VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI)
MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)

Curriculum
(Scheme of Instruction & Evaluation and Course contents)

For
Two Year Postgraduate Programme Leading to
Master of Technology (M.Tech.) Degree in
Production Engineering with specialization in Production Engineering

Implemented from the batch admitted in Academic Year 2014-15

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

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For
Two Year Postgraduate Programme Leading to
Master of Technology (M.Tech.)
In

Production Engineering (212)

VISION (Department)

To become a nationally acclaimed Department for imparting the state of the art knowledge in the field of manufacturing technology, industrial engineering and management to the students, thus making them preferred choice for employment and enabling them to pursue higher studies besides providing consultancy and services to the other stake holders.

MISSION (Department)

1. Undertake research and consultancy as means to upgrade the knowledge and impart cutting edge knowledge and skills through technologically advanced teaching –learning methods.
2. Create an intellectually stimulating environment for research, scholarship, creativity, innovation and professional activity
3. Develop live and synergistic link with industry, academic institutions and professional bodies, alumni for collaborative working, conducting research and sharing of expertise and other resources.
4. Upgrade curricula to meet requirements of stakeholders including industries and impart relevant knowledge to students using appropriate and technologically advanced methods of teaching.
5. Develop engineers having proficient communication, professional attitude, and social responsibility to take up leadership positions mainly in engineering firms.

To serve the community and profession by providing outstanding leadership and contributions in learning, knowledge, innovation and entrepreneurship.

PROGRAM EDUCATION OBJECTIVES

- Develop competent manpower to join a technically sophisticated workforce as successful, practicing engineers in a wide range of production engineering fields
- Continuously improve and expand their technical and professional skills through formal means as well as through informal self-studies
- Pursue advanced degrees in engineering (PhD), business, or other professional fields.
- Advance themselves professionally and personally by accepting responsibilities and pursuing leadership roles

PROGRAM OUTCOMES

1. Prepare graduates with technical competency through imparting advanced, relevant and in depth knowledge in areas of manufacturing technology including automation, industrial engineering and management preferring multidisciplinary approach so as to make them readily employable in engineering firms.
2. To train students with excellent manufacturing and Industrial engineering knowledge so as to understand, analyze and synthesis the knowledge of various courses to design / innovate on the manufacturing systems/processes.
3. Develop proficiency among students in contemporary computer applications (specific software) and process automation, including the use of sensors, actuators, and controllers to automate machines and processes to solve large and complex real life problems
4. To provide students with academic environment that is aware of excellence, leadership, entrepreneurship, ethical responsibility, recent technologies in manufacturing engineering and ability to work in multidisciplinary teams.
5. Making students effective at communicating their ideas in oral, written, and graphical form
6. Develop academic rigor so as to take up research in industry and pursue higher study for PhD
7. To recognize the need for higher studies and lifelong learning to adopt to the changing Technologies and practices and be alive to the ever-changing environment and needs of the Industry and Society.
8. To inculcate in students professional and ethical attitude, team spirit and relate manufacturing issues to broader social context.

SEMESTER I

Scheme of Instruction				Scheme of Evaluation				
Sr. No	**Course code**	**Course Title**	**L-T-P (Hours / week)**	**Credits**	**TA**	**IST**	**ESE**	**ESE hours**
1.	PE5201S	Computational Methods	3-1-0	4	20	20	60	3
2.	PE5002S	World Class Manufacturing	3-0-0	3	20	20	60	3
3.	PE5003T	Advanced Foundry and Welding Technology	3-1-0	4	20	20	60	3
	PE5003P	Casting Simulation Lab	0- 0-2	1	100 % CIE			-
4.	PE5004T	Computer Integrated Manufacturing	3-1-0	4	20	20	60	3
	PE5004P	Computer Integrated Manufacturing Lab	0- 0-2	1	100 % CIE			-
5.		Elective –I	3-0-0	3	20	20	60	3
6.		Elective-II	3-1-0	4	20	20	60	3
		Total	18-3-4	24				

SEMESTER II

Scheme of Instruction				Scheme of Evaluation				
Sr. No	**Course code**	**Course Title**	**L-T-P (Hours / week)**	**Credits**	**TA**	**IST**	**ESE**	**ESE hours**
1.	PE5205S	Research Methodology	3-1-0	4	20	20	60	3
2.	PE5006S	Advanced Metal Forming Technology	3-1-0	4	20	20	60	3
3.	PE5007T	Advanced Metal Cutting and Process Engineering	3-0-0	3	20	20	60	3
	PE5007P	Process Engineering Lab	0-0-2	1	100 % CIE			-
4.	PE5008S	Design Of Production and Industrial Systems	3-1-0	4	20	20	60	3
5.		Elective –III		3				
6.		Elective –IV	3-1-0	4	20	20	60	3
7.	PE5801D	Technical Seminar	0-0-4	2				
		Total	18-4-6	25				

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, **IST**: In Semester Tests (comprise of average of two In semester tests), **ESE**: End Semester Written Examination, **CIE**: Continuous In-semester Evaluation

List of Electives: I

S. No	Course code	Course Title
1.	PE5101S	Principles of Project Management
2.	PE5102S	Quality Engineering and Management
3.	PE5103S	Managerial Economics ,Finance Costing
4.	PE5104S	Manufacturing System and Simulation
5.	PE5105S	Advanced Machine Design

List of Electives: II

S. No	Course code	Course Title
1.	PE5106S	Automation and Control Engineering
2.	PE5107S	Rapid Manufacturing
3.	PE5108S	Processing of Plastics and Composites
4.	PE5109S	Finite Element Method for Manufacturing
5.	PE5110S	Advanced Machine Tool Design

List of Electives: III

S. No	Course code	Course Title
1.	PE5111S	Green Manufacturing
2.	PE5112S	Organizational Behavior and Human Resources Management
3.	PE5113S	Sustainable Manufacturing & Supply Chain Management Operations
4.	PE5114S	Materials Management
5.	PE5115S	Automobile Engineering

List of Electives: IV

S. No	Course code	Course Title
1.	PE5116S	Operations Strategy
2.	PE5117S	Product Lifecycle Management
3.	PE5118S	Tribology
4.	PE5119S	Mechanical Metallurgy
5.	PE5120S	Advanced Refrigeration and Air Conditioning
6.	PE5121S	Design for Manufacturing and Assembly

SEMESTER III and SEMESTER IV – Project work

Sr. No	Course Category	Course Title	Credits	Evaluation pattern	Semester
1.	PE5901D	Stage –I Presentation	4	Graded evaluation by a committee of at least two examiners including supervisor (guide)	III
2.	PE5902D	Stage –II Presentation	4	Graded evaluation by a committee of at least two examiners including supervisor (guide)	III
3	PE5903D	Stage –III Presentation	4	Graded evaluation by a committee of at least two examiners including guide (guide)	IV
4.	PE5904D	Final Presentation and Viva Voce	12	Graded evaluation by a committee of at least two examiners including supervisor (guide) and an external examiner	IV

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5201S	
Course Title	**Computational Methods**	

COURSE OBJECTIVES

1. To lead students to a mastery of high-performance computer programming tools as methods, as well as the acquisition, processing and analysis of large datasets.
2. To educate and train students in computational modeling, simulation and visualization.
3. To educate and train students in obtaining computational solutions to problems of high dimensions or involving large datasets.
4. To teach students to develop novel and robust computational methods and tools to solve scientific, engineering, technology, and business problems.

COURSE OUTCOMES

1. Analyze problems to identify the potential of computational methods
2. Choose appropriate computational methods to solve numerical problems
3. Design and develop software relevant to scientific simulation and modeling processes
4. Translate physical systems into computational models
5. Plan, design and implement software projects for the optimization & automation of the processes
6. Decompose a problem into smaller tasks that can be solved in computational method
7. Explore the knowledge of Computational method in industrial application

SYLLABUS

1. **Overview to Optimization Techniques and Design of Experiment**

   Brief history of Design of Experiments (DOE), Overview of basic statistical concepts, Basic principles of DOE and Types and purposes of DOE methods. Introduction to Decision Making in the Manufacturing Environment, Decision-making Methods Used for optimization

2. **Full Factorial Design:**

   Fundamentals of "full factorials", ANOVA, Factorial effects and plots, and Model evaluation. Fractional Factorial Design: The one-half fraction and one-quarter of the 2^k design, The general 2^{k-p} fractional factorial design and Resolution III, IV and V designs

   The Robust Design: The basics of robust designs, Taguchi designs and Robust design example. Introduction to Response Surface Methodology

3. **Multi Criterion Decision-making (MCDM) Methods:**
   Introduction to multi criterion optimization. Simple Additive Weighting (SAW) Method, Weighted Product Method (WPM), Analytic Network Process (ANP), Analytic Hierarchy Process (AHP) Method, TOPSIS Method, PROMETHEE
4. **Multi- objective Decision making (MODM) Methods:**
   Introduction to Multi objective optimization, Traditional Techniques such as quadratic programming, geometric programming, goal programming, dynamic programming. Glimpses of Non-traditional optimization Techniques such as particle swarm, genetic algorithms, simulated annealing and Techniques based on Neural network & Fuzziness. Data envelopment analysis

Recommended Reading

Textbooks:

Douglas C.Montgomery: Design and analysis of experiments, John Wiley & Sons Inc.

Ranjit Roy: Primer on Taguchi Method ,Competitive Manufacturing Series

R V Rao: Decision Making in the Manufacturing Environment Using Graph Theory and Fuzzy Multiple Attribute Decision Making, Springer Publication

References:

Laurene Fausett: Fundamentals of Neural Networks, Architectures, Algorithms and Applications, Pearson

Xin-She Yang: Nature Inspired Metaheuristics Algorithm, Luniver Press

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5002	
Course Title	**World Class Manufacturing**	

COURSE OBJECTIVES

1. Deepen understanding of quality dimensions, philosophy, paradigm shift and systems that provide competitive edge in globalised market.
2. Equip the students with modern methods of production management techniques that improves productivity and quality.
3. Impart insight into practices followed in Indian and global manufacturing companies.

COURSE OUTCOMES

1. Prepare graduates with technical competency through imparting advanced, relevant and in depth knowledge in areas of World Class Manufacturing preferring multidisciplinary approach so as to make them readily employable in diversified organizations.
2. To promote system thinking including environment conscious approach amongst graduates in order to equip them to handle complex problems in industry and society.
3. To recognize the need for higher studies and lifelong learning to adopt to the changing Technologies and management practices and be alive to the ever-changing environment and needs of the Industry and Society.
4. To inculcate in students professional attitude, team spirit and relate manufacturing issues to broader social context.

SYLLABUS

1. **Historical Perspective:**

   World class Excellent organizations – American and Japanese Companies. Deming Awards, Malcolm Baldrige National Quality Award. Globalization: global companies, models for manufacturing excellence, business excellence.

2. **Bench marks, Bottlenecks and Best Practices:**

   Concepts of benchmarking, bottleneck and best practices, best performers–gaining competitive edge through world class manufacturing. Value added manufacturing–eliminating waste – Toyota Production System – example.

3. **System & Tools for World Class Manufacturing:**

   Improving Product & Process Design – Lean Production – SQC , FMS, Rapid Prototyping , Poka Yoke , 5-S ,3 M, use of IT ,JIT, Product Mix , Optimizing , Procurement & stores practices , Total Productive maintenance , Visual Control.

4. **Human Resource Management in WCM:**

   Adding value to the organization – Organizational learning – techniques of removing Root cause of problems – People as problem solvers – New organizational structures. Associates – Facilitators –Teamsman-ship – Motivation and reward in the age of continuous improvement.

5. **Typical Characteristics of WCM Companies:**

   Performance indicators – what is world class Performance – Six Sigma philosophy. Indian Scenario: Leading Indian companies towards world class manufacturing–Task Ahead.

Recommended Reading

Textbook:

Richard Schonberger: World Class manufacturing, Free Press.

B.S. Sahay, KBC Saxena: World Class Manufacturing – Strategic Perspective

References:

Jeffrey Liker: The Toyota Way, Tata McGraw Hill.

Narayanan: Managing Technology & Innovation for Competitive Advantage

Aquino Chase: Operations Management for Competitive Advantage, Tata McGraw Hill.

M.G. Korgaonkar: Just In Time Manufacturing, Macmillan Publishers India.

Womack: Machine That Changed The World, Simon and Schuster.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE 5003 T	
Course Title	Advanced Foundry and Welding Technology	

COURSE OBJECTIVES

Objectives of this course are:

1. To provide a fundamental understanding of the basic principles underlying casting and welding processes
2. To understand the basic parameters in the casting and welding technology and metallurgical aspects of the casted or welded parts
3. To understand the softwares available for casting simulation and play with a processing parameters to obtain defect free components

COURSE OUTCOMES

1. Comprehensive knowledge of metallurgical concepts, metal flow and solidification process so as to design product and mould that result in sound castings at economical cost
2. Provide critical knowledge of casting and welding processes and limitations enabling them to select the most appropriate process and its parameters.
3. Impart proficiency in using CAD and casting software to improve the efficiency in design and manufacturing.
4. Improve awareness of automation methods and practices followed in foundry and welding.
5. In depth study of the metallurgical aspects of casted and welded parts

SYLLABUS

1. **Casting Metallurgy :**

   Principles of casting-Mechanism of melting and solidification, grain growth and structure, solidification of pure metal, eutectic, and alloys. Shrinkage in cast metals – progressive and directional solidification — Degasification of the melt-casting defects – Castability of steel, Cast Iron, Al alloys, Babbitt alloy and Cu alloy.

2. **Casting Design :**

Melting and ladle metallurgy. Mould filling - fluidity and turbulence, filling under gravity and pressure; filling defects; principles and design of gating and risering. Simulation of mold filling and solidification.

Heat transfer between metal and mould — Design considerations in casting – Designing for directional solidification and minimum stresses. Design of casting for uniform sections, unequal section, junctions. Distortion and residual stresses in Casting. Design for economy. Productivity in Casting and Quality assurance.

3. **Recent Trends In Casting and Foundry Layout :**

Shell moulding, precision investment casting, CO_2 moulding, centrifugal casting, Die casting, and continuous casting. Layout of mechanized foundry – sand reclamation – material handling in foundry pollution control in foundry — Computer aided design of casting.

4. **Fundamental of Welding:**

Critical overview of various welding processes. Analysis of 2D, 3D heat source and flow in welds. Mechanism of metal transfer and solidification of fusion weldments. Principle of weld solidification. Resistance welding process parameters. Design of weldaments. Selection of process. Equipments and consumables. Selection of parameters. Welding productivity and quality assurance. Pre-heat, post-heat and inter-pass temperatures.

5. **Welding Metallurgy and Design :**

Heat affected zone and its characteristics – weldability of steels, cast iron, stainless steel, aluminum, Mg , Cu , Zirconium and titanium alloys – carbon equivalent of plain and alloy steels, hydrogen embrittlement – lamellar tearing – residual stress–distortion and its control. Heat transfer and solidification - analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects. Testing of weldment.

6. **Recent Trends in Welding :**

Friction welding, ultrasonic welding – Modern welding process like electron beam welding – Laser beam welding –Plasma welding – Electro slag welding- narrow gap, hybrid twin wire active TIG– Tandem MIG- modern brazing and soldering techniques – Hot gas, wave and vapour phase soldering. Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.

Recommended Reading

Textbook:

1 Jain P.L. Principles of Foundry Technology: Tata McGraw Hill

2. Parmer R.S: Welding Engineering and Technology, Khanna Publishers, New Delhi.

References:

1 Ghosh and Mullick: Manufacturing Science: East West Press.

2 P.N.Rao : Manufacturing Technology Vol I: Tata McGraw Hill

3 Mukherjee S.P: Metal Casting, Oxford University Press

4 Parmer R.S, Khanna: Welding Metallurgy & Design, Khanna Publishers, New Delhi.

5 Srinivasan N.K.: Welding Technology, Tech Publishers, New Delhi.

6 Houldcorft: Welding Process Technology, Cambridge University Press.

7 Messler R.W : Principles of Welding, John Wiley & Sons.

8 Foseco: Foundryman's Handbook

9 ASM Handbook : Metal Casting: Volume 15

10 ASM Handbook: Welding Brazing & Soldering, Vol.6.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5003P	
Course Title	**Casting Simulation Lab**	

COURSE OBJECTIVES

Inculcate the knowledge of casting design and use of casting simulation softwares for designing defect free castings.

COURSE OUTCOMES

1. Provide numerical and design proficiency in metal sand casting and die casting through solving numerical problems
2. Impart proficiency in using casting software for designing gating and risering system
3. Teach flaw detection skills

Experiments and Assignments:

1. Design and drawing for sand casting with and without CAD.
2. Design and drawing dies and equipments for die casting
3. Numerical analysis and problems in metal casting so as to clear many concepts
4. Simulation to design gating and risering system to obtain defect free sound casting.
5. Simulation for optimizing defects.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5004T	
Course Title	**Computer Integrated Manufacturing**	

COURSE OBJECTIVES

1. The aim of this course is to develop an understanding of the basic principles underlying computer aided tools used in engineering.
2. The objective of this course is to develop students' awareness in the application of CAD and CAM systems in the context of developing engineering products.
3. To study advanced features of CAM so as to be capable of accepting professional responsibilities and to understand the associativity between design and manufacturing.

COURSE OUTCOMES

After completion of this course, the students should be able to:

1. To describe the fundamental theory and concepts of the CAD/CAM.
2. Develop the concepts and underlying theory of modeling and the usage of models in different engineering applications.
3. Compare the different types of modeling techniques and explain the central role solid models play in the successful completion of CAD/CAM-based product development.
4. Develop transformations for 2D, 3D geometric modeling.
5. Explain the basic concepts of CNC programming and machining.
6. Understand the import and export procedure of CAD/CAM electronic neutral files (IGES, STEP).
7. An understanding of using engineering design and modeling techniques towards flow lines, robotics, numerical control and the integration of computer control/usage in manufacturing

SYLLABUS

1. **Computer Aided Design (CAD):**

   Introduction: History of CAD/CAM development, Definition of CAD/CAM tools, CAD/CAM Hardware and Software – Input and output devices, Need of CAD/CAM.

   Scan conversion: scan conversion algorithms for lines and circle.

   2D & 3D Transformations: Translation, Rotation, Scaling, Mirror reflection, Shearing applied to solid objects.

   Projections Transformations: parallel, perspective. Curves & Surfaces.

   Geometric Modeling: Wire frame, Surface and Solid modeling, solid representation schemes such as B- rep, CSG, Feature based modeling, Euler theory etc.

   Graphics standards: IGES, DXF, STEP, STL, etc.

2. **Computer Aided Manufacture (CAM):**

   Introduction: NC, CNC, DNC, Modes, NC Elements, Advantages and Limitations of NC, CNC. Functions of computers in DNC. Numerical Control, CNC and DNC, NC manufacturing.

   NC and CNC machine tools: CNC tooling, Tool presetting, ATC, Work holding, Overview of different CNC machining centers, CNC Turning centers, High speed machine tools.

   CNC Programming: Part program fundamentals, Steps involved in development of a part program, Manual part programming, CAPP: APT Programming in Drilling, Milling & Turning.

3. **Computer Integrated Manufacture (CIM):**

   Introduction to Manufacturing Systems, Material handling Systems - AGV, Robots, AS & RS, Flexible Manufacturing Systems (FMS), Group Technology and Cellular Manufacturing.

4. **Introduction To Finite Element Analysis:**

   Introduction, basic concepts, discretization, element types, nodes & degrees of freedom, mesh generation, constraints, loads, preprocessing, application to static analysis.

Recommended Reading

Textbook:

1 Ibrahim Zeid and R. Sivasubramanian : CAD/CAM Theory and Practice, Tata McGraw Hill

2 P.N.Rao: CAD/CAM Principles and Applications, Tata McGraw Hill

References:

1. Chougule N.K.:CAD/CAM/CAE, Scitech Publications.
2. P. N. Rao, and T.K. Kundra: Computer Aided Manufacturing: Tata McGraw Hill
3. M.P.Groover: Automation, Production Systems and Computer Integrated Manufacturing, Prentice-Hall.
4. J.N.Reddy: An Introduction to the Finite Element Method, McGraw Hill, New York.
5. S.S.Rao: The Finite Element Method in Engineering, Pergamon press, Oxford England
6. P.Radhakrishnan and S.Subramanyan : CAD/CAM/CIM, New Age International
7. Donald Hearn and M. Pauline Baker: Computer Graphics, Prentice Hall.
8. Radhakrishnan and Subramanyan: CAD/CAM/CIM, New Age International.
9. David Rogers and Alan Adams: Mathematical Elements for Computer Graphics, Tata McGraw Hill.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5004P	
Course Title	**Computer Integrated Manufacturing Lab**	

COURSE OBJECTIVES

1. To equip the students with fundamental theories and technologies in computer graphics, geometric modeling algorithms, curves and surfaces, meshing algorithms, introductory optimization algorithms, part programming and tool path generation algorithms that are the foundation of today's CAD/CAM/CAE systems
2. To provide students an extensive and intensive training course of a leading commercial CAD/CAM software (Pro/E) with ample in-depth projects.

COURSE OUTCOMES

1. Become an expert user of an advanced CAD/CAM system (Pro/E) the student will be able to efficiently use the system to conduct an entire product-development process of middle to large-scale project from the very early conceptual design till the final machining G-code generation or rapid-prototyping operation, in a team-work environment .
2. The student will have a thorough understanding of the fundamental mathematical theories and computer algorithms underlying CAD/CAM/CAE software tools.
3. Attain proficiency in drawing complex components and assembly using software available in markets so that students can use this knowledge directly on employment.

SYLLABUS

1. **CAD:**
   Create solid components, Assembly, drawing (Drafting) of given components by using Modeling software like Pro-E. Also prepare and present report on it.
   Write and run a program to draw an entity like line, circle, etc using DDA algorithm and Bresenham's algorithm.
   Assignment on 2D, 3D Geometric transformation & Projection transformation.
   Assignment on geometric design of planar curves and surfaces.
   Assignment on Product Data Exchange Standards.
2. **CAM:**
   Develop CNC program & APT program for given components.
   Create tool path generation using any CAM package.
   Assignment on Rapid Prototyping.
3. **CAE:**
   Analysis exercises using any CAE package

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5205S	
Course Title	**Research Methodology**	

COURSE OBJECTIVES

1. Inculcate creativity and innovativeness through motivating learners to learn the fundamentals of research methodology.
2. Develop capability in using qualitative and quantitative methods with hands on experience in using various statistical softwares.
3. Provide knowledge and skill in writing technical research reports leading to improved communication skill.

COURSE OUTCOMES

1. Graduates will have awareness about significance of research and able to contribute to society development through constructive research.
2. They will be able to demonstrate proficiency in contemporary computer applications (specific software) to solve large and complex real life problems
3. They will be effective at communicating their ideas in oral, written, and graphical form.
4. They will be able to recognize the need for higher studies and lifelong learning to adopt to the changing Technologies and practices and be alive to the ever-changing environment and needs of the Industry and Society.
5. To inculcate in students professional and ethical attitude, team spirit and relate manufacturing issues to broader social context.

SYLLABUS

1. **Introduction of Research Methodology:**

   Meaning and purpose of research, objectives of research, types of research, significance of research, research approaches, research methods v/s methodology, research process, criteria of good research. Research and scientific methods problems encountered by researchers in India.

2. **Research Problem:**

   Steps in Research: Identification, selection and formulation of research problem-Research questions-Research design- Formulation of hypothesis- Review of literature. Definition, necessity and techniques of defining research problem; Formulation of research problem; Objectives of research problem.

3. **Research Design:**

   Meaning need and features of good research design. Types of research designs, basic principles of experimental designs, design of experiments.

4. **Sampling Designs and Technique:**

   Sampling theory-types of sampling-steps in sampling-Sampling and Non-sampling error-Sample size –Advantages and limitations of sampling. Census and Sample surveys, Different types of sample designs, characteristics of good sample design. Techniques of selecting a random sample.

5. **Data Collection:**

   Primary and secondary data. Primary data-Meaning, Collection methods-Observation – Interview-Questionnaire-Schedule-Pretest-Pilot study –Experimental and case studies-Secondary data- Meaning – Relevance, limitations and cautions.

6. **Hypothesis:**

   Definition, Fundamentals and procedure of hypothesis testing, flow diagram for hypothesis testing. Measurement in Research: Measurement scales – Tests of good measurement construction of Likert and Semantic Differential scales-Source of errors in measurement- Scale validation. Parametric and non-parametric tests of hypothesis testing-Important non-parametric tests: Sign, Run Kruskal-Wallis tests and Mann – Whitney test.

7. **Parametric Tests:**

   Testing of significance mean, proportion, variance and correlation- Testing for significance of difference between means, proportions, variances and correlation coefficients. Limitations of tests of hypothesis

8. **ANOVA and Chi-Square Tests:**

   One-way and two-way ANOVA – Latin Square tests for association and goodness of fit.

9. **Technical Paper and Report Writing:**

   Basic concepts of paper writing and report writing, review of literature, Concepts of Bibliography and References, significance of report writing, steps of report writing, Types of Research reports, Methods of presentation of report.

10. **Process and Structuring the Report:**

    Types of reports, Contents, Styles of reporting, Steps in drafting reports, Chapter format, Pagination, Identification, Using quotations, Presenting footnotes – abbreviations, Presentation of tables and figures, Referencing, Documentation, Use and format of appendices- Indexing Editing and evaluating the final draft.

11. **Research Ethics:**

    Ethical Issues, Ethical Principles that govern Research, Ethically valid Information Sources, Regulatory Compliance.

Recommended Reading

Textbook:

1. R. Panneerselvam: Research Methodology, Prentice Hall India.

References:

1. C. R. Kothari: Research Methodology: Methods and Techniques by, New Age International Publishing.
2. Fisher R. A.: Statistical Methods for Research Workers , Macmillan Publishers

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5006S	
Course Title	**Advanced Metal Forming Technology**	

COURSE OBJECTIVES

1. Deepen critical understanding of metal forming processes for selecting appropriate method to manufacture a given part and ability to determine appropriate input parameters for processes to have desired process outcomes
2. Impart analytical capability of mechanics of processes through modeling to determine load requirement and select appropriate equipments
3. Provide capability to design dies for various processes –forging, extrusion, drawing

COURSE OUTCOMES

1. Students with deepened knowledge of processes, capabilities and limitations would be able to select appropriate forming process for manufacturing a given part along with optimal input process parameters.
2. Students would demonstrate the analytical capability of mechanics of processes by determining load requirement for rolling, forging, extrusion, drawing using different approaches and using exact as well as approximate methods.
3. Students would demonstrate capability to design dies for–forging, extrusion, drawing and rolling

SYLLABUS

1. **Fundamentals of Metal Forming:**

   Overview and classification of forming processes, comparison with other manufacturing processes, mechanics of metal working, flow stress determination, effect of temperature, strain rate and metallurgical structure on metal working. Friction and lubrication. Deformation zone geometry, workability and sheet metal formability, formability limit diagram, residual stresses. Materials and alloys for forming. Forming material and product specifications. Modern trends in metal forming.

2. **Analysis of Metal Forming:**

   State of stress, true stress and true strain curves, components of stress, symmetry of stress tensor, principal stresses, stress deviator, Von Mises, Tresca yield criteria, comparison of yield criteria, Octahedral shear stress and shear strain. Analysis of plastic deformation and load calculation for forging, rolling, extrusion, rod/wire drawing and tube drawing using various methods. Design considerations in forming processes.

3. **Sheet Metal Working:**

   Sheet metal production, mechanical properties and their assessment, Forming Limit Diagram (FLD), an-isotopic yield criteria, stress and strain paths. Sheet metal forming processes: shearing, punching/blanking, bending, deep drawing. Pre and post treatment of sheet metal parts. Super plastic forming.

   Process modeling and analysis of typical processes, scope of CAD/CAM in sheet metal forming. Numerical analysis of forming processes. Varieties of sheet metal - ferrous and Non ferrous.

   Forming Machines: Conventional and advanced machines including CNC shears, press brakes. Turret punching press etc. Sheet handling equipment. Tool design & design of inspection fixtures, component handling.

4. **Tooling and Die Design:**

   Tooling materials classification and applications. Design of dies for (i) drop die and upset forging, (ii) extrusion and impact extrusion, (iii) wire, rod and tube drawing, (iv) roll pass scheduling and (iv) Explosive forming.

Recommended Reading

Textbook:

1. George Dieter : Mechanical Metallurgy:, McGraw Hill International
2. G.W.Rowe : Principles Of Industrial Metalworking Processes: CBS Publications, New Delhi.

References:

1. Wagoner R. H. and Chenot J-L: Fundamentals of Metal Forming: Wiley International.
2. Surendra Kumar: Principles of Metal Working: CBS Publications, New Delhi.
3. R. Narayanswamy : Metal Forming Technology, Ahuja Book Co; New Delhi
4. Prakash Joshi: Press Tools- Design and Construction: Wheeler Publishing, New Delhi.
5. Eary and Reed: Techniques of Press Working Sheet Metal and Engineering, Approach to Die Design: Prentice Hall.
6. ASM Metals Handbook, Forming and Forging Vol.14, American Society of Metals.
7. ASM Metals Handbook, Sheet Metal Working Vol.15, American Society of Metals.
8. Handbook of Metal Forming: Kurt Lange Society of Manufacturing Engineers. (SME)Michigan, USA.
9. Grobh Schuler: Metal forming Handbook, Springer Verlag Berlin, Heidelberg.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5007T	
Course Title	**Advanced Metal Cutting and Process Engineering**	

COURSE OBJECTIVES

1. To impart a fundamental knowledge about the various alternative manufacturing processes available
2. To develop an attitude to look for the unconventional manufacturing process to machine
3. To make them to understand and appreciate the latest manufacturing processes and process capabilities
4. To develop a operation sequence such that there is no tolerance builtup

COURSE OUTCOMES

1. Impart problem solving skills in metal cutting
2. Apply analytical tools from a variety of sources their technical courses
3. Perform cutting force and chip formation analysis on metal cutting machines
4. Perform economics of machining and tool life estimation
5. Mathematical modeling of unconventional machining processes

SYLLABUS

1. **Fundamentals of Machine Tools and Machining Processes:**

   General motions of machine tools, single point tool nomenclature, slide and tool motions for different machining processes, machining time calculations, wok holding and clamping elements. Selection of machining parameters. Tool geometry- tool nomenclature systems (British, ASA, DIN). Mechanics of metal cutting - Ernst and Merchant, Lee and Shaffer theory. Chip formation and Chip Control: Chip breakers, prediction of chip curvature, tool wear during chip breaking.

2. **Temperature, Friction, Tool Wear in Metal Cutting:**

   Friction in metal cutting. Heat generation in metal cutting, heat transfer in moving materials, temperature distribution in metal cutting, measurement of cutting temperature. Tool wear. Cutting fluids. Surface roughness parameters and factors affecting surface roughness.

3. **Economics of Metal Cutting:**

   Choice of feed, selection of speed, optimization of tool life and cost, machining at maximum efficiency, machinability aspects

4. **Grinding and Super Finishing Processes:**

   Critical parameter selection: Grinding, Honing, lapping, polishing, buffing, modeling of Super-finishing processes.

5. **Unconventional Machining Processes:**

   Needs, classification and comparative analysis with conventional processes.

   Analytical analysis and modeling of process parameters of important processes-AJM, Chemical machining, ECM, EDM, Wire Cut EDM.

   Laser Beam Machining: Lasing process, types of lasers (Gas and solid state), lasing mediums, laser material processing-cutting, drilling, surface treatment, special applications.

6. **Process Engineering:**

Critical assessment of capability and limitations of manufacturing processes.

Tolerance chart-symbols, rule for adding and subtracting determining layout of tolerance chart, stock removal, constructing and balancing of tolerance chart.

Part Print Analysis: Determining the principal/ alternate processes, functional and critical surface for dimensional control and processing, finishing and identification of operations.

Selection of equipment, operation planning, process pictures, operation routing, tool layout for turning and other general machines, tooling for automates, tool layout, tool design, and cam design.

In-process gauging and multiple gauging systems, various heat treatment processes, heat treatment furnaces, induction hardening, design of inductors.

Recommended Reading

Textbook:

1 Winston Knight and Geoffrey Boothroyd : Fundamentals of Metal Machining and Machine Tools, Taylor and Francis.

2 A Ghosh and A K Mullick: Manufacturing Science, East West Press.

References:

1. B.L. Juneja, G.S. Sekhon, Nitin Seth: Fundamentals of Metal Cutting and Machine Tools, New Age International Publishers.
2. Amitabh Bhattacharya: Principles of metal cutting, Central Book House.
3. Hassan Abdel-Gawad El-Hofy: Advanced Machining Processes, Tata McGraw Hill.
4. Donald Eary and Gerald Johnson: Process Engineering for Manufacturing, Prentice Hall.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5007P	
Course Title	**Process Engineering Lab**	

COURSE OBJECTIVES

To impart knowledge in the basic manufacturing processes and tooling design. Solve the practical problems of preparation of detailed operations sheets and calculate the processing time.

COURSE OUTCOMES

1. Understand the process planning especially sequencing of operations based on process capability and requirement.
2. Develop ability to specify and design tooling- jigs and fixtures, cutting tools and measuring equipments/gauges.
3. Able to select the equipment and design tooling
4. Evaluate a cycle time and prepare a process pictures

Experiments /Assignments

1. Study types of chip formations based on cutting parameters on Lathe /shaper.
2. Measure various cutting forces and infer relationship for orthogonal cutting.
3. Design tolerance chart for a selected component.
4. Develop process planning and drawing process picture for a industry based part involving important manufacturing processes.
5. Process planning for a component on single speed automat.
6. Develop CAPP for a industry based part

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5008S	
Course Title	**Design of Production and Industrial System**	

COURSE OBJECTIVES

1. Deepen the understanding of various aspects of production systems.
2. Develop analytical capability to solve problems involved in design, procurement, manufacturing and distribution.
3. Develop integrative capability to apply principles and practice in design of facilities and logistics networks in designing production system with emphasis on economic justification of alternative designs and use of computer software to aid design process.
4. Projects are essential part of course considering the large scale work involved and final project should be group project.

COURSE OUTCOMES

On completion of this course, students will be able to:

1. Formulate models and analyze the performance of a variety of alternative production system designs and understand the limitations of the analysis
2. Formulate and utilize heuristic solution procedures for different types of design problems, understand the difference between construction and improvement heuristics, and understand the limitations of any heuristic solution approach
3. Apply all of the knowledge and techniques learned in the course to the problem of developing an integrated design of a complete production system.
4. Impart proficiency in using software for solving complex and large scale real problems.

SYLLABUS

1. Production management and manufacturing strategy, system concept of production, types of production system, Elements of the supply chain; logistics system modeling ; minimum location; freight transport; total logistics cost concept
   Product Design: Innovation, product innovation management, management risk and fears of innovation.
   Economic Analysis -Economics of production; discounting; economic analysis of alternative designs
2. Demand management & forecasting with trend and seasonality.
   Business Competitiveness; modeling and Decision-making by Decision tree Concepts; Forecasting Methodologies
3. Facilities location**:** Facility location factors, location analysis techniques – location factor rating – center of gravity technique – load distance technique.
   Facility layout: Classification of layout, Material flow; machine layout; quadratic assignment problem; Group Technology and cellular Manufacturing; department layout; computer-aided layout improvement procedures – ALDEP, CORELAP and CRAFT.
   Line balancing: Rank positional weight method - COMSOAL algorithm.
4. Aggregate Production planning: Aggregate planning strategies – heuristic method and transportation model for aggregate planning. Resource planning for production and operations. Materials requirement planning with Prosim.
5. Inventory analysis and control: inventory control systems and management systems for purchased parts and manufactured parts – quantity discounts – reorder point - Inventory models under uncertainty.

6. Materials, Manpower and Capacity planning : Production system design; design vs. operational problems; basic factory dynamics; line yield; machine sharing and setups; throughput and cycle time feasibility

   Material Handling: Unit load design; characteristics of material handling equipment; material handling equipment selection and evaluation; material handling system design and control.

   Storage and Warehousing: Basic storage/warehousing functions and elements; storage/retrieval policies; storage layout planning; warehouse operations; order picking; activity profiling

   Job Scheduling: Job Shop, Flow Shop, optimal & Heuristics Methods: Project Scheduling, Maintenance and other services in manufacturing; Case studies.

Recommended Reading

Textbook:

1 Stephen Nahimas: Production and Operations Analysis, McGraw Hill International.

2 Martenich, J.B: Production and Operations Management- An Applied Modern Approach John Wiley

References:

1 Wallace Hopp and Mark Spearman: Factory Physics, McGraw-Hill, New York, NY

2 Russell, R.S. and Taylor B.W: Operations Management, Prentice Hall International.

2 R.Paneerselvem :Production and Operations Management , Prentice Hall India

3 R.Paneerselvem: Design and Analysis of Algorithms, Prentice Hall International

4 Vollmann, Berry, Whybark and Jacobs: Manufacturing Planning & Control for Supply Chain Management,"

5 Wheelwright S.C. and Clark K.B: Revolutionizing Product Development, The Free Press.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5801D	
Course Title	**Technical Seminar**	

COURSE OBJECTIVES

Each student shall prepare a seminar write up and power point presentation on any topic of interest related to the core/elective courses being undergone in the first two semesters of the M. Tech. programme. The topic should cover cutting edge research in that subject and should source material from at least five research papers from reputed international journal. He/she shall get the paper approved by the Programme Coordinator/Faculty Members in the concerned area of specialization and shall present it in the class in the presence of Faculty in-charge of seminar class. Every student shall participate in the seminar and grade will be awarded on the basis of the student's paper, presentation and his/her participation in the seminar

COURSE OUTCOMES

1. To provide in depth, precise and latest knowledge in an area of his interest.
2. To impart students technical communication and presentation skills to present latest developments in the given field.
3. Develop attitude for undertaking research and study a given topic in depth.

Elective Subjects

List of Elective I

Programme name	**M. Tech. (**Production Engineering)	**SEMESTER-I**
Course Code	PE5101S	
Course Title	**Principles of Project Management**	

COURSE OBJECTIVES

1. To understand the fundamentals of project management.
2. To learn how to effectively implement complex projects.
3. To develop skills for using softwares for successful implementation of projects.

COURSE OUTCOMES

1. They will be able to understand the significance of Project Management.
2. They will be able to demonstrate the skills required for successful implementation of complex projects.
3. They will be able to understand the need for higher studies and lifelong learning to adapt to the ever-changing environment and needs of the Industry and Society through case study approach.

SYLLABUS

1. Introduction to Project Management

   Definition and characteristics of project and project management. Evolution of project management, the need of project management, appropriateness of project management, projects in contemporary organizations, project life cycle.

2. Project Selection and Appraisal

   Brainstorming and concept evolution, project selection and evaluation, selection criteria and models, types of appraisals, SWOT analysis, cash flow analysis, payback period and net present value.

3. Project Organization and Planning

   Project manager, cross-functional team, dedicated project organization, influence project organization, matrix organization, advantages and disadvantages of project organizations, selection of project organization, Work Breakdown Structure (WBS), integration of project organization and WBS, WBS and responsibility matrix.

4. Project Scheduling and Resource Management

   Gantt chart, Milestone chart, Network techniques: PERT and CPM, AON and AOA representation, Three time estimates, using probability distributions for time computation, probability of project completion, time scale version of network, early start and late start schedules, resource allocation, resource loading and leveling, constrained resource scheduling, multi-project scheduling and resource allocation, crashing a project.

5. Computerized PM

   Computerized PMIS, choosing software for project management, using software for project management.

6. Case Studies on Project Management: Modern cases in project management.

Recommended Reading

Textbook

1 John Nicholas: Project Management for Business and technology, Pearson Prentice Hall.

References

1. A Guide to the Project management Body of Knowledge (PMBOK Guide), PMI.
2. Harold Kerzner: Project Management-Case Studies, John Wiley & Sons, New Jersey.
3. Arun Kanda and S. G. Deshmukh: Project and Production Management, A course by National Programme on Technology Enhanced Learning (NPTEL), IIT Delhi, 2005.

Programme name	**M. Tech. (**Production Engineering)	**SEMESTER-I**
Course Code	PE5102S	
Course Title	**Quality Engineering and Management**	

COURSE OBJECTIVES

The objectives of this course are:

1. To impart a fundamental and comprehensive knowledge of quality control concepts
2. To design and apply a statistical quality control tools
3. To generate knowledge and skills of students to use models and quality management methodology for the implementation of total quality management in any sphere of business

COURSE OUTCOMES

1. Comprehend philosophies of total quality management by important management gurus.
2. Understand concepts of quality related costs.
3. Mastering scientific tools for quality improvement.
4. Introduction to off-line quality control for quality improvement.
5. To impart a experimental design and data analysis capability

SYLLABUS

1. Quality Management Framework

   Quality: Defining quality – philosophies of quality gurus- dimensions of quality - measures of quality – cost of quality – direct costs & indirect costs – 'defectives' and its significance - traditional model and emerging model of 'cost-of-quality.'

   Continuous process improvement: PDSA cycle – problem solving methodology
2. Statistical process control

   Statistical tools - control charts and use of probability distributions, process capability. Acceptance sampling.

   Quality function deployment: Concept - house of quality – QFD process
3. Design of experiments

   ANOVA - full factorial and fractional factorial design.

   Taguchi methods: Loss functions – signal-to-noise ratio - process optimization and robust product design using orthogonal arrays, parametric and tolerance design.

4. Total quality management (TQM)

   Definition - basic concepts – strategies

   Six sigma methodology: Basic concepts – DMAIC problem solving technique.

   Quality system and standards: An overview of ISO 9000 and ISO 14000 series of standards. Overview of TS 16959. Product acceptance control through IS 2500 part 1 and part 2

Recommended Reading

Textbooks

1 Dale Besterfield: Total Quality Management, Pearson Education India.

2 Nicholas Logothetis: Total Quality Management, Prentice Hall India.

References

1. J.M. Juran, Frank Gryana: Quality Planning and Analysis, Tata McGraw Hill.
2. Amitava Mitra : Fundamentals of Quality Control and Improvement, Pearson Education.
3. Zaidi: SPC – Concepts, Methodology and Tools, Prentice Hall
5. Sud Ingle: Quality Circles Master Guide, PHI Publication.
6. Ronald Day.: QFD linking a company with its customers, McGraw Hill Higher Education.
7. Dennis Green: The complete ISO Manual, Kogan Page.
8. Philip Ross: Taguchi Techniques for quality engineering, McGraw Hill Higher Education.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5103S	
Course Title	Managerial Economics, Finance and Costing	

COURSE OBJECTIVES

1. Deepen the understanding of industrial economics and hence develop capability to analyze economic scenario at firm level.
2. Provide basic knowledge of industrial finance, financial markets, accounting, costing and cost controls.
3. Develop capability to solve problems related to economics, finance and costing.

COURSE OUTCOMES

1. Students would be capable of analyzing problems of production, output and pricing, market structures, cost curves, valuation, depreciation, replacement.
2. Able to analyze financial statements along with accounting principles.
3. Identify and appropriate different cost for costing of product and cost control.
4. Demonstrate awareness of financial market, market structure and financial institutions.

SYLLABUS

1. Managerial Economics: The Principles and use of Economic Analysis in Engineering Practice. Discounted cash flow Analysis corporate tax and investment. Depreciation and economic studies. Replacement analysis. Valuation of assets. Economic analysis of projects. Analysis of risk and uncertainty. Elements of demand analysis and forecasting. Theory of firm as an owner and as the producer. Economics of scale. Production function. Output and pricing decisions. Long run and short run cost curves
2. Accounting: Financial statements, accounting concepts. Accounting for income and expenses, cash v/s accrual basis, capital and revenue expenditure, capital and operating income, deferred revenue expenditure; depreciation, depletion and amortization. Accounting for fictitious assets and obsolescence, impact of exchange rate variations on corporate financial statements. Mechanics of accounting; ledger and trial balance based on double entry book keeping. Provision in company law and other legal aspects. Balance sheets, profits and loss statements, annual reports of business enterprises.

3. Costing : Different costs. Cost ascertainment; allocation, apportionment, absorption of overheads and non-production cost; overhead analysis, absorption methods, general considerations. Job costing; factory job costing, contract cost. Unit costing; output and operating cost, Cost planning and control, standard cost and budgetary control, setting standards, variance analysis. Cost reduction; tools, techniques and productivity. Depreciation; causes and significance, methods of providing for depreciation. Investments; fixed cost v/s varying capacity, unit cost v/s varying capacity. Comparison of alternatives; selection in present economy, accepting or nor accepting a single alternative of providing equal / unequal services, unequal first cost and unequal lives, evaluation of replacement. Techniques for comparing alternatives; payout periods, rate of return, discounting methods, minimum acceptable rate, net present value, yield, annual capital charge, cash flow, profit incremental discounted cash flow (DCF) returns.
4. Finance : Contours of finance function in business, goal of finance, profit maximization and others. Sources of finance and their relative importance. PPP arrangements in project finance, Fund allocation, alternative uses of finance. Capital budgeting; need, uses, limitations. Assessment of capital needs; short and long term capital expenditure, project appraisal. Budgetary control; concept, types of budget. Financial markets; money markets, bill market, discount houses, call loan market, etc., Capital markets; mutual funds, stock markets, industrial banks, world bank, UTI, IDBI, ICICI, and state finance corporations. Corporate planning; taxation and other financial incentives, objectives of corporate planning, capital expenditure and financial management, financial statements, fund flow and cash flow analysis.

Recommended Reading

Textbooks

1. I.M. Pandey: Financial Management, Vikas Publication House
2. Jawaharlal :Cost Accounting Third Edition Tata McGraw Hill Publishing

Reference Books

1. M.Y.Khan and P.K. Jain : Management Accounting, Tata McGraw Hill
2. Bhattacharya S.K.: Accounting for Management Text & Cases, Vikas Publishing House
3. Prasanna Chandra : Fundamentals of Financial Management, Tata McGraw Hill
4. Varshney and Maheshwari: Managerial Economics, Sultan Chand and Sons, New Delhi.
5. Thusen and Thusen : Engineering Economics, Prentice hall of India.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5104S	
Course Title	**Manufacturing System and Simulation**	

COURSE OBJECTIVES

1. The course objective is to introduce Discrete-Event Simulation as a design and analysis tool for manufacturing systems.
2. To make the Students to learn how to conduct a simulation project using manufacturing oriented software such as Arena & simulation software & the simulation methodology include: building valid models, selecting input probability distribution, statistical analysis of output, design of simulation experiments, and variance reduction techniques in simulation.
3. To Create the Competence in each student by conducting a simulation project of a manufacturing system.

COURSE OUTCOMES

1. Provide deep understanding of theoretical background of simulation techniques and their applications.
2. Develop proficiency in applying the simulation technique to large scale real life problems of manufacturing system using software.

SYLLABUS

1. Introduction

   Basic concepts of system – elements of manufacturing system - concept of simulation – simulation as a decision making tool – types of simulation – Monte-Carlo simulation - system modeling – types of modeling – Limitations and Areas of application of simulation.

2. Random Numbers

   Probability and statistical concepts of simulation – Pseudo random numbers – methods of generating random numbers – discrete and continuous distribution – testing of random numbers – Kolmogorov-Smirnov test, the Chi-Square test - sampling - simple, random and simulated.

3. Design of Simulation Experiments

   Problem formulation, data collection and analysis, key Variables - logic flow chart starting condition, run size, experimental design consideration – output analysis, interpretation and validation – application of simulation in engineering industry.

4. Simulation Language

   Comparison and selection of simulation languages - Study of GPSS (Basic blocks only) generate, queue, depart, size, release, advance, terminate, transfer, enter and leave.

5. Case Studies

   Development of simulation models using GPSS for queuing, production, inventory, Maintenance and replacement systems – case studies.

Recommended Reading

Textbook

1. Jerry Banks and John S.Carson: Discrete event system simulation, Prentice Hall.

References

1. John H.Mize and J.Grady Cox: Essentials of simulation, Prentice hall.
2. Geoffrey Gordon: System simulation, Prentice Hall of India.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5105S	
Course Title	**Advanced Machine Design**	

COURSE OBJECTIVES

1. Develop an ability to apply knowledge of mathematics, science, and engineering
2. To develop an ability to design a machine system, component, or process to meet desired needs within realistic constraints.
3. To develop an ability to identify, formulate, and solve engineering design problems.

COURSE OUTCOME

1. Be able to analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts
2. Demonstrate knowledge on basic machine elements used in machine design; design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.
3. Be able to approach a design problem successfully, taking decisions when there is not a unique answer.

SYLLABUS

1. Mechanics of Solids

   Analysis of stress and strain, multidimensional stress-strain relationship, plane strain, plane stress and ax-symmetric analysis. Introduction to elastic stability, energy methods, displacement method and force method
2. Analysis of Plates

   Introduction, Love-Kirchoff's theory, stresses resultants. Deflection of plates, governing equation, support conditions. Laminated composite plates, first order shear deformation theory, higher order shear deformation theory, stress- strain relationships
3. Transient Analysis

   Introduction, single degree of freedom system, multi degree of freedom system, explicit schemes, and implicit schemes of solution.

4. Dynamic Analysis

   Introduction, basic concepts of Eigen value problems, basic properties of Eigen values and Eigen vectors, iterative methods, transformation methods, approximate methods, subspace iteration method.

5. Fracture mechanics

   Introduction: Fracture mechanics approach to design, the energy criterion, the stress intensity approach, effect of material properties on fracture, dimensional analysis in fracture mechanics.

   Fundamental concepts: Stress concentration effect of flaws, the Griffith energy balance, the energy release rate, instability and the R curve, stress analysis of cracks, K as a failure criterion. Fracture toughness testing of metals: General considerations, KIC testing, K-R curves testing, J testing of metals, CTOD testing.

Recommended Reading

Textbook

1. L.S. Srinath: Advanced Solid Mechanics, Tata McGraw Hill
2. Timoshenko: Theory of Plates and Shells: Tata McGraw Hill.

Reference Books

1. R.M. Jones: Mechanics of Composite Materials, Wiley International
2. M.A. Rao and R Bhatt: CAD and Design of Machine Elements, New Age International.
3. T.L. Anderson: Fracture Mechanics-Fundamentals and Applications, CRC Press

Elective II

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5106S	
Course Title	**Automation and Control Engineering**	

COURSE OBJECTIVES

1. Have a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.
2. Be able to design, analyze, and test "intelligent" products and processes that incorporate appropriate computing tools, sensors, and actuators.
3. Be able to demonstrate professional interaction and communicate effectively with team members.
4. Be able to work efficiently in multidisciplinary teams.
5. Be prepared for a variety of engineering careers, graduate studies, and continuing education
6. Practice professional and ethical responsibility and be aware of the impact of their designs on human-kind and the environment.

COURSE OUTCOME

1. Employ the knowledge of mathematics, science, and engineering
2. Design and conduct experiments to evaluate the performance of a automation system or component with respect to specifications, as well as to analyze and interpret data
3. Design mechatronics component, system or process to meet desired needs.
4. Define and solve engineering problems.
5. Impart analytical capability to design industrial circuits
6. Provide basic knowledge of robotics.
7. Provide capability to program PLC, micro-processor and micro-controller system.

SYLLABUS

1. Overview of Microcomputer system, Hardware and Software

   Introduction to microprocessor architecture 8085 and 8086/8088. Control unit, memory, working register, internal clock, I/O device and interfaces, bus structure and its hardware connections to processor. Introduction to microprocessor Software. Data representation, Binary and BCD formats, instruction types, addressing modes, instruction formats, instruction timing and operation, 8085 instruction set and basic instructions. Programming techniques with additional instructions, computer and timing delays, branching, looping, stack and sub routines.

2. Components in Hydraulic Systems, Study of Hydraulic Circuit

   Components in pneumatic systems, study of pneumatic circuit. Techniques adopted in pneumatic circuit. Electro - hydraulic systems, Electro - pneumatic systems. Automation, basic concepts, techniques adopted in synthesis of L.C.A. circuits and study of L.C.A components, case studies involving hydraulics in machine tools and automation, automation in machining using transfer machines.

3. Control Theory

   Adaptive Controls. Logic circuit, PLC in Automation, PID controller in Automation, Analysis of control system components such as valves, actuators, transmissions etc., dynamic modeling of Electro Hydraulic/ Pneumatic systems, study of response and concepts of stability.

4. Industrial Robotics

   Fundamentals of Robotics: robot arm geometry, power sources, application areas, control techniques – path control – robot controller operation – open loop and closed loop systems.

   End of arm tooling and sensors: characteristics – classification – special purpose tools – Typical designs, compliance in Wrists. End Effectors: types, mechanical and other types of griper – types of sensors and applications.

   Robot Programming and Languages: Language classification – program commands, arm motion, task point diagram – on line/off line programming, sample programs, program analysis – AI and experts systems. Robot Applications: Robot applications in manufacturing – material transfer and machine loading / unloading – Processing operations like welding and painting – Assembly operations – Inspection Automation. Robot cell layouts – multiple robots and machine interference. Recent developments: Recent developments in advanced Robotics –Modular concept – Special applications of robotics – micro robotics, Bio robotics

Recommended Reading

Textbook

1. Aizerman M A:Pneumatic and Hydraulic Control Systems
2. Groover M.P: Industrial Robotics, McGraw Hill International Editions

References

1. Fawcett J R.: Pneumatic circuits and Low cost automation
2. Pippenger : Industrial Hydraulics
3. Thyer G E: Computer Numeric Control of Machine Control
4. Keramas,J.G. Robot Technology Fundamentals, Delmar Publisher.
5. Jain, K.C, and Aggarwal, L.N: Robotics Principles and Practices, Khanna Publishers.
6. Vickers manual on Hydraulics.
7 Seames W S.: Computer Numeric Control concepts and Programming
8 Festo: Didactic series on pneumatic and PLC.
9 Deb S.R.: Robotics Technology and Flexible Automation, Tata McGraw Hill , New Delhi,

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5107S	
Course Title	Rapid Manufacturing	

COURSE OBJECTIVES

1. Students will understand how rapid prototyping works and why it's an important technology.
2. Students will be able to model the procedure for 3d printing.

COURSE OUTCOMES

1. Demonstrate systematic problem solving skills related to product evaluation and manufacture using Additive Layer Manufacturing (ALM) techniques and the ability to synthesize new knowledge in order to apply innovative physical engineering solutions.
2. Effectively research unfamiliar subject areas in rapid manufacturing and materials related engineering disciplines, and thereby propose and evaluate a broad range of solutions to existing and new engineering problems.
3. Select and apply appropriate software packages for design, analysis, and synthesis of rapid manufacturing applications and critically evaluate the results

SYLLABUS

1. Overview : Overview and evolution of Rapid Product Development.
2. Geometric Modeling : Wire-frame, surface and solid representations; Various types of solid representations; STL format.
3. Reverse Engineering (RE): Principle Legal and ethical issues; Various contact and non-contact methods of capturing a physical object; Construction of the 3D models; Applications and case studies.
4. Virtual and Augmented Reality (VR): Stereo-vision; tracking-based interaction; Multi-modal perception; Augmented Reality; Applications and case studies.
5. Rapid Prototyping (RP): Principle; Popular RP processes -Fused Deposition Modeling (FDM), 3D Printing (3DP), Stereo-Lithography Apparatus (SLA) and Selective Laser Sintering (SLS); Applications/benefits and limitations

6. Overview to Rapid Manufacturing: Definition; Roadmap , Rapid Manufacturing of Metallic and Non-metallic Objects, Rapid Casting Concurrent Engineering (CE) and Design for X (DFX)

Recommended Reading

Textbook

1. Frank Lio: Rapid Prototyping & Engineering Applications, CRC Press.
2. Ali Kamarani: Rapid Prototyping Theory & Practice, Manufacturing System Engineering Series, Springer Verlag.

References

1. T. A. Grimm: Users Guide to Rapid Prototyping, Society of Manufacturing Engineers.
2. C. E. Bocking, AEW Rennie: Rapid & Virtual Prototyping & applications, Wiley Eastern
3. J. A. McDonalds, C. J. Ryall: Rapid Prototyping- case book, Wiley Eastern
4. Dr. K.P. Karunakaran: Rapid Product Development & Manufacturing, Rapid Manufacturing Laboratory, IIT Bombay.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5108S	
Course Title	**Processing of Plastics and Composites**	

COURSE OBJECTIVES

1. Deepen the knowledge types and physical properties of plastics along with suitability of processing so as to develop capability to select the appropriate material for a given application.
2. Impart knowledge of different types of composites, their specific properties and their applications
3. Develop capability to design dies for moulding plastics and fabrication of composites

COURSE OUTCOMES

1. Student would be able to identify, characterize different plastics along with their properties and applications.
2. Students physical properties and processing of polymer matrix and composites, metal matrix composites and ceramics matrix composites.
3. Students would capable of designing a plastic product and die/equipments required specially for injection moulding, blow moulding. Similarly, they would be capable of fabricating a composite component.

SYLLABUS

1. Plastics

   Classification; Properties-chemical, physical, processing and engineering properties of plastics. Properties and applications of Thermo plastics and Thermosetting Plastics – Merits and Disadvantages. Contribution and comparatives performance of plastics in various sectors of business and economy.

2. Processing Of Polymers

   Processing of Plastics: Processes based on type of material, industrial product design and production volume.

   Casting, Moulding processes (injection, compression, transfer), Miscellaneous processes foaming, thermoforming, laminating; Continuous extrusion processes for films, sheets, sections, calendaring, laminating; Joining processes: sealing, welding, adhesive bonding. Finishing processes: printing, embossing.

   General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Mechanical Fasteners – Thermal bonding – Press Fitting.

3 Equipments and Die Design

   Processing Equipment: for moulding, extrusion, blowing, calendaring, welding, etc; construction, major units, operational and control features, specifications. Design of Moulds: for injection, compression and transfer moulding; Design of extrusion dies for different shapes, die materials, manufacture, mounting, heating / cooling of dies.

3. Introduction to Fibres and Composite Materials

   Fibres Fabrication, Structure, properties and applications - Glass, Boron, carbon, organic, ceramic and metallic fibers whiskers– Matrix materials structure – polymers, metals and ceramics ,Physical and chemical properties.

4. Processing of Polymer Matrix Composites

   Open mould process, bag moulding, compression moulding with BMC and SMC filament winding – pultrusion – centrifugal casting – injection moulding – structure, properties and application of PMC's – Carbon Matrix Composites - Interfaces – Properties – recycling of PMC.

5. Processing of - Metal Matrix Composites and ceramic matrix composites
   Solid state fabrication techniques – diffusion bonding – powder metallurgy techniques plasma spray, chemical and physical vapour deposition of matrix on fibers Chemical vapour infiltration – Sol gel – liquid state fabrication methods – infiltration – squeeze, casting – rheo casting – compo casting - Interfaces properties– application of MMC and ceramic matrix composites.

Recommended Reading

1. A. S. Athalye : Plastics- Materials Handbook: Multi-Tech Publishing Company
2. Krishnan Chawla: Composite Materials Science and Engineering, Springer, International Edition.
3. Harold Belofsky: Plastics, Product Design and Process Engineering, Hanser Publishers,
4. Bera.E and Moet .A: High Performance Polymers, Hanser Publishers.
5. J.A.Brydson: Plastics Materials; Butterworth
6. R.T.Fenner: Principles of Polymer Processing; Macmillan.
7. M.V.Joshi: Dies for Plastics Extrusion; Macmillan
8. R.D.Beck: Plastics Products Design; Von Nostrand Reinhold Publication.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5109S	
Course Title	Finite Element Methods for Manufacturing	

COURSE OBJECTIVE

The objective of the course is teaching engineers the basic and specialized theory of Finite Element Method (FEM). This course introduces finite element methods for the analysis of solid, structural, heat transfer and fluid flow problems. Finite element methods and solution procedures of 1-D, 2-D and 3-D domain for linear analysis are presented using physical arguments. The validation of theoretical analysis is performed using general purpose finite element analysis software ANSYS.

COURSE OUTCOMES

1. A strong understanding of the formulation steps involved in the linear finite element model in development of problems of solid and structural and certain heat transfer and fluid flow problems.
2. Generation of finite element data (e.g., selection of elements and mesh, computation of nodal forces), imposition of boundary conditions, post-computation of stresses and strains, etc., exploitation of problem symmetries, and interpretation and evaluation of the results.
3. Develop skills for solving practical problems using ANSYS which include selection among 1D, 2D and 3D domain, and modeling of domain, meshing and performing analysis.

SYLLABUS

1. Finite Element Methods

   Basic concepts, different methods and Steps involved in FEM.

   Interpolation Polynomials – Linear elements Shape function – Element and Global matrices –Two dimensional elements, triangular and rectangular elements – Local and Global Coordinate systems.

   Field problems, Steady state problems – Torsional problem – Fluid flow and Heat transfer problems – Acoustic vibrations – Application in manufacturing problems –

metal cutting and metal forming.

Finite element Solution of structural problems – Two dimensional elasticity problems – Axisymmetric problem.

Higher Order Elements and Numerical Methods – Evaluation of shape functions – Numerical Integration, Gauss Legendre quadrature – Solution of finite element equations – Cholesky decomposition, Skyline storage – Computer implementation- Use of FEM software.

2. Applications

FEM – elements and coordinate system – interpolation polynomials – element and global matrices – local and natural coordinate systems.

FEA – discretization – selecting the proper elements – elements, nodes, degree of freedom –pre-processing – executing the model – post processing –design optimization - Fundamentals of Applied finite element analysis – hardware requirements for doing FEA

Finite Element Analysis in production design - Minimising the product design cycle by interfacing CAD and FEA – FEA of maximum fatigue life and minimum weight – vehicles aerodynamics studies.

Application in metal casting, cutting, metal forming and welding, moulds and dies.FEA in automotive industries - Finite element Models –Finite Element Analysis

Recommended Reading

Textbook

1. J.N. Reddy: An Introduction to the Finite Element Method, McGraw Hill, New York.
2. Larry Segerlind: Applied Finite Element Analysis, John Wiley.

References

1. Bathe KJ: Finite Element Procedures, Prentice Hall.
2. Edward Champion: Finite Element Analysis in Manufacturing Engineering, McGraw Hill.
3. K.J. Bathe and Wilson E L., Finite Element Procedures, Prentice Hall.
4. Huebner K H and Thornton E A: The Finite Element Methods for Engineers, John Wiley& Sons.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-I
Course Code	PE5110S	
Course Title	Advanced Machine Tool Design	

COURSE OBJECTIVES

1. To make the students understand the concepts & broad principles of contents of machine tool design
2. Develop conceptual framework of machine tool design
3. Aim is to provide insight of machine tool drives ,transmission and design
4. Sensitizes the students of the importance of course in real life environment

COURSE OUTCOMES

At the end of the course student will be in a position to

1. Able to understand of basic parts and mechanisms of machine tools
2. Impart advance design practice of machine tools with the modern design techniques and tools.
3. Be able to analyze the stress and strain on machine tool components; and understand, identify and
4. quantify failure modes for mechanical parts
5. List down the factors that influence the application of the course content in the industrial environment
6. Undertake final year project work based upon the application of the course content
7. Identify areas for research oriented work based on the course content
8. Apply the knowledge of the course in solving real life problems

SYLLABUS

1. Drives

   Machine Tool Drive working and auxiliary motion in machine, Machine tool drives, Hydraulic transmission, Mechanical transmission, General requirements of machine tool design, Layout of machine tools
2. Regulation of Speed and Feed Rates

   Objectives of speed feed regulation, stepped regulation of speed, design of speed box, Design of feed box, Special cases of gear box design, Set stopped regulation of speed and feed rates
3. Design of Machine Tool Structure

   Fundamentals of machine tool structures and their requirements, Design criteria of machine tool structure, Static and dynamic stiffness, Design of beds and columns, Design of housing models, Techniques in design of machine tool structure
4. Design of Guide-ways and power Screws

   Function and type of guide-ways, design of slide-ways, Protecting devices for Slide-ways, Design of power screws
5. Design of Spindles and Spindle Supports

   Materials for spindles, Design of spindles, Antifriction bearings, Sliding bearings.
6. Dynamics of Machines Tools

   General procedure of assessing dynamic stability of EES, Cutting processing, Closed loop

   System, Dynamic characteristics of cutting process, Stability analysis.

Recommended Reading

Textbook

1. N.K. Mehta: Machine Tool Design, Tata McGraw Hill
2. Gopal Chandra Sen and Amitabh Bhattacharya: Principles of Machine Tools, New Central Book Agency.

References

1. CMTI, Bangalore : Machine Tool Design Handbook
2. PSG Design Data Book

Elective III

Programme Name	M. Tech. (Production Engineering)	SEMESTER-II
Course Code	PE5111S	
Course Title	**Green Manufacturing**	

COURSE OBJECTIVES

1. To make awareness amongst learners for adoption of green manufacturing practices which are environment friendly
2. Prepare graduates with technical competency through imparting advanced, relevant and in depth knowledge in areas of green manufacturing technology practices preferring multidisciplinary approach so as to make them readily employable.

COURSE OUTCOMES

1. They will be able to contribute to society through adopting Environmentally conscious manufacturing practices.
2. They will be able to implement green manufacturing practices through benchmarking.
3. They will help to ensure sustainability of business through optimized use of resources.

SYLLABUS

1. Environmentally conscious manufacturing overview, environmental strategies overview, environmental tools overview, Cleaner production, CP for manufacturing, CP for other sectors, Environmental audits, energy audits, eco-efficiency, improvement in resource productivity material intensity per unit service, How a company can become water neutral, carbon neutral, setting benchmarks, eco-effectiveness, waste accounting practices, making business case for cleaner production, industrial ecology, ecological footprint.
2. Life cycle assessment of a product: philosophy, framework goal and scope definition, inventory analysis, impact assessment, available software, application of LCA.

3. Design for environment: ugliness of products, framework, philosophy, strategies, application of DFE, ecolabelling, green marketing, Greening of supply chain: concept, impact of supply chain on environment, strategies to reduce the impact, role of companies in promoting green manufacturing in the supply chain. International trades and environmental directives.
4. Environmental assessment of an industry. Strategies and tools and how these fit into the sustainable development frame work.

Recommended Reading

Textbook

1. Thomas Graedel and Jennifer Howard-Grenville: Greening the Industrial Facility Perspectives, Approaches and Tools, Springer Science.

References

1. Freeman H.M., industrial Pollution Prevention Handbook, McGraw Hill International
2. Sarkis : Green Manufacturing Operations: From Design to Delivery and Back, Greenleaf Publishers.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-II
Course Code	PE5112S	
Course Title	Organizational Behavior and Human Resource Management	

COURSE OBJECTIVES

1. Provide in depth understanding of theoretical development in human resource management and OB.
2. Impart critical knowledge of leadership, GD, communication, motivation so to enable it to apply to practice to use these resources efficiently and effectively.

COURSE OUTCOMES

1. They will be able to understand role of Human Resource Management in performance of the organization.
3. They will be able to demonstrate Managerial skills required to handle the complex situation in organization.
2. They will be able to improve performance of organization through the use of organizational behavior & HR knowledge.
3. They will provide leadership for the organization.

SYLLABUS

1. Human Resource Management

   Strategic Human Resource Management, Creating Learning organizations, Corporate Social Responsibility, Value creation through HRM, Talent acquisition and Talent management, Business Leadership, Organization culture, Time management, Conflict management, Work values, HR Valuation and accounting, Emotional intelligence.

2. Organizational Behaviour

   Introduction to Organisational behavior, Management & Managers, OB-The Emerging Challenges, Historical Evaluation of Organisational Behavior, Foundation of Individual Behavior, Intelligence, Personality, Perceptions & attribution, Learning, attitudes & values, Motivation – Theories & principles, Applied Motivation Practices, Work Stress, Group dynamics, Team Dynamics, Power & political behavior, Conflict & negotiation, Leadership, Communication, Organizations, Organizational culture, Creativity & innovation, Organizational change & development, Decision making, Human resource policy & practices, International Organizational behavior.

Recommended Reading

Textbook

1. K. Aswathappa: Organizational Behavior, Himalaya Publications

References

1. Tiffin and Mc Cormack :Industrial Psychology
2. Katz and Kahn: Social Psychology of Organization Behavior by
3. Porter and Lawler :Handbook of Industrial Psychology
4. Ghosh and Ghorpade : Industrial Psychology

Programme Name	M. Tech. (Production Engineering)	SEMESTER-II
Course Code	PE5113S	
Course Title	**Sustainable Manufacturing & Supply Chain**	

COURSE OBJECTIVES

1. To provide strategic framework to analyze and design supply chain.
2. Impart analytical and conceptual skills in managing supply chain in coordinated manner.
3. Provide foundation for sustainable and eco-friendly management of entire product lifecycle.

COURSE OUTCOMES

1. Develop modeling capability for designing supply chain network; planning demand and supply; planning and managing inventories, transportation network.
2. Learn primary modeling in supply chain coordination.
3. Student would apply principles of sustainable and eco-friendly management of entire product lifecycle particularly using closed loop supply chain.

SYLLABUS

1. Sustainable Manufacturing, Green Manufacturing, Value Stream Mapping.
2. Building a Strategic Framework to analyze Supply Chains
   Understanding the supply chain, supply chain performance, supply chain drivers and metrics
3. Designing the Supply Chain Network
   Designing distribution, networks and applications to business, network design in the supply chain and in an uncertain environment.
4. Planning Demand and Supply in a Supply Chain
   Demand Forecasting in a supply chain, aggregate planning in a supply chain, managing predictable variability.
5. Planning and Managing Inventories in a Supply Chain
   Managing economics of scale in a supply chain, managing uncertainty in a supply chain, determining the optimal level of product availability.

6. Designing and Planning Transportation Networks
7. Managing Cross Functional Drivers in a Supply Chain Sourcing decisions in a supply chain, information technology in a supply chain.

Recommended Reading

Textbook

1. Sunil Chopra, Peter Meindel and Kalra D.V: Supply Chain Management: Strategy, Planning & Operation, Pearson Prentice Hall.
2. Janat Shah, Supply Chain Management: Texts & Cases, Prentice Hall India

References

1. Chitale A.K., Gupta R.C. & Gupta H.N : Materials Management Texts & Cases, PHI.
2. B. Mahadevan : The New Manufacturing Architecture, Tata McGraw Hill.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-II
Course Code	PE5114S	
Course Title	**Materials Management**	

COURSE OBJECTIVES

The main objective of this course is to introduce the material management concepts to the students. Study the different inventory control practices.

COURSE OUTCOME

1. Deepen critical understanding of material management system to plan materials requirement for a given final product.
2. Impart analytical capability of MRP-I, MRP-II, ERP systems.
3. Provide capability to design inventory systems.

SYLLABUS

1. Introduction

   Introduction to material management and productivity, functions of material management, organization structures in material management, role of material management techniques in improved material productivity.

2. Material Planning

   Objectives, material requirement planning, manufacturing resource planning, JIT production planning, strategic material planning, material control: acceptance, sampling, inspection, make or buy decision, simple cost analysis, economic analysis, break even analysis, breakeven point theory, whether to add or drop a product line store management and warehousing, product explosion.

3. Purchasing

   Importance of good purchasing system, organization of purchasing functions, purchase policy and procedures, responsibility and limitations, purchasing decisions, purchasing role in new product development, role of purchasing in cost reduction, negotiations and purchase, purchasing research: identification of right sources of supply, vendor rating, standardization, vendor certification plans, vendor and supply reliability, developing new source of supply.

4. Cost reduction

   Cost control v/s cost reduction, price analysis, material cost reduction techniques, variety reduction, cost reduction and value improvement, techniques of cost control, standard costing, cost effectiveness, cost analysis for material management, material flow cost control

5. Inventory management

   Inventory v/s stores, types of inventory, inventory control, inventory build–up, EOQ, various inventory models, inventory models with quantity discount, exchange curve concept, coverage analysis, optimal stocking and issuing policies, inventory management of perishable commodities, ABC–VED analysis, design of inventory distribution systems, surplus management, information system for inventory management, case studies.

Recommended Reading

Textbook

1 P. Gopalkrishnan and M. Sundersen : Material management- An integrated approach, Prentice Hall International.

2 J.R.T.Arnold and S.N. Chapman: Materials Management, Pearson Learning.

References

1 A. K. Dutta: Materials Management, Prentice Hall International.

2 D. S. Ammer : Material Management, Richard Erwin Inc.

3. W. R. Stelzer : Material management, Prentice Hall International.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-II
Course Code	PE5115S	
Course Title	**Automobile Engineering**	

COURSE OBJECTIVES

The objective of this course is to provide the student adequate knowledge of basic Automobile Engineering concepts, working principles related to anatomy of automobile, automobile systems, and recent trends in automobiles.

COURSE OUTCOMES

1. Familiarize students with automotive systems and their design aspects
2. Provide knowledge of current trends in automotive electronics, engine design, fuel alternatives and body design.

SYLLABUS

1. Anatomy of Automobiles

   History and Classifications of automobiles, Understanding Vehicle specifications (in terms of vehicle dimensions, weight and parameters), Current knowledge about Domestic and Global Automobile Industry (various companies, their products, their strengths, their area of operations etc).

2. Overview of Automobile systems

   Power Generation System: Engine, Fuels, Intake systems, Exhaust Systems, Cooling.

   Power Transmission System: Clutch, Gear Box, Transfer Case, Propeller Shaft, Differential, Wheels & Tyres.

   Running Systems : Suspension system, Steering, Braking system

   Comfort System: Battery, Charging System, Alternator.

3. Body Engineering

   Importance of Body design, Materials for body construction-Styling forms-Coach and bus body style, layouts of passenger cars, Bus and truck bodies. Aerodynamic drag, Basic dimensions, Overall Criteria for vehicle comparison, Chassis types and structure types, Frames.

4. Recent Trends in Automobiles

   Electronic Control module (ECM), operating modes of ECM (closed loop and open loop) Inputs required and output signals from ECM, Electronic Spark control, Air Management system, Idle speed control. Multipoint fuel injection system and single point fuel injection. Electronic fuel injectors. Principle of operation, Construction, working & application of temperature sensors, inductive sensors, Position sensors (rotary, linear), Pressure sensors, Knock sensors, Hot wire and thin film air flow sensors, vortex flow/turbine fluid sensors, Optical sensor, Oxygen sensors, Light sensors, methanol sensors, Rain sensor, New developments in the sensor technology, Vehicle Telemetric.

Recommended Reading

Textbook

1. Kirpal Singh, Automobile Engineering (Volume -1 & 2), Standard Publishers Distributors

References

1. T.R. Banga & Nathu Singh, Automobile Engineering, Khanna Publications.
2. Harbans Singh Reyat: The Automobile, S. Chand Limited.
3. William Crouse: Automotive Mechanics, Tata McGraw-Hill Education
4. Joseph Heitner: Automotive Mechanics- Principles and Practices, CBS Publishers
5. Tom Denton: Automobile Electrical and Electronic Systems, Taylor & Francis.
6. Giuseppe Pia and Andrea Tonoli: Automotive Body Design, Vol II System Design Springer Science

Elective IV

Programme Name	M. Tech. (Production Engineering)	SEMESTER-II
Course Code	PE5116S	
Course Title	**Operations Strategy**	

COURSE OBJECTIVES

1. To understand fundamentals of operations strategy and its relevance with business performance.
2. To learn how to prepare a comprehensive framework for development of operations strategy in a given competitive environment and overall business strategy.
3. To impart knowledge regarding operations strategy of successful firms through case studies.

COURSE OUTCOMES

1. They will be able to understand principles of competitive strategy and apply to different industries.
2. They will be able to determine which outputs win orders in the market best suited to produce those results.
3. They will be able to select appropriate operations strategy for competitive advantage.
4. They will be able to examine process improvement programs for gaining competitive advantage.

SYLLABUS

1. Principles of Strategy

   Principles of competitive strategy, partnerships, challenges, and responses. Introduction, need and concepts of operations strategy and links with corporate strategy.

   Operations Strategy in a Factory**:** Manufacturing Outputs and Production Systems, Manufacturing Levers and Capability.

2. Competitive Analysis

   Selecting the Best Production System. Framework for Manufacturing Strategy -Process of formulation and implementation. Emerging theory of manufacturing. Time the new source of competitive strategy. Competing through manufacturing.

3. Operations Strategy in an International network of factories

   Principles of international competitive strategy, manufacturing in the world's major trading regions, manufacturing networks, network outputs, levers and capability, factory-types in international manufacturing networks.

4. Programs used frequently in Operations strategy

   Operations Strategy and Business Strategy. Integrating Operations strategy with business strategy

   -Improvement programs in operations, Focus, soft technologies, hard technologies, benefits of experience and the product life cycle, Evaluation of investments in manufacturing. Seven Production Systems for Focused Factories

   Job shop production system, Batch flow production system, Flexible manufacturing system, Operator-paced line flow production system, Just-in-Tine production system, Equipment-paced line flow production system, Continuous flow production system.

Recommended Reading

Textbook

1. Robert Hayes, Gary Pisano and David Upton: Strategic Operations, Competing through Capabilities. The Free Press
2. John Miltenberg: Manufacturing Strategy, Productivity Press.

References

1. Terry Hill : Manufacturing Strategy, McGraw-Hill, Irwin Inc.

Programme Name	M. Tech. (Production Engineering)	SEMESTER-II
Course Code	PE5117S	
Course Title	**Product Lifecycle Management**	

COURSE OBJECTIVES

1. Demonstrate an understanding of PLM concepts, particularly product data management, change management, workflows and configurations
2. Demonstrate literacy in the application of a PDM tool to support product development processes.

COURSE OUTCOMES

1. Designing products with consideration to business constraints.
2. Understanding the market aspects involved and process involved in bringing new products to the marketplace.
3. Understand the principal issues involved in technical product management throughout all phases of the product life cycle.
4. Be able to develop, plan and manage with a product management plan that covers design, development, test, marketing and sales, and customer support.
5. Be skilled at participating in the development of a strategic plan that relates to organizational objectives for a product or product area including its phase out and replacement at the end of the product life cycle.

SYLLABUS

1. Introduction

   Definition, PLM Lifecycle model, Threads of PLM, Need for PLM, Opportunities and benefits of PLM, Views, Components and Phases of PLM, PLM feasibility study, PLM visioning.

2. PLM Concepts, Processes and Workflow

   Characteristics of PLM, Environment driving PLM,PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of PLM.

3. Product Data Management (PDM) Process and Workflow

   PDM systems and importance, reason for implementing a PDM system, financial justification of PDM implementation. Versioning, check-in and checkout, views, Metadata, Lifecycle, and workflow. Applied problems and solution on PDM processes and workflow.

4. Collaborative Product Development

   Engineering vaulting, product reuse, smart parts, engineering change management, Bill of materials and process consistency, Digital mock-up and prototype development, design for environment, virtual testing and validation, marketing collateral.

5. Developing a PLM strategy and conducting a PLM assessment

   Strategy, Impact of strategy, implementing a PLM strategy, PLM initiatives to support corporate objectives. Infrastructure assessment, assessment of current systems and applications.

Recommended Reading

References

1. Michael Grieves: Product Lifecycle Management, McGraw-Hill.
2. Antti Saaksvuori, Anselmilmmonen: Product Life Cycle Management, Springer
3. John Stark :Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer-Verlag

Programme Name	M. Tech. (Production Engineering)	SEMESTER-II
Course Code	PE PE5118S	
Course Title	**Tribology**	

COURSE OBJECTIVES

1. Provide comprehensive knowledge of tribological system and applied aspects, developing capability for designing these systems and components.
2. Familiarize students with modern trend so as to prepare them to undertake research in these areas

COURSE OUTCOMES

1. Students would have capability for solving quantitative problems in Tribology and design different mechanical elements such as bearings, cams.
2. The student would apply the knowledge to manufacturing –rolling, forging, wire drawing, extrusion to bring down frictional losses

SYLLABUS

1. Introduction

   Tribological systems and their characteristic features: Analysis and assessment of surface; topography; deterministic and stochastic tribo-models for asperity contacts; techniques of surface examination; technological properties of surfaces. Quantitative laws of sliding friction, causes of friction, adhesion theory, laws of rolling friction, measurement of friction.

2. Wear Mechanism

   Introduction, mechanism of wear, types of wear, quantitative laws of wear, measurement of wear, wears resistance materials.

3. Lubrication

   Introduction, dry friction, boundary lubrication, hydrodynamic, hydrostatic and elasto-hydrodynamic lubrication, functions of lubricants, types and properties, lubricant additives. Principles, application to rolling contact bearings, cams, Gears.

4. Bearing Design

   Geometry and pressure equation of journal bearing, hydrostatic bearings, thrust bearings, porous bearings and hydrodynamic gas bearings. Journal bearings with specialized applications. General requirements and different types of bearing materials.

Recommended Reading

Textbook

1. Sushil Kumar Srivastava : Tribology in Industries, S Chand Publishers, New Delhi
2. B.C. Majumdar: Introduction to Tribology of Bearings, A.H.Wheeler Publishers

References

1. Shizhu Wen, Ping Huang : Principles of Tribology , Wiley
2. Dorinson and Ludema : Mechanics and Chemistry of Lubrication, Elsevier
3. Robinowicz: Friction and Wear of Materials, John Wiley

Programme Name	M. Tech. (Production Engineering)	SEMESTER-II
Course Code	PE5119S	
Course Title	**Mechanical Metallurgy**	

COURSE OBJECTIVES

1. Deepened understanding of interacting stress and strain in the material and mechanical aspects of material properties
2. Understanding deformation behaviour of material through dislocation theory and strengthening mechanism
3. Provide insight into mechanical testing methods and failure mechanism
4. Apply theory of deformation to manufacturing processes to determine forces of deformation and load

COURSE OUTCOMES

1. Student would be able to analyze three dimensional stress-strains in a deforming body in elastic and plastic deformation.
2. Capable of applying knowledge of deformation behaviour to strengthen the materials.
3. Able to interpret information /data of testing for required application.
4. Able to determine forces of deformation and load for metal forming and cutting processes.

SYLLABUS

1. Mechanical Fundamentals

   Elastic and plastic behaviour –Engineering and true stress strain curves along with impact of strain rate, temperature ductile brittle behaviour. Concept and type of stress and strains. Stress –strain elastic relations. Plane and three dimensional Mohr circle diagrams. Hydrostatic and deviator stress components. Stain energy and anisotropic elastic behaviour. Stress concentration .Finite Element method applications

   Theory of plasticity-True stress strain. Yield criterion. Flow curves. Plastic stress strain relationship. Octahedral stress strain. Slip line field theory.

2. Metallurgical Fundamentals

Deformation in single crystals. Slip by dislocation movement. CRSS. Deformation in FCC crystals, stacking fault energy. Dislocation theory.

Strengthening mechanisms-Grain boundary deformation and strengthening. Solid solution, fine particle, fiber strengthening, strain hardening, annealing of cold worked metals. Preferred orientation (texturing).Type of fractures in metals.

3. Application to Material testing

Tension test- Tensile properties and effect of strain rate, temperature. Tensile properties of steel, copper, aluminium. Anisotropy. Torsion test

Hardness Test-Basics of standard test-Brinell, Rockwell, Vickers, Meyer. Micro-hardness test. Relationship between flow stress and hardness. Hardness at elevated temperature. Fracture mechanics-stress intensity factor, toughness of material. Probabilistic aspect of fracture mechanics.

Fatigue of metals-stress cycle and SN Curves. Structural features of fatigue. Stress concentration effect on fatigue. Combined stress impact. Design for fatigue and infinite life. Corrosion fatigue .Effect of temperature on fatigue.

Brittle fracture and impact test-Problem of brittle fracture. Transition temperature. Flow and fracture under very rapid rate of loading.

4. Plastic Forming of Metals

Fundamentals of metal working-Mechanics of forming. Flow stress determination. Metal working and temperature, strain rate, metallurgical aspects, friction and lubrication. Hydrostatic pressure. Workability. Experimental techniques in metal forming.

Application of Forming processes: Forging- Analysis and Load calculation for plane strain forging and closed die forging.

Rolling-Forces and geometrical relations in rolling. Simplified analysis of rolling force, torque and power.

Extrusion- Analysis of process and load determination for hot extrusion, impact extrusion.

Drawing of rod, wire, and tube –tonnage determination.

Sheet metal forming-Load computation and blank development.

Mechanics of metal cutting.

Recommended Reading

Textbook

1. George Dieter: Mechanical Metallurgy, McGraw Hill International.
2. Rowe G W: Principles of Industrial Metal Working Processes, CBS Publication, New Delhi

References

1. Sadhu Singh :Theory of Elasticity, Khanna Publishers, New Delhi
2. Sadhu Singh: Theory of Plasticity, Khanna Publishers, New Delhi.
3. Hibbler R.C: Mechanics of Materials: Pearson Prentice Hall.
4. Sanford R.J.: Principles of Fracture Mechanics: Prentice Hall, New Jersey.
5. ASM: Handbook of Metal forming, Vol 13
6. ASM: Handbook of Metal Testing, Vol 03

Programme Name	M. Tech. (Production Engineering)	SEMESTER-II
Course Code	PE5120S	
Course Title	**Advanced Refrigeration and Air Conditioning**	

COURSE OBJECTIVES

This course is designed to provide a practical experience in HVAC & Refrigeration. Fundamentals of HVAC and Refrigeration are covered along with their practical implementations. Working and design of refrigeration and Air conditioning equipments like compressors, condensers, evaporators, expansion devices, Cooling towers, Cold storage units, Freezers, Ice plant, Water coolers will be studied.

COURSE OUTCOMES

1. Fundamental knowledge of Air Conditioning and Refrigeration.
2. Understanding of refrigeration cycles and their practical importance.
3. Identification of Primary Components in Air Conditioning and Refrigeration units and their working.
4. Knowledge of differences, types, and classifications of Refrigerants & Oils used in HVAC and refrigeration.
5. Design of Air conditioning system, refrigeration units, Air distribution Ducts from manufacturing point of view.

SYLLABUS

1. **Refrigeration Fundamentals:**

   Introduction to refrigeration system, Methods of refrigeration, Carnot refrigeration cycle, Unit of refrigeration, Refrigeration effect and C.O.P.

   Open and closed air refrigeration cycles, Reversed Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART).

2. **Vapour Compression Cycle (V.C.C)**

   Working Principle, components, Representation on P-H and T-S diagram, effects of wet compression, dry compression, calculation of COP, Effect of superheating, under cooling, suction pressure and discharge pressure, Actual V.C.C., (simple numerical), Methods of improving COP, Introduction to multistage V.C.C., its necessity, advantages.

Vapour Absorption System: Working Principal of vapour absorption refrigeration system, Comparison between absorption & compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature – concentration diagram & Enthalpy – concentration diagram, Adiabatic mixing of two streams, Ammonia – Water vapour absorption system, Lithium- Bromide water vapour absorption system, Comparison.

Refrigerants: Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants and CFC free refrigerants.

3. **Air Conditioning**

   Introduction to air conditioning, Psychometric properties and their definitions, Psychometric chart, Different Psychometric processes, Thermal analysis of human body, Effective temperature and comfort chart, Cooling and heating load calculations, Selection of inside & outside design conditions, Heat transfer through walls & roofs, Infiltration & ventilation, Internal heat gain, Sensible heat factor (SHF), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP).

4. **Refrigeration Equipments**

   Elementary knowledge of RAC equipments- compressors, condensers, evaporators & expansion devices, Air washers, Cooling, towers & humidifying efficiency, Food preservation, Cold storage, Refrigerates Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans, Basic difference between comfort and industrial air conditioning.

Recommended Reading

Textbook

1. C.P Arora: Refrigeration and Air Conditioning, Tata McGraw Hill
2. Arora and Domkundwar: Refrigeration and Air Conditioning, Dhanpat Rai Publications New Delhi.

References

1. Manohar Prasad: Refrigeration and Air conditioning, New Age International
2. Wilbert Stoecker and Jerold Jones: Refrigeration and Air Conditioning. McGraw-Hill Higher Education
3. Roy Dossat: Refrigeration and Air Conditioning Pearson Education
4. P. L. Ballaney : Refrigeration and Air Conditioning, Khanna Publications

Programme Name	M. Tech. (Production Engineering)	SEMESTER-II
Course Code	PE5121S	
Course Title	**Design for Manufacturing and Assembly**	

COURSE OBJECTIVES:

The objectives of this course are:

1. This course will introduce the student to the principles of design for manufacturing and assembly
2. Examining the modern manufacturing operations and assembly techniques
3. Introduce the students different manufacturing process, capabilities and limitations along with a principles of assembling the parts

COURSE OUTCOMES

1. Provide comprehensive, critical and holistic knowledge of major manufacturing processes so as to enable the students to select proper combination that meet requirements of component and system efficiently and economically.
2. Understand and include manufacturing and assembly aspect in design stage.

SYLLABUS

1. Introduction

Design philosophy. General design rules for manufacturability, economical production, creativity in design.

Materials: Selection of materials. Developments in material technology, criteria for material selection, material selection inter-relationship with process selection, process selection charts.

Machining process: Overview of various machining processes, general design rules for machining - dimensional tolerance and surface roughness, Design for machining, Ease, Redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

Metal casting: Appraisal of various casting processes, selection of casting process, - general design considerations for casting, casting tolerances, use of solidification simulation in casting design, product design rules for sand casting.

2. Design for Manufacturing

Appraisal of various welding processes, Factors in design of elements, general design guidelines, pre and post treatment of welds, effects of thermal stresses in weld joints,

design of brazed joints.

Design factors and guidelines for forging, extrusion, sheet metal components. Development of the assemble process, choice of assembly methods, advantages. Social effects of automation. Automatic assembly transfer systems: continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine.

Design of manual assembly: Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.

3. Manufacturing Guidelines

   DFM guidelines for casting, weldment design – formed metal components – turned parts – milled, drilled parts – non-metallic parts – Computer Aided DFM software – Boothroyd and Dewhurst method of DFMA – DCS – Vis/VSA – 3D Dimensional control –Statistical tolerance Analysis Software – Applications.

4. Tolerance Chart

   Nature of the tolerance buildup – structure and setup of the tolerance chart – piece part sketches for tolerance charts – Arithmetic ground rules for tolerance charts –. Determination of Required balance dimensions – Determination of Mean working dimensions – Automatic tolerance charting – Tolerance charting of Angular surfaces.

Recommended Reading

Textbook

1. George E. Dieter : Engineering Design – Material & Processing Approach, McGraw Hill International
2. Geoffrey Boothroyd, Marcel and Dekker: Hand Book of Product Design

References

1. Serope Kalpakjian: Manufacturing processes and Materials ,PHI

Programme Name	M. Tech. (Production Engineering)	SEMESTER-II
Course Code	PE5901-4 D	
Course Title	**Project**	

COURSE OUTCOMES:

1. To acquaint the student with overall functioning of an industrial organization, exposure to the organization structure, allied direct/indirect activities and procedures associated with the production function.
2. To obtain deep understanding and develop specialization in a area of student's interest
3. Develop ability to apply knowledge of diverse subject in integrative manner to solve practical problems.
4. Develop ability to present technical work in succinct, orderly and unambiguous manner.
5. The student is expected to write at least two research papers based on his project work to develop aptitude for undertaking research in future.

Approach

A project work with a defined problem, solution methodology and expected outcome is essential to tackle real life problem, appropriate case study and investigative assignments. A student is expected to undertake detailed review of extant literature to deepen the understanding of the area of specialization and develop approach and devise solution methodology for a given problem. Investigative and analytical approach looking at a problem in it's entirely and not in isolation. The project report should contain problem definition and objective, background information, possible approaches and approach selected data identification, analysis or investigation carried out, results and concluding discussion. Develop skill in presenting a factual report on specification directed study stressing clarity, brevity and simplicity of styles.

Areas

1. Process engineering and planning
2. Design and manufacture of production tooling.
3. Product / process innovation and development
4. Production Management
5. Quality control, SQC, SPC, TQM and rejection analysis.
6. Cost reduction, value engineering/analysis, method improvement, productivity analysis and improvement, layout and material handling investigation.
7. Industrial engineering and operations research