Anslander,D.M.andKampf,C.J.,Mechatronics:MechanicalSystemInterfacing,Prantice Hall(1995).*
3. *Kamm, L. J., Understanding Electro-Mechanical Engineering, An Introduction toMechatronics, PranticeHallofIndia (2000).*
4. *Alciatore, D. G. and Histand, M. B., Introduction to Mechatronics and Measurement System, McGraw Hill(1999).*
5. *Doebelin, E.O.,MeasurementSystems, Application &Design,McGraw Hill (2004).*
6. *Nagrath,I. J. and Gopal,M., ControlSystem Engineering, New AgeInternational(2008).*

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessionals (Assignments/Projects/Tutorials/Quizes)	25

PPI325: ADVANCED MATERIALS TECHNOLOGY

	L	T	P	Cr
	3	1	0	3.5

Course Objectives: To understand the various strengthening mechanisms and also failure mechanisms for alloy systems to achieve enhanced mechanical performance. To gain knowledge with regards to kinetics of phase transformations and their effect on mechanical properties of alloys. To gain knowledge about the characteristics, processing and applications of polymers and composite materials.

Strengthening Mechanisms for Alloys: Strengthening by grain refinement, effect of grain size on various mechanical properties, solid solution strengthening, strain hardening, precipitation hardening mechanisms for alloys, especially steels and aluminium.

Failure Mechanisms: Ductile and brittle fracture, principles of fracture mechanics, impact fracture testing, design for fatigue, stages of fatigue failure, factors affecting fatigue life, generalized creep behaviour.

Phase Transformations in Steels: Kinetics of Phase Transformations, mechanisms of phase transformations, isothermal transformation diagrams, continuous cooling transformation diagrams, influence of alloying elements on these diagrams, heat treatment and surface hardening of steels (plain carbon as well as special purpose steels). Effect of phase transformations on mechanical properties of steels. Hardenability determination in steels. Modeling and simulation tools for analysing phase transformations.

Characteristics, Applications, and Processing of Polymers: Mechanical behaviour of polymers, mechanisms of deformation and for strengthening of polymers, glass transition phenomena in polymers, stress–strain behaviour, fracture of polymers, degradation of polymers.

Characteristics, Applications, and Processing of Composites: Classification of composites, factors affecting properties of composites, polymer-matrix composites, metal-matrix composites, processing methods for composites.

Advanced High Strength Steels for Automotive Applications: Dual Phase (DP) steels, Transformation Induced Plasticity steels (TRIP), Complex Phase (CP) steels, Super Martensitic Stainless Steels (SMSS), Super alloys.

Research Assignments:
Students will be divided in groups comprising of 4–5 students. Each group will be assigned with a separate research topic in the field of materials technology. Students will be required to go through the topics from sources like reference books, journals etc. in the relevant field. Each group will be required to submit a report (and presentation) containing review of literature, summary, major findings and gaps in the existing literature. The topics may include strengthening mechanisms for a given alloy composition, cases of famous engineering disasters reflecting the failure mechanisms involved, kinetics and also mechanisms of phase transformations in steels etc.

Course Learning Outcomes (CLO):

The student will be able to:

1. Select a suitable strengthening mechanism for a given alloy composition and application.
2. Analyze the type of failure and reasons thereof for an alloy system under different loading conditions.
3. Select a suitable heat treatment/ case hardening for a given alloy application.
4. Identify the key characteristics, processing and applications of composites and AHSS.

Recommended Books:

1. Joachim, R. Harders, S and Baker, M., Mechanical behaviour of engineering materials: metals, ceramics, polymers, and composites, Springer (2007),
2. Parton, V.Z., Fracture mechanics: from theory to practice, CRC Press (1992).
3. Higgins, R. A., Engineering Metallurgy-Applied Physical Metallurgy, Elsevier (2004).
4. Colling, D and Thomas, V., Industrial materials: polymers, ceramics, and composites, Printice-Hall (1995).

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	45
3.	Sessional (may include Research Assignments/ Tutorials/Quizes)	25