CURRICULUM & SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

FOR

MASTER OF TECHNOLOGY (M.Tech.)

(2 Year Post Graduate Degree Programme)

In

PRODUCTION ENGINEERING

(As per National Education Policy, 2020)

[w. e. f. 2025-26]

FACULTY OF ENGINEERING AND TECHNOLOGY

SRM UNIVERSITY DELHI-NCR, SONEPAT

39, Rajiv Gandhi Education City, Sonepat

Haryana-131029

SRM UNIVERISTY DELHI-NCR, SONEPAT FACULTY OF ENGINEERING AND TECHNOLOGY

ENGINEERING GRADUATES EMPLOYABILITY ATTRIBUTES

Sound Knowledge & Skill of Basic Science &Engineering Sciences

An Engineer should be able to apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.

Problem formulation, Analysis & Solving

An Engineer should be able to identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using principles of mathematics, natural sciences, and engineering sciences.

Design and Development of a Solution

An Engineer must be able to design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Investigation

An Engineer should use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Modern Tools Usage

An Engineer should be able to create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

The Engineer and the Society

An Engineer should be able to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional Engineering practice.

Individual and Teamwork

An Engineer should be able to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Lifelong Learning

An Engineer must recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Environment and Sustainability

An Engineer must understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Professional Ethics

An Engineer should be able to apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice.

Effective Communication

An Engineer should be able to communicate effectively on complex Engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

SRM UNIVERISTY DELHI-NCR, SONEPAT

FACULTY OF ENGINEERING AND TECHNOLOGY

ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES (EPEOs)

1. Advancement to a professional position by virtue of their knowledge, skills and attitude.
2. Recognition for solving engineering problems and developing design solutions that consider safety and sustainability.
3. Work as successful professionals in diverse engineering disciplines and enterprises;
4. Increasing responsibilities of technical and managerial leadership in their work organizations;
5. Professional development through a commitment to career-long learning.

ENGINEERING PROGRAM EDUCATIONAL LEARNING OUTCOMES (EPELOs)

1. An ability to identify, formulate, and solve real time engineering & socio-economic problems by applying principles of engineering, science, mathematics, humanities and social sciences
2. An ability to use the advanced skill enhancement techniques and modern engineering tools as per industry 4.0 necessary for engineering practice.
3. An ability to apply engineering design to produce solutions that meet specified needs with realistic considerations of environmental, ethical, health & safety and sustainability
4. an ability to adapt and work with multidisciplinary teams and communicate effectively;
5. An ability to function effectively on a team whose members together provide leadership, to create a collaborative environment, to establish goals and to execute plan tasks.
6. an understanding of professional and ethical responsibility;
7. An ability to acquire and apply new knowledge using appropriate learning strategies with inner quest to learn, unlearn and relearn.

MASTER OF TECHNOLOGY (PRODUCTION ENGINEERING) DEGREE COURSE

PROGRAM COURSE'S STRUCTURE SEMESTER WISE

SEMESTER – I

COURSECODE	COURSE	CATEGORY	HOURS PER WEEK				CREDITS
			L	T	P	TOTAL HOURS	
	Theory						
23PE101	Theory of Metal Cutting	PC	3	0	0	3	3
23PE102	Advanced Metal Forming	PC	3	0	0	3	3
23PE103	Advanced Casting and Welding Technologies	PC	4	0	0	4	4
24PE104	Elements of Mechatronics	PC	3	0	0	3	3
23PE105	Research Methodology	PC	3	0	0	3	3
24OEXXX	Open Elective	OE	3	0	0	3	3
	Practical						
24PE151	CAM Lab	Lab	0	0	2	2	1
TOTAL			**19**	**0**	**2**	**21**	**20**

L : Lecture
T : Tutorials
P: Practical
PC-Professional Core (Major)
OP-Open Elective

MASTER OF TECHNOLOGY (MECHANICAL ENGINEERING) DEGREE COURSE

PROGRAM COURSE'S STRUCTURE SEMESTER WISE

SEMESTER – II

COURSECODE	COURSE	CATEGORY	HOURS PER WEEK				CREDITS
			L	T	P	TOTAL HOURS	
	Theory						
24PE201	Semiconductor Manufacturing Technology	PC	3	0	0	3	3
23PE202	Rapid Prototyping Technologies	PC	3	0	0	3	3
24PE203	Product Innovation and Startup Strategy	PC	3	0	0	3	3
24PE204	Robotics and Automation	PC	4	0	0	4	4
24PE20X	Professional Elective – I	PE	3	0	0	3	3
	Practical						
24PE251	Robotics and Automation Lab	Lab	0	0	2	2	1
24PE252	Seminar-I		2	0	0	2	2
TOTAL			**18**	**0**	**2**	**20**	**19**

L : Lecture
T : Tutorials
P: Practical
PC-Professional Core (Major)
PE-Professional Elective (Minor)

MASTER OF TECHNOLOGY (MECHANICAL ENGINEERING) DEGREE COURSE

PROGRAM COURSE'S STRUCTURE SEMESTER WISE

Course Code	Course	Category	Hours Per Week				Credits
			L	T	P	Total Hours	
Theory							
24PE20X	Professional Elective – II	PE	3	0	0	3	3
24PE20Y	Professional Elective – III	PE	3	0	0	3	3
Practical							
23PE351	Project Work Phase – I	LP	0	0	16	16	8
TOTAL			**6**	**0**	**16**	**22**	**14**

SEMESTER – III

L : Lecture
T : Tutorials
P: Practical
PE-Professional Elective
LP- Live Project

MASTER OF TECHNOLOGY (MECHANICAL ENGINEERING) DEGREE COURSE

PROGRAM COURSE'S STRUCTURE SEMESTER WISE

SEMESTER – IV

Course Code	Course	Category	Hours Per Week				Credits
			L	T	P	Total Hours	
Practical							
23PE451	Project Work Phase – II	LP	0	0	32	32	16
TOTAL			**0**	**0**	**32**	**32**	**16**

L : Lecture
T : Tutorials
P: Practical
LP-Live Project

Semester	I	II	III	IV	Total	%
Total Credits	**20**	**19**	**14**	**16**	**69**	**100**

List of Elective Subjects

Code	Course	L	T	P	C
Elective I					
23PE205	Tool Design	3	0	0	3
23PE206	Composite Materials	3	0	0	3
24PE207	Object Oriented Programming C++	3	0	0	3
Elective II					
24PE301	Industrial Engineering	3	0	0	3
24PE302	Precision Engineering	3	0	0	3
23PE303	Design for Manufacture & Assembly	3	0	0	3
Elective III					
23PE304	Production Planning & Control	3	0	0	3
24PE305	Advanced Manufacturing Processes	3	0	0	3
24PE306	Total Quality Management	3	0	0	3

Theory of Metal Cutting	
Course Code: 23PE101	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. Understand mechanism of chip formation in different machining condition.
2. Estimate the tool life for different tool materials.
3. Develop knowledge and importance of metal cutting parameters
4. Select the appropriate tool material and design for the given cutting conditions.
5. Understand the principles and applications of various modern machining and manufacturing processes.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Apply cutting mechanics to metal machining based on cutting force and power consumption.
2. Operate lathe, milling machines, drill press, grinding machines, etc.
3. Select cutting tool materials and tool geometries for different metals.
4. Select appropriate machining processes and conditions for different metals.
5. Learn machine tool structures and machining economics.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1 Mechanics of Metal Cutting

Mechanism of chip formation, Orthogonal & Oblique cutting, Types of chips, Built-up edge, Determination of shear plane angle, Forces on the chips, forces in orthogonal cutting, Merchant circle diagram and analysis, Theory of Lee & Shaffer, Co-efficient of friction, Power & Energy Relationship, Velocity Relationship, Shear-Strain, Factors affecting forces and power, Problems.

Unit-2 Geometry of Cutting Tools

Single point and Multi point cutting tools, Tools nomenclature, Tool point reference systems, Tool angle specifications –ISO and ASA systems, Conversion from one system to another. Recommended tool angles, Effect of cutting parameters on tool geometry.

Unit-3 Tool Materials and Their Properties

Characteristics of Tool Materials, Types of tool materials – Carbon tool steels, High speed steels, Cast alloys, Cemented carbides, Ceramics, Diamonds, SIALON, CBN, UCON, Recommended Cutting Speeds for the above Tools, Water, Oil hardening of Tools and their applications.
Measurement of Cutting Forces: Reasons for measuring cutting forces, Classification of cutting force dynamometers – Mechanical, Hydraulic, Strain gage type Dynamometers.

Unit-4 Tool Wear, Tool Life

Mechanisms of tool wear, Sudden & gradual wear, crater wear, Flank wear, Tool failure criteria, tool life equations, Effect of process parameters on tool life, Tool life tests, conventional & Accelerated tool wear measurement, Machinability index. Thermal Aspects in Metal Cutting:
Heat sources in metal cutting, Temperature in chip formation, Temperature Distribution, Experimental Determination of Tool Temperatures.

Unit-5 Cutting Fluids

Basic actions of cutting fluids, properties of cutting fluids, Selection of cutting fluids, application of cutting fluids, Filtration of fluids, recommended cutting fluids.
Economics of Machining: Introduction, Elements of total production cost, Optimum cutting speed and tool life for Minimum cost, Optimum cutting speed and Tool life for Maximum Production, Problems.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. M.C. Shaw, *Metal Cutting Principles*, Oxford Publication, 1985.
2. B.L.Juneja& G.S Sekhar,*Fundamentals of Metal Cutting & Machine Tools*, Wiley Eastern.
3.V.C.Venkatesh&S.Chandrasekhanan,Metal *Cutting*, Pantice Hall – 1991.
4. Dr. B.J.Ranganath, *Metal Cutting*, Vikas Publications

ADVANCED METAL FORMING	
Course Code: 23PE102	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. The basics of metal forming analysis
2. Forging and strip rolling processes
3. Extrusion and drawing of metals
4. Sheet metal forming

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Determine major process/processes of manufacturing used for given application.
2. Explain when and why metal forming is chosen compared to other compatible methods.
3. Analyze effect of parameters influencing metal forming and compare hot working and cold
4. working with applications.
5. Explain capabilities and applications of bulk metal forming processes and sheet metal work.
6. Outline tooling and equipments required for important metal forming processes.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Materials Behaviour

Structure of metals, Plastic deformation on work Hardening , strain Hardening, Recovery, Recrystallization and grain Growth Cold, Warm& Hot Working , True Stress and True Strain Rate of deformation , Super plasticity, Ductile & Brittle Fracture, Residual stresses , Ductility & Formability

Unit-2: Analysis Of Stresses and Strain

Principal stresses, Maximum shear stresses, Yield condition, Von Misses Hypothesis of yielding, Tresca's Hypothesis of Yielding Graphical Representations of Yield Criteria , Constriction of slip Lines

Unit-3: Forging and Strip Rolling Processes

Forging Machines, Upsetting and Swaging, Analysis of Plain strain compression, Sticking friction, Slipping and Sticking Friction, Analysis of compression of circular dies with slipping friction- with sticking friction , longitudinal rolling of strips and sheets Rolling load and power elastic deformation of rolls Rolls camber Rolling process and mills.

Unit-4: Extrusinon and Drawing of Metals

Cold and hot, impact and hydrostatic extrusion, die design and lubrication analysis of extrusion load, Empirical formulation for extrusion pressure, lubrication in wire drawing , drawing stresses , optimum die angle , analysis of tube drawing.

Unit-5: Sheet Metal Forming

Fine blanking , High energy rate forming processes – Explosive forming , Electro hydraulic forming , Magnetic pulse forming , Bending , spring back , deep drawing , Redrawing , strip development , component & progressive dies.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. Joneja, B.L, *Fundamental of Metal Forming Processes*, New Age International Publishers, New Delhi, 2018.
2. Surinder Kumar, *Technology of metal forming processes*, PHI Learning Pvt Ltd, Delhi, 2015.
3. Sharma P.C, *A textbook of Production Technology*, .S Chand and Co, New Delhi.
4. A S T M E., *Fundamentals of Tool design*, Prentice Hall of India.
5. Kalpakjian. *"Manufacturing Eng. and Technology*", Pearson.

Advanced Casting and Welding Technologies	
Course Code: 23PE103	Continuous Evaluation: Marks
Credits: 4	End Semester Examination: Marks
L T P : 4 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. Introduction to Casting and its gating system
2. Knowledge of Special casting methods
3. Study of Welding Processes
4. Detailed study Welding Metallurgy
5. Knowledge of Design of Weldments and Testing of Welded Joint.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Describing safety precautions when using trade-related hand and power tools and equipment
2. Selecting appropriate trade-related equipment for the job
3. Safely operating trade-related equipment to complete specified welding processes efficiently and correctly
4. Employing math concepts to measure thickness and layout materials to complete task

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Casting

Patterns, pattern allowances, mould and core making, melting practice and furnaces, cooling and solidification, Elements of gating system, design of gating system, Theoretical consideration, Directional solidification, Design of risers, Modulus Caine's and shape factor methods, application of chills.

Unit-2: Different moulding and casting processes

Permanent mould casting, shell moulding, die casting, vacuum die casting, squeeze casting, centrifugal casting, investment casting-die casting continuous casting-low pressure casting, Casting defects and their remedies, Fettling and testing of casting.

Unit-3: Welding Processes

Classification, structure and characteristics of welding arc, Arc blow, Methods of arc initiation and maintenance, arc stability, arc welding power sources, Duty cycle, Metal transfer, Selection of Welding process, Different welding processes: Shielded Metal Arc Welding (SMAW), Submerged Arc Welding (SAW), Gas Tungsten Arc Welding (GTAW/TIG), Gas Metal Arc Welding (GMAW), Welding Electron Beam Welding, Plasma arc Welding, Laser Beam Welding, Explosion Welding, Diffusion Welding, Ultrasonic Welding, Friction welding and Thermit welding.

Unit-4: Welding Metallurgy

Heat flow in welding, Metallurgical transformation in and around weldment, Implication of cooling rates, Heat affected zone (HAZ), Weldability of plain carbon steels, Stainless steels, Cast iron, Aluminium and its alloys.

Unit-5: Design of weldments

Joint design, Residual stresses and distortion, Testing of welded joints, Destructive Tests and Non-destructive tests (NDT)

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. P. L. Jain, *Principles of Foundry Technology, 5th edition*, TMH Publications, 2009.
2. Richard Heine, Carl Loper, Philip Rosenthal*, Principles of Metal Casting*, TMH Publications, 2004.
3. R. S. Parmar, *Welding Processes and Technology*, 3 rd Edition, Khanna Publishers, New Delhi, 2011.
4. A. Ghosh and A. K. Mallik, *Manufacturing Science*, East west press, New Delhi, 2006,
5. H.S.Bawa, *Manufacturing Technology-I*, TMH Publications, New Delhi, 2007.
6. SeropeKalpakjian and Steven R. Schmid, *Manufacturing Processes for Engineering Materials*,
7. Richard L. Little,*Welding and Welding Technology*, TMH Publications.

Elements of Mechatronics	
Course Code: 24PE104	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. Combination of mechanical, electrical, electronics and information engineering
2. The understanding ability of microelectronics to reduce the demand on mechanical systems
3. To have cognizance of performance of commonly used sensors and actuation system
4. Design of Mechatronics System

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit I

Introduction to Mechatronics systems and components, Principles of basic electronics – Digital logic, number system logic gates, Sequence logic flip flop system, JK flip flop, D-flip flop.

Unit II

Microprocessors and their applications – Microcomputer computer structure/microcontrolles, Integrated circuits – signal conditioning processes, various types of amplifiers, low pass and high pass filters.

Unit III

Sensors –sensors and transducers. Displacement, position proximity sensors , velocity, force sensors. Fluid presence temperature, liquid level and light sensors. Selection of sensors., Actuators, Pneumatic

and hydraulic systems, Mechanical actuation system, Electrical actuation system.Other Electrical/Electronic hardware in Mechatronic system

Unit IV

Principles of Electronic system communication, Interfacing, A.D. and D.A.convertors, Software and hardware principles and tools to build mechatronic systems., Basic system models mathematical models, mechanical and other system , Building blocks, System models – Engg. Systems, rotational, translation, elected mechanical, Hydraulic mechanical system., System Transfer functions, First-second order system in series.

Unit V

Design and selection of Mechatronics statements namely sensors line encoders and revolvers, stepper and servomotors Ball screws, solenoids, line actuators and controllers with application to CNC system, robots, consumer electronics products etc, Design of a Mechatronic Product using available software CAD packages MATLAB and SIMULINK

TEXT BOOKS

1. Bolton, W., *Mechatronics*, Addison Wesley, 2nd Edition, New Delhi, 1999.
2. Bradley, D.A., Dawson D., Dawson, D. BurdN.C.and Loader A.J.,*Mechatronics*, Chapman and Hall Publications, New York, 1993.
3. GalopVisoy, A., and Devries, W.R., *Microcomputer Applications in Manufacturing*, John Wiley, New York, 1989.
4. David G. Alciatore, Michael B. Histand,*Introduction to Mechatronics and Measurement Systems* ,McGraw Hill

REFERENCE BOOKS/NPTEL RESOURCES

1. James Harter, *Electromechanics, Principles and Concepts and Devices*, Prentice Hall, New Delhi.
2. David W. Pessen, *Industrial Automation Circuit Design and Components*, John Wiley, New York, 1990.
3. Rohner, P., *Automation with Programmable Logic Controllers*, Macmillan / McGraw Hill, New York, 1996.
4. Brian Morris, *Automatic Manufacturing Systems Actuators*, *Controls and Sensors*, McGraw Hill, New York, 1994.
5. Goankar, R. S., *Microprocessor Architecture Programming and Applications*, Wiley Eastern, New Delhi, 1997.
6. Godfrey C. Onwuvolu, *Mechatronics Principles and applications*, Butterworth-Heinemann, New Delhi, 2006.
7. F.H.Raven, *AutomaticControl Engineering*, McGrawHill International.

Research Methodology	
Course Code: 23PE105	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. To give an overview of the research methodology and explain the technique of defining a research problem
2. To explain the functions of the literature review in research.
3. To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
4. To explain various research designs and their characteristics.
5. To explain the details of sampling designs, and also different methods of data collections.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process

Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance

Unit-2

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.
Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.

Unit-3

Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.

Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

Unit-4

Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.
Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

Unit-5

Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman& Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari
4. Select references from the Internet

CAD/ CAM Lab	
Course Code: 24PE151	Continuous Evaluation: Marks
Credits: 2	End Semester Examination: Marks
L T P : 0 0 2	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. To impart the students with necessary computer aided modeling skills using standard CAD packages.
2. To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes
3. To writing part program for simple machine parts.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Modeling of simple machine parts and assemblies from the part drawings using standard CAD packages.
2. Generate CNC Turning and Milling codes for different operations using standard CAM packages.
3. Write manual part programming using ISO codes for turning and milling operations

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3
CO1	✓		
CO2		✓	
CO3			✓

COURSE CONTENTS

1. **Study Experiment about CAD and CAM**
2. Plain Turning And Facing Operation
3. Step Turning Operation
4. Pattern Repeated Cycle
5. Thread Cutting
6. Circular Inter Polation
7. NC Code Generation For Drilling Operation By Using Cadem Software
8. NC Code Generation For Side Milling Operation By Using Cadem Software
9. Nc Code Generation For Pocket Milling, Drilling And Tapping Operation By Using Cadem Software
10. NC Code Generation For Mirroring And Pocket Milling

Semiconductor Manufacturing Technology	
Course Code: 24PE201	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. To Introduce semiconductor thin film technology for fabrication of electronic and photonic devices and integrated circuits.
2. To make the students familiar with the Silicon wafer preparation those are used in semiconductor industries.
3. To explain the different micro and nano fabrication methods used in semiconductor manufacturing.
4. Different advanced technologies to be explained on testing and measurements of thin film.
5. To explain Principle, model, methods of deposition, doping and anti-doping, Substrate Engineering, MBE,

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Get the theoretical basis for processing of semiconductor devices and integrated circuits.
2. Able to do photolithography and simple processing of semiconductors in clean room, and to do characterization with selected techniques.
3. Able to present and discuss the theoretical basis for processing and characterization.
4. Able to process integrate the all complex activities of semiconductor manufacturing.
5. Able to know the advanced technologies on testing and measurements of thin film.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-I

Introduction: Historical Evolution, Present trend, importance, classification, IC manufacturing steps, Microchip, Fundamentals of micro and nano fabrication technologies.

Unit-II

Semiconductor Basics and Device: Semiconductor Materials, Transport and recombination theory, pn and Schottky barrier diodes, bipolar and junction field-effect transistors, and MOS capacitors, ICs and transistors. Semiconductor Manufacturing Environment: Contamination, its control, Clean rooms, design, Silicon Wafers, preparation, safety requirements, cleaning process, wet chemical etching techniques. Silicon growth: Silicon crystal structure, Defects, single crystal growth, EGS from MGs, theory, methods, preparation, required properties. Epitaxial growth: Principle, model, methods of deposition, doping and anti-doping, Substrate Engineering, MBE, Defects, Application

Unit-II

Oxidation: Kinetics of Silicon dioxide growth both for thick, thin and ultra-thin films, Oxidation technologies, Thermal Processes, RTP, Characterization of oxide films, Defects.
Thin Film Deposition: Synthesis and properties of various types of inorganic membranes and thin films, sol-gel process, synthesis of porous materials and thin films, Chemical and physical Vapor Deposition and Dielectric Thin Films, Metal Film Deposition: Evaporation and sputtering techniques, Failure mechanisms in metal interconnects, Atomic Layer Deposition (ALD), Deposition of Dielectrics and Semiconductor Layers.

Unit-IV

Diffusion: Laws, Diffusivities, systems, Impurity Incorporation, modeling. Lithography: hotolithography, steps, optical lithography, E-beam lithography and advanced newer lithography techniques and back-end processing, Mask generation, Vapor Prime to Soft Bake, Alignment and Exposure, Photoresist Development. Etching: classification, type, parameters, Ion beam milling, Doping, Chemical Mechanical Polishing Ion Implantation: Plasma Basics, Theory, Implanters, annealing, channeling, applications.

Unit-V

Introduction to MEMs: Types, characteristics, microprocessing, methods, packaging. Assembling and Packaging: materials, types, die attachment techniques, packaging fabrication techniques, sealing, encapsulation, assembly process, techniques, reliability problems in packaging. Process monitoring: Assessment of semiconductors by electrical Testing (resistivity, mobility, doping levels), by ion beam techniques (SIMS), and by microscopy and imaging (optical, SEM, TEM, STM, AFM), Micro-chip cooling technologies.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. Parasuraman Swaminathan, Semiconductor Materials, Devices and Fabrication, Wiley India , 2017
2. G. S. May and S. M. Sze, Fundamentals of Semiconductor Fabrication, Wiley India , 2004
3. Stephen A. Campbell, The Science and Engineering of Microelectronic Fabrication, Oxford University Press , 2012
4. S. Franssila, Introduction to Microfabrication, Wiley-Blackwell , 2010

Rapid Prototyping Technologies	
Course Code: 23PE202	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. The fundamental Theory behind RP process.
2. Study the Process parameters of different machine.
3. Study different types of Rapid tooling.
4. Based on the industrial standards, learn how Prepare manufacturing DATA.
5. The basics concept of different software used in RP system.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1

Introduction & History of Rapid Prototyping - Need for the compression in Product development Growth of RP Industry, Classification of RP, Stereo lithography(SLA) system & principle, Process parameter, process details of SLA, Data preparation, data files of SLA , Machine details & Application of SLA

Unit-2

Selective Laser Sintering (SLS)- Introduction, SLS Machine Type – Details, SLS principle of operation, Process parameters of SLS, Data preparation for SLS, Fused Deposition Modeling (FDM) – Introduction, FDM Principles, Process Parameters, Path generation & Application of FDM, Solid Ground curing (SGC) - Principle of operation, SGC machine details & application.

Unit-3

Laminate Object Manufacturing (LOM) - Principle of operation, LOM materials, LOM Process details & Application, Concepts modelers – Principle, Thermal Jet Printer, Sander model maker – Explanation, 3-D Printer, Genesis Printer & HP Systems, Object Qudra system.

Unit-4

Rapid tooling -Indirect rapid tooling, Silicon Robber tooling, Aluminium filling epoxy tooling, Spray metal tooling, Direct rapid tooling, Quick cast process, copper Polyamide, DMILS – explanation, Prometals, sand casting tooling, Soft tooling & hard tooling.

Unit-5

STL files, Solid View, Magics, Imics, Magic communicator, Internet based software, Rapid Manufacturing – Introduction, Factors influencing accuracy, Data preparation errors, Part building errors, Errors in finishing, Influence of build orientation

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. Paul F. Jacobs: "*Stereo lithography and other RP & M Technologies*", SME, NY 1996.
2. Flham D. T &Dinjoy S.S "*Rapid Manufacturing*" Verlog London 2001.
3. Lament wood, *Rapid automated*, Indus press New York
4. Terry Wohlers "*Wohler's Report 2000*" Wohler's Association 2000.
5. Gurumurthi, *Rapid prototyping materials*, IISc Bangalore.

Product Innovation and Startup Strategy	
Course Code: 24PE203	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. To introduce the students the fundamentals of sustainable product design, development and manufacturing.
2. Explain the core of product innovation and structures of the processes.
3. Understand the knowledge of the legal foundations of intellectual property market vision, the ability.
4. To analyze the possibilities of innovative development, barriers and risks to its Commercialization.
5. Assess the economic potential of innovation, the cost of implementing a research Project.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Knowledge enhancement for sustainable product design, development and manufacturing.
2. Enhancement of knowledge of the theoretical foundations, models and methods of innovative entrepreneurship, management, marketing, finance.
3. Able to organize the work of the creative team to achieve the defined goal
4. Able to develop a plan and program for the organization of innovative activities of scientific and production units for start-up.
5. Development of ability to form a strategy for commercialization of innovation.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1

Design Thinking and Affordable Innovation Introduction to engineering design process. Product development processes, organizations, planning, concepts, idea generations, selection, specifications, industrial design, architecture, prototyping, concept of frugal engineering for developing innovative affordable products, effective user-interface

Unit II

Product Innovation Introduction to the bottlenecks of new product innovation process, Introduction to innovation engineering, Industrial dynamics of technological innovation, sources, types, and patterns of innovation, disruptive innovation, Management and organizing of innovation, collaborative and open innovation, evaluation and selection of innovation projects, user- and customer focused innovation, managing ideas, knowledge and learning for innovation, Innovation performance measurement and management.

Unit III

Startup Plan an overview, motivation. Development, Preparing Business Concept Document, taking product to create value, Patent and copyrights importance and process.
Going to market Strategy Understanding and delivering Value, Product- Market Matrix, Delivery Strategy with a Difference. tartup Economics Economic consideration for starting a venture, Understanding Feasibility analysis
Market considerations for startups Understanding market, targeting customer and positioning product

Unit IV

Factors influencing success of a business, Business model innovation, Business process management, competitive advantages, Business model canvas. Funding options of your business Boot strapping, angel investors, incubation and acceleration, concept of break-even point.

Unit V

Digital Technology startup/Entrepreneurship Industry 4.0 landscape and innovations using digital technologies like AI, IOT, AR/VR, Cloud, SAAS, User Applications. The basic technology framework and development platforms. . Analytics- based opportunities startup in Data Analytics.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, TMH
2. Peter Drucker, Harper Collins, Innovation and Entrepreneurship, Harper Collins Publishers
3. Kevin Otto and Kristin Wood, Product Design, PHI
4. Thomas N. Duening, Robert D. Hisrich and Michael A. Lechter, Technology Entrepreneurship Taking Innovation to the Marketplace, Elsevier

Robotics and Automation	
Course Code: 24PE204	Continuous Evaluation: Marks
Credits: 4	End Semester Examination: Marks
L T P : 4 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. To impart basic knowledge and importance on Robotics in Engineering Fields among the students.
2. To create the awareness on Robotics in Research and Application area.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Knowledge will be gained on application and utility of Robotics used in various sectors and fields.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1

Robotics: Historical back ground, Definitions. Laws of Robotics, Robotics systematic robot anatomy Common Robot configurations, coordinate system, work envelop.

Unit-II

Elements of robotic system and effector, actuators, controller, teach pendant, sensors Specification of robots. Applications, Safety measures. Robot Kinematics: Forward and reverse Kinematics of 3 DOF Robot arms. Homogeneous transformations.

Unit-III

Kinematics equation using homogeneous transformations. Actuators: Hydraulic actuators. Pneumatic actuator, Electrical actuators, Directional control, Servo Control Flow control valves.

Unit-IV

End effectors: Classification, Drive systems. Magnetic, Mechanical, Vacuum and Adhesive Grippers, force analysis in Grippers. Sensors:

Unit-V

Need for sensing systems, Sensory devices, Types of sensors, Robot vision system Robot Languages and Programming, Description of AI techniques used for Robot control.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. Kevin M. Lynch, Frank C. Park, Modern Robotics, Cambridge University Press
2. J.J.Craig, Introduction to Robotics, Pearson
3. Y. Korem, Robotics for engineers, Mc Graw-Hill
4. M.P. Groover, M Weiss, R.N. Nagel, N. Odrey, A Dutta, Robotics Technology, Programming and Application, Tata McGraw-Hill

Professional Elective – I	
Course Code: 24PE20X	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. Tool materials and their properties
2. Design of single point cutting tools and twist drills
3. Design of various types of dies
4. Blank development for different components
5. Design of jigs and fixtures for simple components

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: TOOL DESIGN

Different tool materials: cemented carbides, coated carbides, cermets, ceramics and polycrystalline tool materials – compositions - properties of tool materials - Selection and treatments - Plastics as tooling materials - New tooling materials Design of single point turning and threa ding tools - Selection of tool holders and inserts for turning - Chip breakers - Design of twist drill and reamers.

Unit-2: PRESS TOOL DESIGN

Press working terminology - Presses and press accessories - Computation of capacities and tonnage requirements - Strip layout - Types of dies – Design and development of various types of cutting, forming, bending and drawing dies - Progressive dies, Combination dies and compound dies - Blank development for cylindrical and non cylindrical shells, Simple problems.

Unit-3: DESIGN OF JIGS

Principles of jigs and fixtures - Locating elements - Drill bushes - Different types of jigs - Plate, latch, channel, post, angle plate, turn over, and pot jigs - Automatic drill jigs, Design and development of jigs for given components.

Unit-4: DESIGN OF FIXTURES

Design principles of fixtures - Design of fixtures for milling, boring. Design of fixture for assembly, inspection and welding. Design and development of fixtures for given components

Unit-5: TERM PROJECT

Submission of an industrial report on observation training in Jigs, fixture and press tools. (A group comprising of 3 or 4 students should identify a component from an industry and should design jig and fixture or press tool as per the requirement).

TEXT BOOKS

1. Sadasivan, T. A., and Sarathy, D., *Cutting tools for Productive machining* , 1st edition, Widia (India) Ltd, Bangalore, 1999.
2. Donaldson, C., Lecain, G. H. and Goold, V. C., *Tool Design*, Tata McGraw Hill publishing company limited, New Delhi, 2002.
3. Edward G. Hoffman, *Jigs and Fixture design*, 2nd edition, Galgotia publication Pvt. Ltd., New Delhi, 1987.

REFERENCE

1. Hiram E. Grant, *Jigs and Fixtures - Non standard clamping device*, Tata McGraw Hill, New Delhi, 1971.
2. Prakash H. Joshi, *Press tool design and construction*, 1st edition, Wheeler Publishing, New Delhi, 2000.
3. Kempster, M. H. A., An *Introduction to Jig and tool design*, 3rd edition, ELBS, 1987.
4. Prakash H. Joshi, *Cutting tools*, 1st edition, Wheeler Publishing, New Delhi, 1997.
5. Prakash H. Joshi, *Tooling Data*, 1st edition, Wheeler Publishing, New Delhi, 2000.
6. ASTME, *Fundamentals of Tool design*, 11th Edition, Prentice Hall of India, New Delhi, 1987.

Robotics and Automation Lab	
Course Code: 24PE251	Continuous Evaluation: Marks
Credits: 2	End Semester Examination: Marks
L T P : 0 0 2	
Prerequisite:	

COURSE OBJECTIVES (COs)

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

Seminar-I	
Course Code: 24PE252	Continuous Evaluation: Marks
Credits: 2	End Semester Examination: Marks
L T P : 2 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

Professional Elective – II	
Course Code: 24PE20X	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Unit Name

Unit-2: Unit Name

Unit-3: Unit Name

Unit-4: Unit Name

Unit-5: Unit Name

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

Professional Elective – III	
Course Code: 24PE20Y	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Unit Name

Unit-2: Unit Name

Unit-3: Unit Name

Unit-4: Unit Name

Unit-5: Unit Name

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

Project Work Phase – I	
Course Code: 23PE351	Continuous Evaluation: Marks
Credits: 16	End Semester Examination: Marks
L T P : 0 0 16	
Prerequisite:	

- M.Tech students, M.Tech Thesis / Project will be done in **IIIrd** & **IVth** semester either in Department / Institute or outside (Department / Institute with the prior permission of the department).
- The project will be carried out under the supervision/ guidance of the faculty member designated as Supervisor/ Guide as assigned by the Department.
- The topic should be decided at the end of **IInd**semester. The student(s) will submit a synopsis at the beginning of **IIIrd**semester and make a progress presentation at the end of **IIIrd**semester.

Project Work Phase – II	
Course Code: 23PE451	Continuous Evaluation: Marks
Credits: 32	End Semester Examination: Marks
L T P : 0 0 32	
Prerequisite:	

- M.Tech students, M.Tech Thesis / Project will be done in **IIIrd** & **IVth** semester either in Department / Institute or outside (Department / Institute with the prior permission of the department).
- The project will be carried out under the supervision/ guidance of the faculty member designated as Supervisor/ Guide as assigned by the Department.
- The topic should be decided at the end of **IInd**semester. The student(s) will submit a synopsis at the beginning of **IIIrd**semester and make a progress presentation at the end of **IIIrd**semester.
- The final internal and external evaluation for the thesis will be done at the end of **IVth** semester. For external evaluation an external examiner from outside the institution is required.

ELECTIVES

Tool Design	
Course Code: 23PE205	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. Tool materials and their properties
2. Design of single point cutting tools and twist drills
3. Design of various types of dies
4. Blank development for different components
5. Design of jigs and fixtures for simple components

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Unit Name

TOOL DESIGN

Different tool materials: cemented carbides, coated carbides, cermets, ceramics and polycrystalline tool materials – compositions - properties of tool materials - Selection and treatments - Plastics as tooling materials - New tooling materials Design of single point turning and threa
ding tools - Selection of tool holders and inserts for turning - Chip breakers - Design of twist drill and reamers.

Unit-2: Unit Name

PRESS TOOL DESIGN

Press working terminology - Presses and press accessories - Computation of capacities and tonnage requirements - Strip layout - Types of dies – Design and development of various types of cutting, forming, bending and drawing dies - Progressive dies, Combination dies and compound dies - Blank development for cylindrical and non cylindrical shells, Simple problems.

Unit-3: Unit Name

DESIGN OF JIGS

Principles of jigs and fixtures - Locating elements - Drill bushes - Different types of jigs - Plate, latch, channel, post, angle plate, turn over, and pot jigs - Automatic drill jigs, Design and development of jigs for given components.

Unit-4: Unit Name

DESIGN OF FIXTURES

Design principles of fixtures - Design of fixtures for milling, boring. Design of fixture for assembly, inspection and welding. Design and development of fixtures for given components.

Unit-5: Unit Name

TERM PROJECT

Submission of an industrial report on observation training in Jigs, fixture and press tools. (A group comprising of 3 or 4 students should identify a component from an industry and should design jig and fixture or press tool as per the requirement).

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. Sadasivan, T. A., and Sarathy, D., *Cutting tools for Productive machining* , 1st edition, Widia (India) Ltd, Bangalore, 1999.
2. Donaldson, C., Lecain, G. H. and Goold, V. C., *Tool Design*, Tata McGraw Hill publishing company limited, New Delhi, 2002.
3. Edward G. Hoffman, *Jigs and Fixture design*, 2nd edition, Galgotia publication Pvt. Ltd., New Delhi, 1987.
4. Hiram E. Grant, Jigs and Fixtures - Non standard clamping device, Tata McGraw Hill, New Delhi, 1971.
5. Prakash H. Joshi, Press tool design and construction, 1st edition, Wheeler Publishing, New Delhi, 2000.
6. Kempster, M. H. A., An Introduction to Jig and tool design, 3rd edition, ELBS, 1987.
7. Prakash H. Joshi, Cutting tools, 1st edition, Wheeler Publishing, New Delhi, 1997.
8. Prakash H. Joshi, Tooling Data, 1st edition, Wheeler Publishing, New Delhi, 2000.
9. ASTME, Fundamentals of Tool design, 11th Edition, Prentice Hall of India, New Delhi, 1987.

Composite Materials	
Course Code: 23PE206	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. Basic of Composites
2. Polymer Matrix Composite
3. Metal Matrix Composites
4. Ceramic Matrix Composites
5. Advanced Composites

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: INTRODUCTION TO COMPOSITES

Fundamentals of composites - need for composites – Enhancement of properties - classification of composites –Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC). Ceramic matrix composites (CMC) – Reinforcement – Particle reinforced composites, Fibre reinforced composites. Applications of various types of composites.

Unit-2: POLYMER MATRIX COMPOSITES

Polymer matrix resins – Thermosetting resins, thermoplastic resins – Reinforcement fibres – Rovings – Woven fabrics – Non woven random mats – various types of fibres. PMC processes - Hand lay up processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics (GRP).

Unit-3: Unit Name

METAL MATRIX COMPOSITES

Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC, Limitations of MMC, Metal Matrix, Reinforcements – particles – fibres. Effect of reinforcement - Volume fraction – Rule of mixtures. Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting.

Unit-4: Unit Name

CERAMIC MATRIX COMPOSITES

Engineering ceramic materials – properties – advantages – limitations – Monolithic ceramics - Need for CMC – Ceramic matrix - Various types of Ceramic Matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing).

Unit-5: Unit Name

ADVANCES IN COMPOSITES

Carbon / carbon composites – Advantages of carbon matrix – limitations of carbon matrix Carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol gel technique. Composites for aerospace applications.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. Mathews F.L. and Rawlings R.D., *Composite materials: Engineering and Science*, Chapman and Hall, London, England, 1st edition, 1994.
2. Chawla K.K., *Composite materials*, Springer – Verlag, 1987

3. Clyne T.W. and Withers P.J., *Introduction to Metal Matrix Composites*, Cambridge University Press, 1993.
4. Strong A.B., *Fundamentals of Composite Manufacturing*, SME, 1989.
5. Sharma S.C., *Composite materials*, Narosa Publications, 2000.

Object Oriented Programming C++	
Course Code: 24PE207	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. The working of OOPS programming approach.
2. The knowledge of object oriented programming style.
3. The basic concepts involved in computer programming.
4. Important programming aspects i.e object, class, inheritance and polymorphism.
5. Knowledge with respect to the software development phase of OOPS.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Unit Name

INTRODUCTION

Introduction, comparison between procedural programming paradigm and object-oriented programming paradigm, basic concepts of object-oriented programming- abstraction, encapsulation, data hiding.

Unit-2: Unit Name

OBJECT & CLASS

concepts of an object and a class, interface and implementation of a class, operations on objects, relationship among objects, specifying a class, creating class objects, accessing class members, access specifiers, static members, use of const keyword, friends of a class, empty classes, nested classes, local classes, abstract classes, Need for constructors and destructors, destructors.

Unit-3: Unit Name

INHERITANCE
Introduction, Base Classes and Derived Classes, Protected Members, type of inheritance, Using Member Functions, Overriding Base -Class Members in a Derived Class, Using Constructors and Destructors in derived Classes, Concept of binding - early binding and late binding, virtual functions, pure virtual functions, abstract classes.

Unit-4: Unit Name

POLYMORPHISM
Polymorphism: Overloading, Overriding, Abstract Classes, Operator Overloading: Introduction, Fundamentals of Operator Overloading, Restrictions on Operators Overloading, Operator Functions as Class Members vs. as Friend Functions.

Unit-5: Unit Name

EXCEPTION HANDLING AND I/O
Basics of C++ Exception Handling: Try Throw, Catch, Throwing an Exception;- Catching an Exception, Re-throwing an Exception, Processing Unexpected Exceptions,
Files and I/O Streams and various operation on files.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. Object Oriented Programming in Turbo C++ by Robert Lafore , 1994, The WAITE Group Press.
2. Programming with C++ By D Ravichandran, 2003, T.M.H
3. Object oriented Programming with C++ by E Balagurusamy, 2001, Tata McGraw-Hill
4. C++ How to Program by H M Deitel and P J Deitel, 1998, Prentice Hall
5. Computing Concepts with C++ Essentials by Horstmann, 2003, John Wiley,
6. The Complete Reference in C++ By Herbert Schildt, 2002, TMH.
7. C++ Programming Fundamentals by Chuck Easttom, Firewall Media

Industrial Engineering	
Course Code: 24PE301	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Unit Name

Unit-2: Unit Name

Unit-3: Unit Name

Unit-4: Unit Name

Unit-5: Unit Name

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

Precision Engineering	
Course Code: 24PE302	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. The basics of precision engineering
2. The various techniques of precision engineering like Nano technology etc,
3. The accuracy, influence of static stiffness, vibration accuracy etc.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Unit Name

ACCURACY

General concept of accuracy – Spindle rotation accuracy – Test methods-Displacement accuracy – Dimensional wear of cutting tools - Accuracy of NC systems - Clamping errors - Setting errors - Errors due to Location - Location of rectangular prism, cylinder.

Unit-2: Unit Name

ACCEPTANCE TESTS FOR MACHINE TOOLS

Basic type of tests – Measuring instruments used for testing machine tools - Alignment tests-Straightness, Flatness, Parallelism, Squareness, Circularity, Cylindricity.

Unit-3: Unit Name

INFLUENCE OF STATIC STIFFNESS, THERMAL EFFECTS

Static stiffness – Nature of deformation in a machine tool – Overall stiffness of a lathe – Compliance of work piece-Errors due to the variation of the cutting force and total compliance – Inaccuracies due to thermal effects
– Methods of decreasing thermal effects-Influence of vibration on accuracy.

Unit-4: Unit Name

NANOTECHNOLOGY

Introduction - Top down and bottom up approach - Development of Nanotechnology - Precision and micro-machining - Micro EDM. Diamond turning of parts to nanometer accuracy - Stereo microlithography. Carbon nanotubes - Production methods, applications. Nano-manufacturing.

Unit-5: Unit Name

NANOMEASURING SYSTEMS

In - Process measurement of position of processing point - Post process and on line measurement of dimensional features - Mechanical measuring systems - Optical measuring systems - Electron beam measuring systems - SEM and TEM - pattern recognition and inspection systems.

Applications of Nanotechnology: Nano–Lithography–Photolithography - Electorn beam lithography–Ion -Beam lithography - Nanocoatings - AFM applic.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. Murthy R. L., *Precision Engineering in Manufacturing*, New Age International, New Delhi, 1996.
2. Norio Taniguchi, *Nanotechnology*, Oxford university press, Cambridge, 1996.
3. Lee Tong Hong, *Precision Motion control, Design and Implementation*, Springer Verlag, U.K., 2001.
4. Liangchi Zhang, *Precision Machining of Advanced Materials*, Trans Tech Publications Ltd., Switzerland, 2001.
5. HiromuNakazawa, *Principles of precision engineering*, Oxford university press,1994.

Design for Manufacture & Assembly	
Course Code: 23PE303	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

COURSE LEARNING OUTCOMES (CLOs)

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CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Unit Name

Unit-2: Unit Name

Unit-3: Unit Name

Unit-4: Unit Name

Unit-5: Unit Name

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

Production Planning & Control	
Course Code: 23PE304	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Unit Name

Unit-2: Unit Name

Unit-3: Unit Name

Unit-4: Unit Name

Unit-5: Unit Name

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

Advanced Manufacturing Processes	
Course Code: 24PE305	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Unit Name

Unit-2: Unit Name

Unit-3: Unit Name

Unit-4: Unit Name

Unit-5: Unit Name

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

Total Quality Management	
Course Code: 24PE306	Continuous Evaluation: Marks
Credits: 3	End Semester Examination: Marks
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (COs)

1. Meaning of TQM and Theories about TQM
2. Planning and manufacturing for quality its tools and techniques
3. Human involvement to improve quality and the development and transformation due to such involvement.
4. About failure models, component reliability & system reliability
5. About mean down time, maintainability of systems & condition monitoring.

COURSE LEARNING OUTCOMES (CLOs)

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MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: BASIC CONCEPTS

Evolution of total quality Management - Definition of quality - Comparison between traditional approach and TQM, Deming – Crosby – Juran - Taguchi, Ishikawa theories - Quality costs - Product quality Vs Service quality Strategic planning - Goal setting - Steps involved in strategic planning - TQM implementation.

Unit-2: TQM PRINCIPLES & BASIC TOOL

Customer Satisfaction – Types of customers, customer supplier chain, Customer perception of quality customer feed back - Customer complaints - Customer retention - Service quality.

Employee involvement – Employee motivation - Maslow's hierarchy of needs - Herzberg theory - Empowerment and team work.

Basic Tools: Introduction to seven basic tools–Check sheets, histograms - Control charts, Pareto diagram - Cause and effect diagram – Stratification - Scatter diagrams.

Unit-3: NEW SEVEN MANAGEMENT TOOLS & ADVANCED TOOLS

Affinity diagram - Relations diagram - Tree diagram - Matrix diagram - Matrix data analysis diagram - Process decision program chart - Arrow diagram.

Advanced QC tools: Advanced QC tools like QFD - Root cause analysis - Taguchi method - Mistake proofing(poka-yoke) - Failure mode and effects analysis (FMEAs), failure mode and effects criticality analysis (FMECAs) and Fault tree analysis (FTAs) etc. - Quality Management Systems, 7 QC Tools.

Unit-4: RELIABILITY

Definition - Probabilistic nature of failures - Mean failure rate - Meantime between failures - Hazard rate - Hazard models, Weibull model - System reliability improvement – Redundancy – Series - Parallel and Mixed configurations.

Unit-5: MAINTAINABILITY

Introduction - Choice of maintenance strategy - Mean time- to repair (MTTR) - Factors contributing to Mean Down Time (MDT) - Fault diagnosis, and routine testing for unrevealed faults - Factors contributing to Mean Maintenance Time - (MMT) on condition maintenance - Periodic condition monitoring - Continuous condition monitoring - Economics of maintenance.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

1. Joel E. Rose, *Total Quality Management*, 2nd Edition, Kogan Page Ltd., USA 1993.
2. Srinath, L. S., *Reliability Engineering*, Affiliated East West Press, New Delhi 1995.
3. Balagurusamy, E., *Reliability Engineering* Tata McGraw Hill publishing Co., New Delhi, 1984.
4. Greg Bound, et.al, *Beyond Total Quality Management towards the emerging paradigm,* McGraw Hill Inc., 1994
5. Zeiri, *Total Quality Management for Engineers,* Wood Head Publishers, 1991.