सावित्रीबाईफुले पुणे विद्यापीठ

Savitribai Phule Pune University, Pune

(Formerly University of Pune)

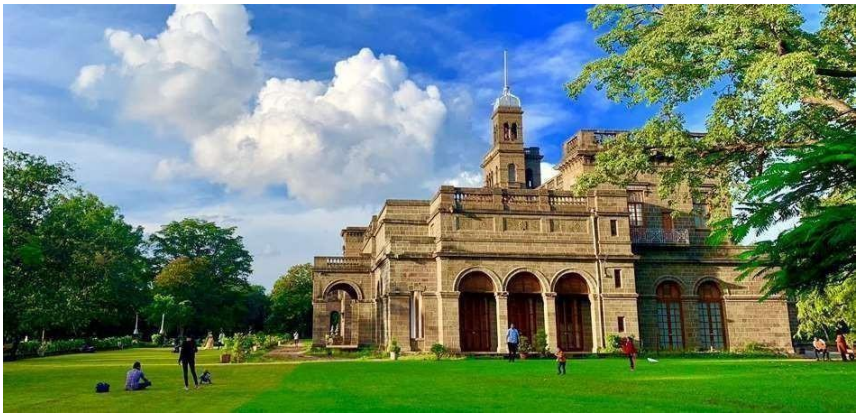
Syllabus

TE (**Production Engineering)**

(2024 Pattern)

(With effect from Academic Year 2026-27)

National Education Policy (NEP)-2020 Compliant Curriculum



Contents

Abbreviations

AEC	Ability Enhancement Course
BSC	Basic Science Course
CCC	Co-Curricular Courses
CCE	Comprehensive Continuous Evaluation
CEP	Common Engineering Project
CO	Course Outcome
ELC	Experiential Learning Courses
ESC	Engineering Science Course
FP	Field Project
IKS	Indian Knowledge System
INT	Internship
MDM	Multidisciplinary Minor
NEP	National Education Policy
OE	Open Elective
OJT	On Job Training
PCC	PCC
PEC	Programme Elective Course
PO	Program Outcomes
PR	Practical
PRJ	Project
PSO	Program Specific Outcome
RM	Research Methodology
TH	Theory
TU	Tutorials
VEC	Value Education Course
VSE	Vocational and Skill Enhancement Course

Preface by Board of Studies

Dear Students and Faculty Members,

We, the members of the Board of Studies in Production and Industrial Engineering, are pleased to present the revised syllabus for Third year Production Engineering, effective from the Academic Year 2026–27. This curriculum will be progressively implemented for Final Year in the academic years 2027–28.

Production engineering is a specialized branch of engineering focused on planning, designing, and optimizing the manufacturing process. It merges manufacturing technology with management science to turn raw materials into finished goods as efficiently, safely, and cost-effectively as possible. It helps in design and implementation of production systems and automated solutions across industries. This curriculum aims to provide students with a strong foundation in core concepts, emerging technologies, and practical applications, while preparing them for the dynamic landscape of Industry 4.0 and beyond.

The syllabus has been carefully aligned with the vision of the National Education Policy (NEP) 2020, and adheres to the guidelines of Savitribai Phule Pune University, AICTE, UGC, and leading accreditation bodies. It emphasizes innovation, multidisciplinary learning, and industry relevance to ensure students are well-equipped for the future.

This outcome-based curriculum has been developed through collaborative input from academic experts, industry professionals, and alumni. It not only addresses current industry needs but also nurtures the skills required for higher studies, research, and entrepreneurial ventures in the field of robotics and automation.

We are confident that this revised curriculum will empower students to emerge as technically sound, ethically responsible, and future-ready professionals, contributing meaningfully to society and the technological ecosystem.

Dr.K N Nandurkar
Co-ordinator
Board of Studies (Production and Industrial Engineering)

Members of Board of Studies: Production and Industrial Engineering	
Dr S S Ohol	Dr N G Shekapure
Dr S H Wankhade	Dr S M Kherde
Dr K R Borole	Dr N K Kamble
Dr R S Katikar	Dr V M Deshpande
Dr S S Sarnabot	Mr Nilesh Bagul
Dr S S Patil	

Program Specific Outcomes (PSO)

PSO1: Interdisciplinary Engineering Skills: The ability to apply knowledge from mechanical systems, electronics, control systems, and manufacturing processes to design, analyze, and implement intelligent manufacturing systems.

PSO2: Problem Solving and Innovation: The ability to model, simulate, and optimize manufacturing processes using modern engineering tools and methodologies to solve real - world industrial and societal challenges.

PSO3: Professional Growth and Entrepreneurship: The ability to pursue successful careers in manufacturing, industrial automation and related fields, with an entrepreneurial mindset and a commitment to lifelong learning, innovation, and societal development.

Programme Educational Objectives (PEO)

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

PEO	PEO Focus	PEO Statements
PEO1	**Core Competence**	Attainment of fundamental principles of Mechanical, electrical, and manufacturing engineering to enable graduates to design, build and operate various manufacturing systems.
PEO2	**Problem Solving and Ethics**	Ability to analyze engineering problems and provide Sustainable manufacturing solutions while adhering to ethical practices and engineering standards.
PEO3	**Professionalism and Lifelong Learning**	Cultivate professionalism, a spirit of innovation, and a lifelong learning attitude to adapt to emerging technologies and make meaningful contributions to industry and society.

Knowledge and Attitude Profile (WK)

A Knowledge and Attitude Profile (KAP), often represented as WK (Knowledge and Attitude Profile) in some contexts, is a framework or assessment tool used to evaluate an individual's knowledge and attitudes related to a specific area, topic, or domain.

WK1	A systematic, theory-based understanding of natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Engagement with selected knowledge in current research literature of discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9	Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Reference: Self-Assessment Report (SAR) Format Undergraduate Engineering Programs Graduate Attributes and Professional Competencies Version 4.0 (GAPC V4.0) - (August 2024) Page 55.

Program Outcomes (POs)

PO1 – Engineering Knowledge

Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2 – Problem Analysis

Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3 – Design/Development of Solutions

Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4 – Conduct Investigations of Complex Problems

Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5 – Engineering Tool Usage

Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6 – The Engineer and The World

Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7 – Ethics

Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8 – Individual and Collaborative Teamwork

Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9 – Communication

Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10 – Project Management and Finance

Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11 – Life-Long Learning

Recognize the need for and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

General Rules and Guidelines

- **Course Outcomes (CO):** Course Outcomes are narrower statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behavior that students acquire in their progress through the course.
- **Assessment:** Assessment is one or more processes, carried out by the institution, that identify, collect, and prepare data to evaluate the achievement of Program Educational Objectives and Program Outcomes.
- **Evaluation:** Evaluation is one or more processes done by the Evaluation Team, for interpreting the data and evidence accumulated through assessment practices. Evaluation determines the extent to which Program Educational Objectives or Program Outcomes are being achieved, and results in decisions and actions to improve the program

Guidelines for Examination Scheme

Theory Examination: The theory examination shall be conducted in two different parts Comprehensive Continuous Evaluation (CCE) and End-Semester Examination (ESE).

Comprehensive Continuous Evaluation (CCE) :

1. CCE of 30 marks based on all the Units of course syllabus to be scheduled and conducted at institute level.
2. Case studies included under each unit are intended to support applied learning and are part of Comprehensive Continuous Evaluation
3. These case studies will be assessed through internal assessment components such as presentations, assignments, or group discussions. They shall not be included in the End-Semester Theory Examination.
4. To design a Comprehensive Continuous Evaluation scheme for a theory subject of 30 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Sr.	Parameters	Marks	Coverage of Units
1	Unit Test	12 Marks	Units 1 & Unit 2 (6 Marks/Unit)
2	Assignments / Case Study	12 Marks	Units 3 & Unit 4 (6 Marks/Unit)
3	Seminar Presentation / Open Book Test/ Quiz	06 Marks	Unit 5

5. CCE of 15 marks based on all the Units of course syllabus to be scheduled and conducted at institute level. To design a CCE scheme for a theory subject of 15 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Sr.	Parameters	Marks	Coverage of Units
1	Unit Test	10 Marks	Units 1 & Unit 2 (5 Marks/Unit)
2	Seminar Presentation / Open Book Test/ Assignments/Case Studies	05 Marks	Units 3 & Unit 4

Format and Implementation of Comprehensive Continuous Evaluation (CCE)

- Unit Test Format: Questions designed as per Bloom's Taxonomy guidelines to assess various cognitive levels (Remember, Understand, Apply, Analyze, Evaluate, Create).
  - **Implementation**: Schedule the test after completing Units 1 and 2. Ensure the question paper is balanced and covers key concepts and applications.

- Sample Question Distribution
  - Remembering (2 Marks): Define key terms related to [Topic from Units 1 and 2].
  - Understanding (2 Marks): Explain the principle of [Concept] in [Context].
  - Applying (2 Marks): Demonstrate how [Concept] can be used in [Scenario].
  - Analyzing (3 Marks): Compare & contrast [Two related concepts] from Units 1 and 2.
  - Evaluating (3 Marks): Evaluate the effectiveness of [Theory/Model] in [Situation].

- **Assignments / Case Study:** Students should submit one assignment or one Case Study Report based on Unit 3 and one assignment or one Case Study Report based on Unit 4.
  - **Format:** Problem-solving tasks, theoretical questions, practical exercises, or case studies that require in-depth analysis and application of concepts.
  - **Implementation:** Distribute the assignments or case study after covering Units 3 and 4. Provide clear guidelines and a rubric for evaluation.

- Seminar Presentation:
  - **Format:** Oral presentation on a topic from Unit 5, followed by a Q&A session.
  - **Deliverables:** Presentation slides, a summary report in 2 to 3 pages, and performance during the presentation.
  - **Implementation:** Schedule the seminar presentations towards the end of the course. Provide students with ample time to prepare and offer guidance on presentation skills.

- Open Book Test:
  - **Format:** Analytical and application-based questions to assess depth of understanding.
  - **Implementation:** Schedule the open book test towards the end of the course, ensuring it covers critical aspects of Unit 5.

- Quiz :
  - **Format:** Quizzes can help your students practice existing knowledge while stimulating interest in learning about new topics in that course. You can set your quizzes to be completed individually or in small groups.
  - **Implementation:** Online tools and software can be used to create a quiz. Each quiz is made up of a variety of question types including multiple choice, missing words, true or false, etc.
- Example Timeline for conducting CCE:
  - Weeks 1-4 : Cover Units 1 and 2
  - Week 5 : Conduct Unit Test (12 marks)
  - Weeks 6-8 : Cover Units 3 and 4
  - Week 9 : Distribute and collect Assignments / Case Study (12 marks)
  - Weeks 10-12 : Cover Unit 5

-Week 13 : Conduct Seminar Presentations or Open Book Test or Quiz (6 marks)

– Evaluation and Feedback:

- **Unit Test:** Evaluate promptly and provide constructive feedback on strengths and areas for improvement.
- **Assignments / Case Study:** Assess the quality of submissions based on the provided rubric. Offer feedback to help students understand their performance.
- **Seminar Presentation:** Evaluate based on content, delivery, and engagement during the Q&A session. Provide feedback on presentation skills and comprehension of the topic.
- **Open Book Test**: Evaluate based on the depth of analysis and application of concepts. Provide feedback on critical thinking and problem-solving skills.

End-Semester Examination (ESE)

End-Semester Examination (ESE) of 70 marks written theory examination based on all the unit of course syllabus scheduled by university. Question papers will be sent by the University through QPD (Question Paper Delivery). University will schedule and conduct ESE at the end of the semester.

- Format and Implementation:

- **Question Paper Design:** Below structure is to be followed to design an End-Semester Examination (ESE) for a theory subject of 70 marks on all 5 units of the syllabus with questions set as per Bloom's Taxonomy guidelines and 14 marks allocated per unit.

- **Balanced Coverage**: Ensure balanced coverage of all units with questions that assess differ-ent cognitive levels of Bloom's Taxonomy: Remember, Understand, Apply, Analyze, Evaluate, and Create. The questions should be structured to cover:
  * Remembering: Basic recall of facts and concepts.
  * Understanding: Explanation of ideas or concepts.
  * Applying: Use of information in new situations.
  * Analyzing: Drawing connections among ideas.
  * Evaluating: Justifying a decision or course of action.
  * Creating: Producing new or original work (if applicable).

- **Detailed Scheme for 70 Marks:** Unit-Wise Allocation (14 Marks per Unit): Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.
- **Detailed Scheme for 35 Marks:** Unit-Wise Allocation (08 Marks for Unit 1 , 09 Marks for Unit 2, Unit 3 and Unit 4): Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.

NEP2020CompliantCurriculumStructure

Third Year Engineering (2024Pattern)

Production Engineering

Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks						Credits			
			Theory	Tutorial	Practical	CCE*	End-Sem	Termwork	Practical	Oral	Total	Theory	Tutorial	Practical	Total
	Semester V														
PCC-301-PEE	PCC	Material Forming Technology	3	-	-	30	70	-	-	-	**100**	3	-	-	**3**
PCC-302-PEE	PCC	Machining Science and Technology	3	-	-	30	70	-	-	-	**100**	3	-	-	**3**
PCC-303-PEE	PCC	Metrology and Instrumentation	3	-	-	30	70	-	-	-	**100**	3	-	-	**3**
PCC-304-PEE	PCC	Material Forming Technology Lab	-	-	2	-	-	25	25	-	**50**	-	-	1	1
PCC-305-PEE	PCC	Machining Science and Technology Lab	-	-	4	-	-	25	-	25	**50**	-	-	2	2
PEC321-PEE	PEC	Program Elective1	3	-	-	30	70	-	-	-	**100**	3	-	-	3
PEC322- PEE	PEC	Program Elective1 Lab	-	-	2	-	-	25	-	-	25	-	-	1	1
MDM331 PEE	MDM-3	Quality Management	-	2	2	-	-	25	25	-	**50**	-	2	1	3
	OE	Open Elective	2	-	-	30	70	-	-	-	**100**	2	-	-	2
ELC342- PEE	Technical Seminar	Technical Seminar			2				25		**25**			1	1
Total			**14**	**2**	**12**	**150**	**350**	**100**	**75**	**25**	**700**	**14**	**2**	**6**	**22**

***Note:** Students can opt for Open Electives offered by different discipline/faculty like Arts, Science, Commerce, Management, Humanities or Inter-Disciplinary studies. Example – Open Elective I- IPR and Cyber Laws, Sustainability Development, Digital Personal Data Protection, The Constitution of India

Program Elective1-

a) Finite Element Analysis
b) Advanced Manufacturing Systems
c) Machine Tool design
d) Supply Chain Management

NEP 2020Compliant Curriculum Structure

Third Year Engineering (2024 Pattern)

Production Engineering

Course Code	Course Type	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks						Credits			
			Theory	Tutorial	Practical	CCE*	End-Sem	Termwork	Practical	Oral	Total	Theory	Tutorial	Practical	Total
	Semester VI														
PCC-351-PEE	PCC	Production and Operations Management	3	-	-	30	70	-	-		100	3	-	-	3
PCC-352-PEE	PCC	Process Engineering and Resource Planning	2	-	-	30	70	-	-	-	100	2	-	-	2
PCC-353-PEE	PCC	Production and Operations Management Lab	-	-	4	-	-	25	25		50	-	-	2	2
PCC-354-PEE	PCC	Process Engineering and Resource Planning Lab	-	-	2	-	-	25	-	25	50	-	-	1	1
PEC361- PEE	PEC-2	Program Elective2	3	-	-	30	70	-	-	-	100	3	-	-	3
PEC362- PEE	PEC-3	Program Elective3	3	-	-	30	70	-	-	-	100	3	-	-	3
PEC363- PEE	PEC-Lab	Program Elective2Lab	-	-	2	-	-	25		25	50	-	-	1	1
MDM371- PEE	MDM-4	Materials Management	-	1	2	-	-	25	25		50	-	1	1	2
MDM372- PEE	VSEC	CNC Programming	-	-	2	-	-	50	-	-	50	-	-	1	1
ELC381- PEE	Internship /OJT	Experiential Learning Course (Internship/OJT)	-	-	8	-	-	-	50		50	-	-	4	4
Total			**11**	**1**	**20**	**120**	**280**	**150**	**100**	**50**	**700**	**11**	**1**	**10**	**22**

Program Elective 2-

a) Advanced Manufacturing Processes
b) Mechatronics
c) Production Tooling
d) Industrial Robotics

Program Elective 3-

a) Product Design and Development
b) Precision Manufacturing
c) Statistics and Numerical Methods
c) Financial Management

Savitribai Phule Pune University
Third Year of Engineering (2024Pattern)

Course Code: PCC-301-PEE

Course Name: Material Forming Technology

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	**03**	**CCE : 40Marks** **End-Semester: 60Marks**

Prerequisite Courses, if any: Manufacturing process

Course Objectives:

1. Introduce the fundamentals of material deformation and the mechanics of metal forming processes.
2. Explain stress–strain behavior and plastic deformation of materials under different forming conditions.
3. Study bulk deformation processes such as rolling, forging, extrusion, and wire drawing.
4. Understand sheet metal forming processes including bending, deep drawing, and shearing operations.
5. Analyze defects, tooling, lubrication, and process parameters affecting product quality.

Course Outcomes:

After successful completion of the course, learner will be able to:

1: Explain the principles of plastic deformation and stress–strain relationships in forming processes.
2: Analyze mechanics of bulk deformation processes such as rolling, forging, extrusion, and drawing.
3: Apply analytical models to estimate forces, power, and energy requirements in forming operations.
4: Describe sheet metal forming processes and analyze defects and failure modes.
5: Select appropriate material forming processes, tools, and lubricants for given industrial applications.

Course Contents

Unit I	Fundamentals of Material Forming	(06Hours)

Introduction of forming processes. Concept of plastic deformation Classification of material forming process, True stress-True strain, Strain hardening, flow stress determination, Theory of plasticity, Yield criteria for ductile materials: Von- mises criteria, Tresca criteria. Effect of temperature, strain rate, friction, metallurgical microstructure. Concept of Formability, formability limits and formability diagram

Unit II	Forging	(06Hours)

Introduction, Classification of forging processes. Forging equipment- Hammers, presses, Up setter etc., construction, working, capacities and selection of equipment. Basic forging operations such as Fullering, edging, drawing, blocking, finishing etc., Types of forging dies, Forge ability tests, design of forging as a product, friction in forging. Cleaning and finishing of forgings, Forging defects and the remedies. Analysis of forging with sliding and sticking friction, New technologies: Liquid metal forging, isothermal forging, No draft forging, P/M forging, Rotary swaging, roll forging, Lubrications in forging.

Unit III	Rolling of Metals	(06Hours)
Scope and importance of rolling. Types of Rolling Mills - Construction and working. Roll bite, reduction, elongation and spread. Deformation in rolling and determination forces required. Process variables, redundant deformation. Roll flattening, Roll cambering, Mill spring – its effect on rolling process. Defects in rolling. Automatic gauge control(AGC), Roll pass classification & design. Lubrication in rolling.		
Unit IV	**Wire, Rod ,Tube Drawing and Extrusion**	**(06Hours)**
Introduction to rod and wire drawing machines - construction and working. Preparation of stock for wire drawing. Wire drawing dies, material and design. Analysis of wire drawing operation, Variables in wire drawing, Maximum reduction in wire in one pass, forces required in drawing. Multiple drawing, work hardening, lubrication in wire drawing, strip drawing. **Tube Drawing**: Methods, force calculation, stock preparation. lubrication in tube drawing. Types: Direct, Indirect, impact, hydrostatic extrusion. Dies for extrusion, stock preparation. Extrusion ratio, Circumscribing circle diameter (CCD), Shape factor. Equipment (with and without friction), Work done in extrusion, Metal flow in extrusion, defects. Role of friction and lubricants. Manufacture of seam-less tubes.		
Unit V	**Advances in Metal Forming**	**(06Hours)**
High Energy Rate Forming process (HERF), High Velocity Forming(HVF) - principles, comparison with conventional forming processes. Explosive forming, Magnetic pulse forming, Electro hydraulic Forming. Petro-forge forming , Micro forming, Microcoining, micro extrusion, Micro bending, Stretch forming, coining embossing, curling spinning, flow forming advantages, limitations and application of the process, methods of measuring friction in metal forming		

Learning Resources

Text Books:

1. Dieter, “Mechanical Metallurgy” ISBN0071004068
2. P.N. Rao, “Manufacturing Technology”, Tata-McGraw Hill ISBN0070087695
3. G.W. Rowe, “Principles of Industrial Metal Working Process”, Edward Arnold ISBN8123904282.
4. Juneja B. L., “Fundamentals of metal forming processes”, New Age International Ltd

Reference Books:

1.Dr. R. Narayanswamy, Metal Forming Technology, Ahuja Book Co., ISBN8176190020
2. Surender Kumar, Principles of Metal Working.
3. ASM: Metal Handbook, Volume 14, “Forming”.
4. SME: Tool and Manufacturing Engineers Handbook, Volume 2, “Forming”

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Third Year of Engineering(2024Pattern)

Course Code: PCC-302-PEE

Course Name: Machining Science and Technology

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	**03**	**CCE : 40Marks** **End-Semester: 60Marks**

Prerequisite Courses, if any: Manufacturing process

Course Objectives:

1. Introduce the basic concepts of machining science like mechanics of machining,
2. Explain Tool wear, tool life and cutting forces
3. Study the different cutting tool geometry and economics of machining.
4. Understand the different cutting tools Calculate the cutting force components in orthogonal cutting.
5. Analyze aspects of economics of machining in practice and design of single point and multipoint tools

Course Outcomes:

After successful completion of the course, learner will be able to:

1. Know with the basic concepts of machining science like mechanics of machining,
2. Evaluate Tool wear, tool life and cutting forces
3. Infer the different cutting tool geometry and economics of machining
4. Design and draw the different cutting tools Calculate the cutting force components in orthogonal cutting
5. Apply aspects of economics of machining in practice and design of single point and multipoint tools.

Course Contents

Unit I	Mechanics of Machining	(06Hours)

Mechanics of chip formation, Types of chips Orthogonal & oblique cutting, Concept of feed, depth of cut and cutting speed, Geometry of single point tool, Tool signature, Mechanics of metal cutting- effect of tool-geometry and other cutting parameters, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant's assumptions, Merchant circle and derivation of relationships between the cutting forces, chip thickness ratio, shear angle, stress and strain in the chip, work done and power required in metal cutting. Numericals based on metal-cutting

Unit II	Cutting tool Materials, standards &Dynamometry	(06Hours)

Cutting tool materials, Desirable properties of tool material, Coated tools , Coating techniques on tool, Heat treatment of tools Tool angle specification systems-British system, American system, German system, ISO system,
Nonconventional tool geometry: Koleshov tool, Antichatter tool, Gustin tool,
Classification of dynamometers, Study of working principles in Lathe, Milling, Drilling, Grinding dynamometers, piezoelectric dynamometry

Unit III	Thermal aspect, Tool life& Economics of cutting tools	(06Hours)

Sources of heat generation, Temperature in primary and secondary deformation zone, ,Effect of cutting speed on temperature, Tool wear and its type, Tool wear mechanism, Types of cutting fluids, Functions of cutting fluids, Characteristics of cutting fluid Selection of cutting fluids, Taylor's Tool life equation. Factors affecting tool life, Tool failure criteria. Machinability, Machinability rating, Machinability criteria, Economics of machining, Criteria for minimum cost & maximum production. Numerical based on tool life.

Unit IV	Tool life and machining economics:	(06Hours)

Definition, flank wear and crater wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life. Taylors tool life equation. Experimental methods to find Taylor exponents. Components of product cost, Optimum cutting velocity for minimum cost of production and maximum production rate.

Unit V	Design of single point cutting and Multi point cutting tools	(06Hours)

Design of shanks for single point solid cutting tools , tipped tools, , Chip breakers Throwaway indexable inserts , ANSI inserts specification, ANSI tool holder specification for indexable insert. Design of single point solid cutting tool .Deign of drills, reamers, broaches, milling cutters, form tools, grinding wheels. Constructional details and fields of application of multipoint cutting tools.

Learning Resources

Text Books:

1. Wilson, “Fundamentals of tool design”, A.S.T.M.E.
2. Dr.B.J. Runganath ”Metal Cutting and Tool Design”, Vikas publication, ISBN0706975103
3. G. Kuppuswamy, “Principles of Metal Cutting”, University press, ISBN 8173710287.
4. Basu, Mukherjee and Mishra, “Fundamentals of Tool Engineering and Design”, Oxford publishing. ISBN812040016X

Reference Books:

1.P C Sharma, “Production Engineering”, Khanna publishers. ISBN 8121904218.
2. P.C. Sharma, “Machine tools & Tool Design”. Khanna publishers, ISBN:812192362X.
3. Surender Kumar, “Production Engineering Design”, Satya Publication
4. Dolalson, Lecain and Goold, “Tool design”, Tata McGrawhill.ISBN0070992746.
5. Hoffman, “Introduction to Jigs and fixtures” Delnar Cengage Learning Publication
6. “Tool Engineering Handbook”, A.S.T.M.E.
7. R. K. Jain, “Production Technology”, KhannaPublishers.ISBN8174090991
8. Milton Shaw, “Metal cutting principle” CBS Publication

Savitribai Phule Pune University
Third Year of Engineering (2024Pattern)

Course Code: PCC-303-PEE

Course Name: Metrology and Instrumentation

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	03	CCE : 40Marks End-Semester: 60Marks

Prerequisite Courses, if any:

- Basic knowledge of Engineering drawing, Machine drawing, Dimensioning and tolerances, various geometrical features.
- Various manufacturing processes and their capabilities, correlation between operating parameters and process responses.
- Basic knowledge of standard machine tools such as: Lathe, Drilling machine, Milling Machine, etc.
- Basic knowledge of standard machine components such as: Gear, spring, Screw threads etc.

Course Objectives:

1. Introduce the fundamentals of metrology and its importance in precision manufacturing and quality control.
2. Explain standards of measurement, limits, fits, and tolerances used in engineering practice.
3. Develop understanding of measurement errors, uncertainty, and calibration of instruments.
4. Introduce principles of sensors, transducers, and instrumentation systems for measuring physical quantities.
5. Explain students to advanced and modern measurement techniques used in industry.

Course Outcomes:

After successful completion of the course, learner will be able to:

1. Explain the principles of metrology, standards of measurement, and their role in manufacturing quality.
2. Design limit gauges and work with special measuring devices for gear, screw thread and surface finish measurements
3. Use linear and angular measuring instruments for accurate measurements, Distinguish various comparators and use profile projector
4. Describe the working principles and applications of sensors, transducers, and instrumentation systems.
5. Explain advanced measurement systems such as comparators, CMM, optical, and laser-based instruments.

Course Contents

Unit I	Concept of measurement, Limits, fits and tolerances	(06Hours)

Linear Measurement: Precision and Non-Precision Measuring instruments, Slip Gauges. Angular Measurement: Sine bar, Sine Center, Uses of sine bars, angle gauges, Auto Collimator, Angle Dekkor. Comparators: Uses, Types, Advantages and Disadvantages of various Comparators. Cost-Tolerance relationship, concept of Interchangeability, selective assembly, Indian Standard System. Design of limits Gauges using Taylor's Principle, Interferometry: Introduction, Flatness testing by interferometry, NPL Interferometer.

Unit II	Measurement of Thread, Gear and Surface finish Transforms	(06Hours)

Screw Thread Metrology: External Screw Thread terminology, effective diameter measurement methods, Pitch and flank Measurement of External Screw Thread, Application of Tool Maker's Microscope, Use of Profile Projector.

Gear Metrology: Spur Gear Parameters, Gear tooth thickness measurement: Gear tooth vernier caliper, Constant chord method, Span Micrometer, Base tangent method.

Surface Finish Measurement: methods of evaluation of surface roughness, Tomlinson's Surface Recorder, Talysurf and Taylor-Hobson Surface Meter Recent Trends in Engineering Metrology, Universal coordinate measuring machine (CMM)

Unit III	Quality Assurance tools and techniques	(06Hours)
Meaning of Quality, Quality of Product, Quality of Service, Cost of Quality, Value of Quality, Introduction to Statistical Quality Control: Control Charts, X, R, P and C Charts, Sampling inspection, OC Curves and Sampling Plans, Process Capability Index (PCI), Quality Assurance tools and techniques, Total quality management (T.Q.M):- Deming's and Juran's Approach, Seven quality tools and new seven quality tools, Q.F.D., Quality Circles, Kaizen, six sigma, T.P.M. Introduction to ISO 9001-2000, ISO 9000- 1998 Series standards, ISO 14000, TS 16949 Standards		
Unit IV	**Introduction to measuring Instruments**	**(06Hours)**
Classification of measuring instrument, Stages in generalized measuring system – Sensor-Transducer stage, Signal Conditioning stage, Readout-Recording stage; Types of input quantities; Active and Passive transducers. Performance characteristic of measuring devices –Static and dynamic		
Unit V	**Measurement of stress, vibration and temperature**	**(06Hours)**
Measuring instruments for - Strain and Stress Measurement, Force and torque, Vibration measurement, Temperature Measurement		

Learning Resources

Text Books:

1. K.J. Hume, "Engineering Metrology", Kalyani publication
2. K.W.B. Sharp, "Practical Engineering Metrology", Pitman Publication
3. F. M. Gryna, R. Chua & J. Defco, "Juran's Quality Planning and Analysis for Enterprise Quality", McGraw Hill series

Reference Books:

1. R.K. Jain, "Engineering Metrology", Khanna Publication.
2. I.C. Gupta, "A Textbook of Engineering Metrology", Dhanpat Rai and Sons.
3. Kaoru Ishikawa, "Guide to Quality Control", Asian Productivity Organization,
4. Juran's Quality Handbook
5. Thomas G. Beckwith, John H. L., Roy D. M., Mechanical Measurements, 6/E , Pearson Prentice Hall, 2007
6. Ernest O. Doebelin, Dhanesh N. Manik, Measurement Systems Application and Design, McGraw-Hill, 2004

Savitribai Phule Pune University Third Year of Engineering (2024 Pattern) Course Code: PCC-304-PEE Course Name: Material Forming Technology Lab		
Teaching Scheme	**Credit**	**Examination Scheme**
Practical : 2Hours/Week	**01**	**Pr: 25 Marks** **TW: 25Marks**
Oral will be based on term-work below Term work shall consist of: 1. Assignment based on each topic of syllabus 2. Study of roll pass design for one structural shape -Round or Square 3. Report on Industrial visit (Min. 2 Industrial visit)		

Savitribai Phule Pune University
Third Year of Engineering (2024Pattern)

Course Code: PCC-305-PEE

Course Name: Machining Science and Technology Lab

Teaching Scheme	Credit	Examination Scheme
Practical : 4Hours/Week	**02**	**Oral : 25 Marks** **TW: 25Marks**

Oral will be based on term-work andExperiments:
List of Experiments:
1. Experiments on chip formation.
2. Measurement of cutting forces (anyone) in Turning / Milling /Drilling.
3. Study of effect of tool geometry, cutting speed, feed, depth of cut on cutting parameters.
4. Design and working drawing of single point cutting tools
5. Design and working drawing of drills and reamers
6. Design and working drawing of broach
7. Design and working drawing of milling cutter

Savitribai Phule Pune University
Third Year of Engineering (2024Pattern)

Course Code: PEC-321-PEE

Course Name: Program Elective1- a) Finite Element Analysis

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	**03**	**CCE : 40Marks** **End-Semester: 60Marks**

Prerequisite Courses: Fundamentals of Programming Language, Engineering Mechanics, Strength of Material, Kinematics of Manufacturing Machines, Design of Machine Elements, Heat and Fluid Engineering

Course Objectives:

1. Model and analyze one-dimensional engineering problems using the finite element method.
2. Develop finite element models of truss structures subjected to mechanical loading and analyze their structural response.
3. Formulate and analyze two-dimensional problems using constant strain triangular (CST) elements.
4. Perform finite element modeling of triangular elements and two-dimensional isoparametric elements for engineering applications.
5. Analyze steady-state heat transfer problems, including one-dimensional and two-dimensional heat conduction and convection using FEA.

Course Outcomes:

After successful completion of course, student will be able to,

1. Model and Analyze 1-D problem.
2. Model and Analyze Truss subjected to loading
3. Model and Analyze Two-Dimensional Problem Using Constant Strain Triangles
4. Perform finite element modeling of triangular element and 2-D iso-parametric elements
5. Analyze steady state heat transfer - 1D and 2D heat conduction and convection

Course Contents

Unit I	**Introduction**	**(06Hours)**

Introduction, One-Dimensional Problem, Finite Element modeling, Coordinate and Shape function, Derivation of stiffness matrix and Load Vector using Potential Energy approach, Properties of Stiffness Matrix, Assembly of Global Stiffness Matrix and Load Vector, Elimination and penalty approach, shape function, Quadratic Shape Function.

Unit II	**Trusses**	**(06Hours)**

Introduction to different approaches used in FEA such as direct approach, Variational approach, weighted residual, energy approach, Galerkin and Raleigh Ritz approach, Introduction to Plane trusses, Assembly of global Stiffness Matrix for Banded Skyline solutions.

Unit III	**Two-Dimensional Problem Using Constant Strain Triangles**	**(06Hours)**

Introduction, finite element formulation, load considerations and boundary conditions, problem modeling, member end forces, plane frame.

Formulation of elemental stiffness matrix and load vector for Plane stress/strain such as Linear Strain Rectangle (LSR), Constant Strain Triangles (CST), Pascal's triangle , primary and secondary variables, properties of shape functions.

Unit IV	**Axi-symmetric solids subjected to axi-symmetric loading**	**(06Hours)**

Introduction, axi-symmetric formulation, finite element modeling of triangular element

Two-dimensional iso-parametric elements- Introduction, four node quadrilaterals, introduction to higher order elements.

Unit V	Finite element analysis of heat transfer and Dynamic analysis	(06Hours)

Introduction, steady state heat transfer - 1D and 2D heat conduction and convection, governing differential equation, boundary conditions, formulation of element, Types of dynamic analysis, General dynamic equation of motion, point and distributed mass, lumped and Consistent mass, Mass matrices formulation of bar and beam element.

Learning Resources

Text Books:

1. Daryl L. Logan, A First Course in the Finite Element Method,
2. Seshu P., Textbook of Finite Element Analysis, PHI Learning Private Ltd. New Delhi, 2010.3.
3. R. D. Cook, et al., Concepts and Applications of Finite Element Analysis, Wiley, India

Reference Books:

1. Chandrupatla T. R. and Belegunda A. D., ―Introduction to Finite Elements in Engineering‖, Prentice Hall India.
3. Bathe K. J., Finite Element Procedures, Prentice-Hall of India (P) Ltd., New Delhi.
4. Fagan M. J., Finite Element Analysis, Theory and Practice, Pearson Education Limited
5. Kwon Y. W., Bang H., Finite Element Method using MATLAB, CRC Press, 1997
6. S. Moaveni, Finite element analysis, theory and application with Ansys,
7. Fundamental of Finite Element Analysis, David V. Hutton, Tata McGraw-Hill
8. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite, Pune

Savitribai Phule Pune University
Third Year of Engineering(2024Pattern)

Course Code: PEC-321-PEE

Course Name: Program Elective1- b) Advanced Manufacturing Systems

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	03	CCE : 40Marks End-Semester: 60Marks

Prerequisite Courses: Basics of manufacturing processes, industrial engineering, statical and numerical methods, operation research, basics of simulations.

Course Objectives:

1. To Learn the way of analyzing the systems.
2. Classification of systems-based nature of dynamics and knowledge of elements.
3. To develop simulation model for dynamic discrete - event stochastic system.
4. To run the model and collect the data.
5. To analyze the output data of simulation for specified for performance measures based on type of simulation and method of output data analysis.

Course Outcomes:

After successful completion of course student will be able to,

2. Define the state of system W.R.T specified performance measures
3. Identify Dynamic Discrete- event stochastic system.
4. Develop simulation model for the said system
5. Analyze the model and present the results to specified confidence level
6. Demonstrate the output data of simulation for specified for performance measures bases on type of simulation

Course Contents

Unit I	Introduction of Advanced Manufacturing Systems	(06Hours)

System - ways to analyze the system - Model - types of models - Simulation - Definition - Types of simulation models - steps involved in simulation - Advantages & Disadvantages. Parameter estimation - estimator - properties - estimate - point estimate - confidence interval estimates - independent - dependent - hypothesis - types of hypotheses- steps - types 1& 2 errors - Framing - strong law of large numbers.

Unit II	Building of Simulation model	(06Hours)

Validation – verification – credibility – their timing – principles of valid simulation Modeling – Techniques for verification – statistical procedures for developing credible model. Modeling of stochastic input elements – importance – various procedures – theoretical distribution – continuous – discrete – their suitability in modeling.

Unit III	Generation of random variants	(06Hours)

factors for selection - methods - inverse transform - composition - convolution - acceptance - rejection - generation of random variables - exponential - uniform - Weibull - normal Bernoulli - Binomial - uniform - poison. Simulation languages - comparison of simulation languages with general purpose languages - Simulation languages vs Simulators - software features - statistical capabilities - G P S S - SIMAN-SIMSCRIPT -Simulation of M/M/1 queue - comparison of simulation languages.

Unit IV	Output data analysis	(06Hours)

Types of Simulation with respect to output data analysis - warm up period Welch algorithm - Approaches for Steady - State Analysis - replication - Batch means methods - comparisons.

Unit V	Applications of Simulation	(06Hours)
flow shop system – job shop system – M/M/1 queues with infinite and finite capacities – Simple fixed period inventory system – New boy paper problem		

Learning Resources

Text Books:

1. Simulation Modelling and Analysis by Law, A.M. & Kelton, McGraw Hill, 2nd Edition, New York,
2. Discrete Event System Simulation by Banks J. & Carson J.S., PH, Englewood Cliffs, NJ, 1984.

Reference Books:

1. Simulation of Manufacturing Systems by Carrie A., Wiley, NY, 1990.
2. A Course in Simulation by Ross, S.M., McMillan, NY, 1990.
3. Simulation Modelling and SIMNET by Taha H.A., PH, Englewood Cliffs, NJ, 1987

Savitribai Phule Pune University
Third Year of Engineering (2024 Pattern)
Course Code: PEC-321-PEE
Course Name: Program Elective1- c) Machine Tool design

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	03	CCE : 40Marks End-Semester: 60Marks

Prerequisite Courses :Machine Tool Operations, Mechanics of Materials and Design of Machine Elements, Kinematics of Manufacturing Machines.

Course Objectives:

1. An ability to apply knowledge of Machine tool Design.
2. An ability to identify & solve engineering problems.
3. An ability to identify, conduct experiments as well as analyze the data.
4. An ability to design a system, component to meet the desired needs of subject to constraints.
5. Proficiency in process, assembly and product engineering
6. Understand the design of machine tools

Course Outcomes:

After successful completion of course student will be able to,

1. Design multi-stage gear box for machine tool applications
2. Design machine tool structures like bed, column, table.
3. Design of bearings, powers crews, guideways etc.
4. Perform the analysis of vibration and dynamic characteristics of machine tools
5. Design of Stepless drives and mechanical variators.

Course Contents

Unit I	**Gear Box Design**	**(08Hours)**

Design considerations for drives based on continuous and intermittent requirement of power, Types and selection of motor for the drive, Regulation and range of speed based on preferred number series, geometric progression. Design of speed gear box for spindle drive and feed gear box.

Unit II	**Design of Machine Tool Structures**	**(07Hours)**

Analysis of forces on machine tool structure, static and dynamic stiffness. Design of beds, columns, housings, bases and tables. Design of spindle and spindle support using deflection and rigidity analysis, analysis of Antifriction bearings, preloading of antifriction bearing.

Unit III	**Design of Guide ways and Power Screw**	**(07Hours)**

Functions and types of guide ways, design criteria and calculation for slide ways, design of Hydrodynamic, hydrostatic and aerostatic slide ways, Stick-Slip motion in slide ways. Design of power screws: Distribution of load and rigidity analysis.

Unit IV	**Controls and Stability of machine tools**	**(06Hours)**

Dynamic characteristic of the cutting process, Stability analysis, vibrations of machine tools. Control Systems: Mechanical and Electrical, Adaptive Control System, relays, push button control, electrical brakes, drum control.

Unit V	**Special Features of Machine Tools**	**(067Hours)**

Design considerations of Stepless drives, electromechanical system of regulation, friction, and ball variators, PIV drive, Epicyclic drive, principle of self locking, Machine tool monitoring and safety.

Learning Resources

Text Books:

1 Mehta N.K., —Machine Tool Design and Numerical ControlII, Tata McGraw Hill,2002, ISBN 0-07-451775-9.
2. Bhattacharya A. and Sen S.G., —Principles of Machine Tool, New central book agency Calcutta, 2009, ISBN 81-7381-1555.

Reference Books:

1. Pal D.K., Basu S.K., Design of Machine Tool, 4th Edition. Oxford IBH 2005, ISBN:81204-0968.
2. Date P. P., ―Introduction to Manufacturing Technology, Principles and Practices, Jayco Publishers, Mumbai,2010, ISBN8179929973, 9788179929971
3. Koenigsberger F., Design Principles of Metal Cutting Machine Tools, The Macmillan Company, New York
4. CMTI Banglore, ―Machine tool design handbookll Tata McGraw-Hill, New Delhi, 1982

Savitribai Phule Pune University
Third Year of Engineering (2024Pattern)
Course Code: PEC-321-PEE
Course Name: Program Elective1- d) Supply Chain Management

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	03	CCE : 40Marks End-Semester: 60Marks

Prerequisite Courses: Basic principles of management and organizational functions, Basic concepts of inventory management such as EOQ, safety stock, and reorder levels., Elementary knowledge of logistics and transportation systems.

Course Objectives:

1. Introduce the fundamental concepts and scope of Supply Chain Management, including its role in organizational competitiveness.
2. Explain strategic sourcing and procurement practices for effective supplier selection and relationship management.
3. Provide knowledge of warehouse management systems and distribution operations for efficient material handling and storage.
4. Develop understanding of supply chain network design and integration across suppliers, manufacturers, and distributors.
5. Explain demand planning, inventory management, and supply planning techniques to balance cost and service levels.

Course Outcomes:

After successful completion of course student will be able to,

1: Explain the concepts, objectives, and importance of Supply Chain Management in modern organizations.
2: Apply strategic sourcing and procurement strategies for effective supplier and cost management.
3: Analyze warehouse management and distribution operations to improve efficiency and responsiveness.
4: Evaluate supply chain network design decisions and integration strategies.
5: Apply demand forecasting, inventory control, and supply planning techniques in supply chain systems.

Course Contents

Unit I	**Introduction**	**(06Hours)**

Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases - Supplier- Manufacturer Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy - Supply Chain Performance Measures.

Unit II	**Strategic Sourcing**	**(06Hours)**

Outsourcing – Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation. Creating a world class supply base- Supplier Development - World Wide Sourcing.

Unit III	**Warehouse Management**	**(06Hours)**

Stores management-stores systems and procedures-incoming materials control-stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling-transportation and traffic management -operational efficiency productivity-cost effectiveness-performance measurement

Unit IV	**Supply Chain Network**	**(06Hours)**

Distribution Network Design – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models. Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design decisions using Decision trees

Unit V	**Planning Demand, Inventory and Supply**	**(06Hours)**

Managing supply chain cycle inventory. Uncertainty in the supply chain –- Analyzing impact of supply chain redesign on the inventory - Risk Pooling - Managing inventory for short life - cycle products -multiple item -multiple location inventory management. Pricing and Revenue Management.

Learning Resources

Text Books:

1.Janat Shah, Supply Chain Management – Text and Cases, Pearson Education, 2009.
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson Education, 2013.
3. Daniel Stanton, Supply Chain Management For Dummies, John Wiley & Sons, 2017,
4. Martin Christopher, Logistics & Supply Chain Management, Pearson UK,

Reference Books:

1. Ballou Ronald H, Business Logistics and Supply Chain Management, Pearson Education, 5 th Edition, 2007.
2. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill, 2005.
3. Altekar Rahul V, Supply Chain Management-Concept and Cases, PHI, 2005.
4. Shapiro Jeremy F, Modeling the Supply Chain, Thomson Learning, Second Reprint, 2002.
5. Joel D. Wisner, G. Keong Leong, Keah-Choon Tan, Principles of Supply Chain Management- A Balanced Approach, South-Western, Cengage Learning 2008

Savitribai Phule Pune University
Third Year of Engineering(2024Pattern)

Course Code: PEC-322-PEE

Course Name: Program Elective1-Lab - a) Finite Element Analysis

Teaching Scheme	Credit	Examination Scheme
Practical : 2Hours/Week	**02**	**Practical : 00Marks** **TW : 25Marks**

Term work shall consist of following Practical's:

1. Computer program for axial bar subjected to axial forces.
2. Computer program for truss subjected to plane forces
3. Computer program for beams subjected to transverse forces and moments
4. Stress and deflection analysis of two-dimensional truss using FEA software
5. Stress and deflection analysis of any machine component consisting of 2-D elements using FEA software
6. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software
7. Shear force and Bending Moment Calculations of Shaft using FEA software
8. Modal analysis of any machine components.

Savitribai Phule Pune University
Third Year of Engineering(2024Pattern)

Course Code: PEC-322-PEE

Course Name: Program Elective1-Lab - b) Advanced Manufacturing Systems

Teaching Scheme	Credit	Examination Scheme
Practical : 2Hours/Week	**02**	**Practical : 00Marks** **TW : 25Marks**

Term work will be based on term-work below
Term work shall consist of:
1. Assignment based on each topic of syllabus
2. Study of any one software mini tab/design expert
3. Report of one of case study of Advanced Manufacturing Systems from one of industry.

Savitribai Phule Pune University
Third Year of Engineering (2024Pattern)

Course Code: PEC-322-PEE

Course Name: Program Elective1-Lab - c) Machine Tool design

Teaching Scheme	Credit	Examination Scheme
Practical : 2Hours/Week	**02**	**Practical : 00Marks** **TW : 25Marks**

Term work will be based on following term-work

Term work shall consist of:

1. Design and drawing of speed gear box
2. Design and drawing of feed gear box
3. Study of step-less drives.
4. Design of machine tool structure.
5. Design for spindle and power screw.
6. Design for guide ways and slide ways.

Savitribai Phule Pune University
Third Year of Engineering (2024Pattern)

Course Code: PEC-322-PEE

Course Name: Program Elective1-Lab - d) Supply Chain Management

Teaching Scheme	Credit	Examination Scheme
Practical : 2Hours/Week	**02**	**Practical : 00Marks** **TW : 25Marks**

Term work will be based on one assignment on each unit, and any one case studies are to be prepared separately by every project group.

1. Case study on Supplier selection.
2. Case study on Logistics management.
3. Case study on Supply Chain Management

Savitribai Phule Pune University
Third Year of Engineering(2024Pattern)
Course Code: MDM-331-PEE
Course Name: MDM-3-Quality Management

Teaching Scheme	Credit	Examination Scheme
Theory: 1Hours/Week **Practical:** 4Hours/Week	03	**PR:** 25Marks **TW:** 25Marks

Prerequisite Courses: Basic principles of management and organizational functions.,
Fundamentals of production and operations management, including processes and workflows.,
Elementary statistics and data analysis concepts

Course Objectives:

1. Introduce the fundamental concepts quality management, including dimensions of quality, evolution of quality practices, and ISO 9001 standards for organizational excellence.
2. To develop understanding of statistical quality control techniques, process capability analysis, sampling methods, and Six Sigma methodology for effective monitoring and improvement of manufacturing and service processes.
3. To impart knowledge of Total Quality Management (TQM) principles, continuous improvement techniques, quality assurance systems, and lean concepts for achieving organizational excellence and operational efficiency.

Course Outcomes:

After successful completion of course student will be able to,

1: Explain the principles and evolution of quality management systems, and ISO 9001 standards used in modern industries.

2: Apply statistical quality control tools such as control charts, process capability indices, sampling techniques, and Six Sigma DMAIC methodology to analyze and improve process performance and quality.

3: Apply TQM principles, Kaizen, FMEA, ISO 9000 standards, quality audit practices, and lean concepts to improve quality, productivity, and supply chain performance in industrial organizations.

Course Contents

Unit I	Introduction to Quality and Quality Management	**(06Hours)**

Definition of quality, dimensions of quality, Evolution of quality management (Inspection → Quality Control → Total Quality Management), Quality gurus: Deming, Juran, Crosby, Ishikawa, Quality policy, objectives, and quality culture, Quality awards: Deming Prize, Malcolm Baldrige National Quality Award, ISO 9001 standards

Unit II	**Quality Control and Statistical Tools**	**(06Hours)**

Process control and statistical quality control (SQC), Control charts for variables and attributes (X-bar, R, P, C charts), Process capability analysis: Cp, Cpk, Sampling techniques and acceptance sampling, Introduction to Six Sigma concepts and DMAIC methodology

Unit III	**Total Quality Management (TQM) and Quality Systems**	**(06Hours)**

Principles and concepts of TQM, Quality circles and continuous improvement (Kaizen), Failure Mode and Effects Analysis (FMEA), ISO 9000 series standards and quality audits, Lean concepts and integration of quality with production and supply chain

Tutorials (5–6 suggested topics)

1. Case study: Implementation of quality management in a manufacturing company
2. Control chart problems (X-bar, R, P, C charts)
3. Process capability calculation exercises (Cp, Cpk)

4. Acceptance sampling exercises using single and double sampling plans
5. Six Sigma DMAIC case study for a process improvement scenario
6. Analysis of quality award winners (Deming Prize / ISO certified companies)

Assignments / Practical Exercises (6 suggested)

1. Prepare a quality manual for a small manufacturing setup (unit 1 application)
2. Construct control charts using sample data from lab or hypothetical process (unit 2)
3. Calculate process capability indices (Cp, Cpk) for given production data
4. Perform a failure mode and effect analysis (FMEA) for a simple product or process (unit 3)
5. Conduct a mini audit of a lab or workshop process for compliance with ISO 9001 standards
6. Analyze a real-life case study for TQM implementation and prepare a report with recommendations

Learning Resources

Text Books:

1.Janat Shah, Supply Chain Management – Text and Cases, Pearson Education, 2009.
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson
Education, 2013.
3. Daniel Stanton, Supply Chain Management for Dummies, John Wiley & Sons, 2017,
4. Martin Christopher, Logistics & Supply Chain Management, Pearson UK,

Reference Books:

1. Ballou Ronald H, Business Logistics and Supply Chain Management, Pearson Education, 5 th Edition, 2007.
2. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill, 2005.
3. Altekar Rahul V, Supply Chain Management-Concept and Cases, PHI, 2005.
4. Shapiro Jeremy F, Modeling the Supply Chain, Thomson Learning, Second Reprint, 2002.
5. Joel D. Wisner, G. Keong Leong, Keah-Choon Tan, Principles of Supply Chain Management- A Balanced Approach, South-Western, Cengage Learning 2008

Savitribai Phule Pune University
Third Year of Engineering(2024Pattern)

Course Code: ELC-342-PEE

Course Name: Technical Seminar

Teaching Scheme	Credit	Examination Scheme
Practical : 2Hours/Week	**01**	**PR : 25Marks**

1)The objective of Seminar is to test the student on his/her ability for self-study and his/her ability to communicate -Written and oral.

2. Seminar will be in the form of a report submitted by the student:
a) On topic of his/her choice based on literature survey/ a case study wherever applicable/possible and approved by the staff- in- charge.
b) A report with 20-25 pages of A-4 size paper, 1.5 spaced typed material, and appropriately bound.
c) Title font/figures/graphs shall be black and white.

3. The term work evaluation will be based on the report submitted and (orally) presented.

Savitribai Phule Pune University
Third Year of Engineering (2024 Pattern)

Course Code: PCC-351-PEE

Course Name: Production and Operations Management

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	03	CCE : 40Marks End-Semester: 60Marks

Prerequisite Courses, if any: Industrial Engineering and Management

Course Objectives:

1. Develop understanding of production system design, planning, control, and decision-making techniques for efficient manufacturing and service operations.
2. Provide knowledge of product design principles, development processes, and strategies required to create competitive and customer-oriented products.
3. Impart knowledge of production planning and control techniques for efficient scheduling, coordination, and monitoring of manufacturing operations.
4. Develop understanding of facility location, layout design, and material handling systems for efficient production planning and cost optimization.
5. Develop knowledge of modern production planning systems, lean and agile manufacturing, and digital technologies for efficient and sustainable operations.

Course Outcomes:

After successful completion of the course, learner will be able to:

1: Analyze production systems and apply appropriate operational strategies to improve productivity, quality, and efficiency.

2: Design and evaluate products using systematic development methods considering technical, economic, and market factors.

3: Apply PPC methods to plan, schedule, and control production systems for improved productivity and timely delivery.

4: Analyze facility alternatives, design effective layouts, and evaluate material handling systems using quantitative methods.

5: Analyze and apply advanced production planning tools such as MRP, line balancing, and digital supply chain technologies for improved operational performance.

Course Contents

Unit I	Introduction	(06Hours)

An overview of Production and Operations Management (POM), Managing a Production System, Types of Production Systems, Significance of Productivity, Decision making in POM, Problems in POM, Sub functional areas of POM, Recent trends in POM.

Unit II	Product Planning and Development (PPD)	(06Hours)

What is a Product? Need, Objectives and Challenges of PPD, characteristics of Successful Product Development, New Product development Strategy and Process, Factors to be considered in Product Development, The Product Life Cycle Concept, Factors affecting Product Design and Product Development, Stages in Product Design and Product Development.

Unit III	Production Planning and Control	(06Hours)

Classification of PPC functions, Factors determining PPC, procedure Role of PPC in POM, Principles of PPC, PPC in different Production System, Organisation of PPC department

Unit IV	Facility Location and Materials Handling	(06Hours)

The need for location decision, Procedure for making location decisions, Factors affecting location decisions, Methods of evaluating location decisions (numerical on this topic). Facility Layout / Plant Layout Types of Layout, Significance and Factors influencing layout choices, Principles of Plant layout, Computerized Layout Techniques.

Materials Handling

Function, Importance and Objectives of Material Handling, Material handling Principles, Types of Material Handling Systems, Selection of Material Handling Equipments, Evaluation of Material handling Performance Relationship with Plant layout (numerical on this topic)

Unit V	Advance Topics in POM	(06Hours)

Material Requirement Planning (MRP) (numerical on this topic), Manufacturing Resource Planning (MRP II), Enterprise Resource Planning (ERP), Just in Time Manufacturing, Lean Production, Agile Manufacturing, Line Balancing (numerical on this topic), Line of Balance (numerical on this topic), Sustainable Production and Green Manufacturing. Block chain technology for Supply chain monitoring, Materials provenance and counterfeit detection, Identity management, Asset tracking, Quality assurance, Regulatory compliance

Learning Resources

Text Books:

1. Paneerselvam R., “Production and Operations Management”, Prentice Hall India 2012, 3rd Edition ISBN9788120345553
2. Chary S. N., “Production and operations management”, McGraw Hill Education 5th Edition, ISBN 9781259005107
3. Riggs. J. L., “Production system, planning, analysis and control”, John Weily and sons, New York. ISBN 0471858889.
4. James Dilworth, “Production and operation management”, McGraw Hill Book Company, New York. ISBN 9780070169876
5. Martand Telsang, “Industrial Engineering and Production Management”, S Chand & Co, New Delhi. ISBN 8121917735
6. Prasanna Chandra, “Project Planning Analysis Selection Implementation and Review”. ISBN 0074620495

Reference Books:

1. Buffa. E.S., “Modern Production and Operation Management”, Willey, New Delhi. ISBN9971511630.
2. Adam EE & RJ Ebert, “Production and operation management, Prentice Hall Englewood Cliff, N.J. ISBN 8120308387.
3. Garg A. K., “Production and operations management”, McGraw Hill Education 1st Edition, ISBN 9781259005107
4. Samuel Eilon, “Production planning and control”. Universal Publishing Corporation ISBN8185027099.
5. Joseph Monks, “Operation Management Theory and Problems”, McGraw Hill Book Company, New York. (1991), ISBN007100579X.
6. F. L. Francis, J. A. White, L. F. McGinnis, “Facilities Layout and Location”, Prentice Hall of India Pvt. Ltd., ISBN 81-203- 1460-3. 8120314603.
7. Richard Muther, “Systematic Layout Planning, Van Nostrand Reinhold; 2nd edition ISBN978-0933684065

Savitribai Phule Pune University
Third Year of Engineering (2024Pattern)
Course Code: PCC-352-PEE
Course Name: Process Engineering and Resource Planning

Teaching Scheme	Credit	Examination Scheme
Theory : 2Hours/Week	**02**	**CCE : 40Marks** **End-Semester: 60Marks**

Prerequisite Courses, if any: Basic knowledge of CAD, Machine Drawing and Computer Graphics, Manufacturing Process, Cutting Tool Engineering, Production Practice, Industrial Engineering and Management

Course Objectives:

1. Provide understanding of product design interpretation, process planning principles, and coordination required for efficient manufacturing.
2. Develop understanding of dimensional analysis, geometric tolerances, surface integrity, and tolerance calculations required for precision manufacturing.
3. Develop understanding of work piece control, locating principles, and systematic process planning for accurate and efficient manufacturing.
4. Develop understanding of machine selection, tooling systems, and process planning documentation required for efficient manufacturing.
5. Develop understanding for process selection, capacity planning, and computer-aided process planning techniques for efficient manufacturing system design.

Course Outcomes:

After successful completion of the course, learner will be able to:

1: Interpret engineering drawings, plan manufacturing processes, and apply design-for-manufacturing concepts in production environments.
2: Analyze dimensional chains, evaluate tolerances, and assess surface quality to ensure functional and manufacturable product designs.
3: Plan manufacturing sequences, select appropriate operations, and design proper locating and clamping methods to achieve dimensional accuracy and production efficiency.
4: prepare complete process sheets, select appropriate machines and tooling, and estimate machining time for manufacturing components.
5: Analyze capacity requirements, evaluate process alternatives, and apply CAPP approaches for optimized manufacturing planning.

Course Contents

Unit I	Process Engineering	(06Hours)

Product design and role of product designer Analysis of part print: Method of reading and interpreting the part print, identification of nature of work to be performed, Identification of functional surfaces, grouping of related surfaces to be machined, Identification of basic process for processing and sequence of operation from part print. Process engineering and its functions, Co-ordination of process Engineering with other departments., Organization chart, general manufacturing processes, concept of design for manufacturing, communication in engineering Industry, glossary of terms used in process planning.

Unit II	Geometric dimensioning and tolerance analysis	(06Hours)

Dimensional Analysis: Types of dimensions, concept of baseline dimensions, datum selection, dimensional chain and linkage analysis, concept of straightness, flatness, roundness, concentricity and other geometrical forms. Surface quality and surface finish/surface integrity and its effect on product properties. Tolerance Analysis: Producing accuracy and attainable accuracy- process capability relation with statistical accuracy, prime accuracies, tolerance chart, tolerance grades and its calculations, tolerance stack, tolerance analysis for assembly.

Unit III	Work-piece control and selection of operations	(06Hours)
Causes of work-piece variations, variables influencing work-piece control, equilibrium theories, mechanical, geometrical and dimensional control, Concept of location – fundamentals of locating, datum features, errors in location and clamping, establishing process areas, guidelines for identifying holding areas, supporting areas and critical areas. Study of basic process operations, principal processes and auxiliary processes, Identification of major, critical, qualifying, re-qualifying and supporting operations. Selection of single or combined operations, Identification of finishing operations, Establishing manufacturing sequence.		
Unit IV	**Equipment & Tooling Selection**	**(06Hours)**
Factors to be considered in equipment/machine selection, determining machine up and down time. Types of tooling, Factors affecting selection of tooling, use of multi-tooling set-up. Process Sheet Design: Study of the part-print , logical design of process plan, stock preparation, blank size selection with material estimates, Selection of datum surfaces, identification of machining surfaces, dimension and tolerance analysis, selection of machining methods with time estimates and standard time for each operation, Preparation of process picture sheet and operation route sheet for complete manufacturing part.		
Unit V	**Process Selection, Capacity Planning and Computer aided process planning**	**(06Hours)**
Component of process selection, Factor affecting on process selection decisions, Deigning the process (Process flow analysis, Process Re-engineering, Product –Process Mix, Operations Strategy, Capacity utilization, Capacity Planning, Importance of capacity decisions, Defining and measuring capacity, Dimensions of capacity, Determining capacity requirements, , Factors determining effective capacity, OEE and its calculation, Advantages over manual process planning, approaches for CAPP: Generative Process Planning, Knowledge-based Process Planning, Feature Recognition in Computer Aided Process Planning, recent trends		
Learning Resources		
Text Books: 1.Eary D. F., Johnson G. E., “Process Engineering for manufacture” Prentice Hall of India Pvt. Ltd. 2. Narayana K. L., Kannaiah P., Vankata Reddy K., “Production Drawing”, New age international Publishers. 3. Groover Mikell P., Automation, Production Systems, and Computer-Integrated Manufacturing, Third Edition, PHI Learning Private Limited.		
Reference Books: 1.Scallan P., “Process Planning- Design/Manufacture Interface”, John Wiley & Sons, 1995. 2.Jos. V. Abelln-Nebot, Carlos Vila Pastor, Hector Refuel Siller-Carillo,” Manufacturing Process Planning: A Practical Approach for Mechanical Engineering” John Wiley & Sons Inc (2025)		

Savitribai Phule Pune University
Third Year of Engineering (2024 Pattern) Course

Code: PCC-353-PEE

Course Name: Production and Operations Management Lab

Teaching Scheme	Credit	Examination Scheme
Practical : 4 Hours/Week	**02**	**PR : 25 Marks** **TW : 25Marks**

PR will be based on following Term work**:**
Term work shall consist of (any Six):

1. Introduction to Production Systems by arranging machines as per type of Production Systems
2. Assessment of Layout of Machines based on the time required to complete the product: Selection of best Layout.
3. Selection of Material handling equipment. Material Handling System Planning and analysis.
4. Inventory Model Implementation for the case of Product.
5. Preparation of Material Requirement Plan for the product selected.
6. Simulation case study based on Production Planning
7. Simulation case study based online balancing
8. Simulation case study using PLM software to prepare Material Requirement Plan and Product data management

Savitribai Phule Pune University Third Year of Engineering (2024 Pattern) Course Code: PCC-354-PEE Course Name: Process Engineering and Resource Planning Lab		
Teaching Scheme	**Credit**	**Examination Scheme**
Practical : 4 Hours/Week	**01**	**Oral : 25 Marks** **TW : 25Marks**

Oral will be based on following Term work**:**
Term work shall consist of:
1. Part print analysis of one industrial component drawing
2. Process sheet design of one component on GPM for Batch Production.
3. Process sheet design of one component for mass production.
4. Time estimation for assembly using flow-charting techniques

Savitribai Phule Pune University
Third Year of Engineering (2024 Pattern)

Course Code: PEC-361-PEE

Course Name: Program Elective 2- a) Advanced Manufacturing Processes

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	03	CCE : 40Marks End-Semester: 60Marks

Prerequisite Courses: Fundamentals of Manufacturing process

Course Objectives:

1. To introduce operational of USM, AJM, WJM machining processes.
2. To present process mechanism and analysis of advanced manufacturing processes
3. To provide practical knowledge of foundry engineering.
4. Analyze welding processes.
5. Identify appropriate finishing processes for components.

Course Outcomes:

After successful completion of course, student will be able to,

1. Classify & compare various mechanical based unconventional machining processes
2. Classify and compare various thermal & chemical energy based non-conventional machining processes.
3. Evaluate & select suitable advanced casting process for wide variety of applications
4. Understand advanced welding process.
5. Understand the advanced fine finishing process

Course Contents

Unit I	Unconventional Machining Processes-I	(06Hours)

Need & types of non-conventional methods & importance of methods, Principle of working, equipment, Mechanism of material removal, Process parameters, performance characterization, Applications of following process such as Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive Water jet machining (AWJM), Ultrasonic machining (USM).

Unit II	Unconventional Machining Processes-II	(06Hours)

Principle of working, equipment, Mechanism of material removal, Process parameters, performance characterization, Applications of following process such as Electrochemical machining (ECM), Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM) processes, working principal of Plasma arc machining.

Unit III	Advanced Casting Processes	(06Hours)

Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting.

Unit IV	Advanced Welding Processes	(06Hours)

Heat Flow in Welding: Calculation of peak temperature; Width of Heat Affected Zone (HAZ); cooling rate and solidification rates; weld thermal cycles; residual stresses and their measurement; weld distortion and its prevention.

Weld Design: Types of welds & joints, Joint Design, Welding Symbols, weld defects, Inspection/testing of welds, Introduction to Welding Procedure Specification & Procedure Qualification Record.

Unit V	Advanced Fine Finishing Process and special manufacturing processes	(06Hours)

Magnetic Abrasive Finishing (MAF), Magneto Rheological Abrasive Finishing (MRAF) - Process principle; Process equipment; Process Parameters; Process Capabilities; Applications; Limitations.

Broaching: Types of broaching machines. Parts of the machines and their functions. Components machined on broaching machine. Broach geometry.

Gear Manufacturing: Gear cutting processes- Gear hobbing, Gear shaping, Gear shaving, Gear lapping and gear grinding. Construction and working of the machines.

Thread Manufacturing; Thread cutting, chasers and dies. Thread milling, thread rolling, thread lapping and thread Grinding

Learning Resources

Text Books:

1. Vasudev Malhotra, Advanced Manufacturing Processes, CRC Press
2. P.C. Sharma, A Textbook of Production Technology: Manufacturing Processes, S. Chand
3. Vyom Sharma, Mahavir Singh, “Unconventional Machining Processes Fundamental Principles and Recent Developments” CBS Publishers & Distributors Pvt Ltd.

Reference Books:

1. H. K. Dave, U. S. Dixit, Dumitru Nedelcu (Eds.) Recent Advances in Manufacturing Processes: Select Proceedings of RDMPMC 2020 (Lecture Notes in Mechanical Engineering)
2. Yashvir Singh, Nishant K. Singh, Mangey Ram (Eds.) Advanced Manufacturing Processes (Mathematical Engineering, Manufacturing, and Management Sciences)
3. Ian Gibson, David Rosen, and Brent Stucker, “Additive Manufacturing Processes” (Second Ed.), Springer
4. Golam Kibria, Vijaysingh U. Rathod, “Introduction to Advanced Machining and Finishing Processes” Alpha Science International, Limited, 2019

Savitribai Phule Pune University
Third Year of Engineering(2024Pattern)

Course Code: PEC-361-PEE

Course Name: Program Elective 2- b) Mechatronics

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	**03**	**CCE : 40Marks** **End-Semester: 60Marks**

Prerequisite Courses: Engineering Mathematics III, Basic Electrical Engineering, Basic electronics Engineering

Course Objectives:

1. To provide knowledge of mechatronics systems, control systems, and industrial sensors/transducers used for measurement, monitoring, and automation applications.
2. To develop understanding of passive circuits, filters, Wheatstone bridge, and operational amplifier circuits used in signal conditioning and instrumentation applications.
3. To provide knowledge of digital electronics, number systems, logic circuits, and data conversion techniques used in modern electronic and mechatronic systems.
4. To provide understanding of controller actions and PID control modes used in industrial automation and process control systems.
5. To provide knowledge of PLC architecture, programming languages, ladder logic, and timer/counter instructions used in industrial automation systems.

Course Outcomes:

After successful completion of course student will be able to,

1 Analyze control systems and select appropriate sensors and transducers for measurement and automation in mechatronic and industrial systems

2. Analyze and design basic electronic circuits using passive components, Wheatstone bridge, and Op-Amp configurations for measurement and signal processing applications.

3. Apply Boolean algebra, perform number system conversions, and analyze ADC, DAC, and sampling circuits for digital signal processing applications.

4.Analyze and compare P, I, D, PI, PD, and PID controller responses and apply suitable control strategies for process control applications.

5. Develop and analyze PLC ladder programs using relay, timer, and counter instructions for industrial control applications.

Course Contents

Unit I	Sensors and Transducers	(07Hours)

Introduction to Mechatronics, Open and Closed loop control system, Block Diagram Algebra With respect to Types, Range, and Applications and limitations, Thermocouples, Thermistors and Resistance Temperature Detectors With respect to Construction, Working and Applications, Linear Variable Differential Transducer. With respect to Principle, Types, and Applications, Strain Gauges, Gauge Factor and Measurement of Strain With respect to construction, working and specifications Electromagnetic Flow meter. With respect to specifications and applications, Capacitive and Inductive Proximity sensors Angular Velocity measurement, Tacho generators, Rotary Encoders

Unit II	Analog Signal Conditioning	(07Hours)

Passive Circuits, Voltage dividers, Wheatstone ‘s bridge, Low pass, high pass and bandpass filters. Op-Amps, Characteristics and Specifications, Voltage Follower, Inverting Amplifier, Non-Inverting Amplifier, Summing Amplifier, Instrumentation Amplifier, Integrator, Differentiator. Current To Voltage Converter, Current to Voltage Converter Numerical Examples based on Wheatstone‘s Bridge and Op-Amps		
Unit III	**Interfacing**	**(07Hours)**
Logical Gates, Boolean Algebra, Binary, Octal and Hexadecimal Number Systems and their significance. Analog to Digital Conversion SAR & R-2R Digital to Analog Conversion Sample and Hold Circuits, Sampling Theorem, Samplifing Frequency, Quantization. Numerical Examples based on ADC, DAC and Sampling		
Unit IV	**Control System**	**(07Hours)**
Controller Actions, Proportional Controllers (P Mode), Integral Controllers (I Mode) with examples of plotting controller action vs time for respective error time plot Proportional-Integral Controllers (PI Mode) with examples Derivative Controllers (D Mode) Proportional-Derivative Controllers (PD Mode) with examples Proportional-Integral-Derivative Controllers (PID Mode) with examples		
Unit V	**PLC Programming**	**(07Hours)**
Introduction to PLC Programming, Types of PLC Languages, Ladder Diagram Format, Ladder Relay Instructions, Ladder Relay Programming, Timer Instructions with example Counter Instructions with example		
Learning Resources		
Text Books: 1. C D Johson, Process Control Instrumentation Technology, 7th Edition, Prentice Hall of India Pvt Ltd. 2005. 2. L. A. Bryan, E. A. Bryan, Programmable Controllers: Theory and Applications, Industrial Text Company Publications, 2/e		
Reference Books: 1Alciatore&Histand, Introduction to Mechatronics and Measurement system, 4th Edition, Mc-Graw Hill publication, 2011. 2. Bishop (Editor), Mechatronics – An Introduction, CRC Press, 2006		

Savitribai Phule Pune University
Third Year of Engineering(2024Pattern)

Course Code: PEC-361-PEE

Course Name: Program Elective 2- c) Production Tooling

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	**03**	**CCE : 40Marks** **End-Semester: 60Marks**

Prerequisite Courses: Machine drawing, Material, Manufacturing technology

Course Objectives:

1. To provide knowledge of strip layout design, press tool calculations, cutting force analysis, and die design standards used in sheet metal operations. To present design process of Press tools, forging dies and Injection molds.
2. To impart knowledge of drawing and bending die design, blank size calculation, force analysis, and press capacity selection for sheet metal forming operations.
3. To provide knowledge of multi-impression and upsetting die design, including stock calculation, impression design, die dimensions, and forging parameters used in closed die forging operations.
4. To provide knowledge of die casting processes, die construction, solidification control, cooling, venting, lubrication, and defect analysis in die casting operations.
5. To provide knowledge of plastic molding materials, molding techniques, feed and cooling system design, ejection mechanisms, and CAD applications in mould design.

Course Outcomes:

After successful completion of course student will be able to,

1. Design strip layouts, calculate press tool parameters, and apply die design principles and standards for sheet metal manufacturing processes. Choose appropriate dies/press tools/molds based on type of operations
2. Design drawing and bending dies, calculate forming parameters, and analyze forces and spring back effects in sheet metal manufacturing processes.
3. Design multi-impression and upsetting dies, calculate forging parameters, and apply standard forging design principles for efficient metal forming processes.
4. Analyze die casting processes, design die components, and identify defects and remedies for efficient and quality die casting production.
5. Design plastic mould components, calculate molding parameters, and apply CAD tools for efficient plastic mould design and manufacturing.

Course Contents

Unit I	Design of Blanking dies and progressive dies	(07Hours)

Strip layouts, percent utilization, analysis of cutting force and stripping force, Method of reducing the cutting forces, calculation of press tonnage, clearance, Standards and specifications. Aspects of die design and drawing

Unit II	Design of Drawing and Bending Dies	(07Hours)
Design of shallow and deep drawing dies, Calculation of blank size by area and graphical method percentage reduction and diameter and height of cup in each stage in each stage, number of draws, drawing force and blank holding force in each draw, press capacity. Types of Bending dies, Developed length calculation, bending force, spring back		
Unit III	**Design of Forging Dies**	**(07Hours)**
Multi Impression Die: Design of forging die for multi-impression die-: selection of parting line, stock size calculation, flash and gutter, drafts, fillet & comer radii, ribs and webs, design of fullering, edging, blocking, finishing impressions, trimming dies, Die block dimensions, die inserts. Upsetting die: Rules for upset forging, design of upset die.		
Unit IV	**Die casting die design**	**(07Hours)**
Die casting process, machines, die casting materials, specific details of die constructions, casting ejection, cores, slides, loose die pieces, types of cores, directional solidification, types of feeders, die venting, water cooling, classification of dies- single, combination, multi-impression. General details of die design, inserted impressions, die casting defects & their remedies, die lubrication- types & methods		
Unit V	**Design of Injection mold**	**(07Hours)**
Plastic molding materials, types of plastic processing techniques, Determination of number of cavities, design of feed system- design of sprue, sprue puller, runners & gates, types of cooling system, design of cooling channels, heat 32 transfer considerations, , determination of mould opening force & ejection force, design of ejector system, use of CAD for mould design.		

Learning Resources

Text Books:

1 Donaldson, Lecain and Goold, “Tool Design”, Tata McGraw Hill, ISBN 0 07 0992746.
2. Rao P.N., “Manufacturing Technology, Foundry, Forming and Welding”, Tata McGraw Hill, ISBN 0 07 4518631.
3. Pye R.G. W., “Injection Mould Design (Design manual for plastic industry)”, Affiliated East West Press Pvt. Ltd.
4. Sharma P. C., “Production Engineering”, S. Chand, ISBN 81 219 04218.

Reference Books:

1. J R Paquin, “Die design Fundamentals”, Industrial Press Inc., ISBN 0 8311 11720.
2. Doehler H.H,” Die Casting”, McGraw Hill
3. Joshi P.H., “Press Tools Design & Construction”, Wheeler Pub., ISBN 8185814465.
4. Dr. Surender Kumar, “Production Engineering Design” (Tool Design), Satya Prakashan
5. AthalyeA.S., “Plastics Materials handbook”, MultiTech Pub. Co.,

Savitribai Phule Pune University
Third Year of Engineering (2024 Pattern)

Course Code: PEC-361-PEE

Course Name: Program Elective 2- D) Industrial Robotics

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	03	CCE : 40Marks End-Semester: 60Marks

Prerequisite Courses: Basic knowledge of Engineering drawing, Theory of Machines, Mechanics of Materials, Design of Machine Elements, Kinematics of Manufacturing Machines

Course Objectives:

1.Learn various types of Robots and the functional elements of Robotics
2. Identify and Judge application specific selection of Robot Drive Systems
3. Recognize various types End-effectors and Sensors used in Robotic Automation
4. Study use of machine vision system of robotics and Robot Programming.
5. Study the advancement in robotics.

Course Outcomes:

After successful completion of course student will be able to,

1. Understand the basic concepts of Robotics
2. Identify and evaluate appropriate Drive for Robotic Applications
3. Compare and select End-effectors and Sensors as per Application
4. Understand the fundamentals of Machine vision system and robot programming.
5 Identify application of robots in different areas where they will work in future.

Course Contents

Unit I	Fundamentals of robotics	(07Hours)

Introduction: History, Definitions specified by Agencies, Classification and Applications, Laws of robotics, Specifications of robots, Flexible automation Vs. Robotics technology, Safety measures in robotics, Role of Robots in Automation.

Robot Anatomy and configurations: Cartesian, Cylindrical, Polar, Articulated, SCARA, Pendulum Arm, Multiple Joint Arm, Parallel Manipulator, Work Envelope/Volume, Degree of Freedom associated with Robot Arm & Wrist, Joints & Joint Notification Scheme, Precision of Movement

Unit II	Robot Drive Systems	(07Hours)

Pneumatic Drives, Hydraulic Drives, Mechanical Drives, Electrical Drives - D.C. Servo Motors, Stepper Motors, A.C. Servo Motors, BLDC - Salient Features, Applications and Comparison of all these Drives, Micro actuators, Selection of drive, Power and Motion Transmission Systems for Robot, Motion Conversion, Determination of Power of motor, Types of Gearbox - Planetary, Harmonic, Cycloidal Gearbox and Gear Ratio, Variable Speed Arrangements

Unit III	End-effectors & Sensors	(07Hours)

End-effectors/Grippers/Tooling: Introduction, Types, Classification, Construction, Working, Selection and Design Considerations of End-Effectors/Grippers/Tooling Interface used in various Robotic Applications, Active and Passive Compliance

Sensors/Transducers: Introduction, Types, Classification, Construction, Working, Selection and Design Considerations of Transducers, Sensors, Resolvers, Encoders, Switches, Position/Range/Touch/Force/Torque/Safety Sensors and Transduces

Unit IV	Machine Vision System and Robot Programming	(07Hours)

Machine Vision System: Vision System Devices, Image acquisition, Masking, Sampling and quantization, Image processing techniques, Noise reduction methods, Edge detection, Segmentation.

Robot Programming: Methods of robot Programming, Methods of defining positions in space, Motion interpolation, branching, Textual robot programming languages.

Unit V	Advanced Applications of Robots and Robot Interfacing	(07Hours)

Pick and place Robot, Arc Welding Robots, Assembly and mega-assembly Robots, Walking Robots, Climbing Robots, Machine mounted Robots. Interfacing Robots with computers.Obstacle Avoidance: Lee's Algorithm; Counter Path Defining using 'via' point, blending technique.

Learning Resources

Text Books:

1S. R. Deb, Sankha Deb, (2010), ―Robotics Technology and Flexible Automation‖, Tata McGraw Hill Publications, New Delhi. ISBN: 978-007-007-7911

2. Yoram Koren, (1985) "Robotics for Engineers", McGraw Hill Book Co. ISBN: 978-007-035-3992.

3. Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel, Ashish Dutta, (2017), ―Industrial Robotics -Technology, Programming and Applications (SIE), 2nd Edition, McGraw Hill Book Co., ISBN: 978 125-900-6210

4. King-Sun Fu, C.S. George Lee, Ralph Gonzalez, (1987), "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill Book Co., ISBN: 978-007-100-4213.

Reference Books:

1. Hartenberg and Denavit, (1964),"Kinematics and Synthesis of Linkages", McGraw Hill Book Co. ISBN: 978-007 026-9101.

2. Hall A.S., (1966), "Kinematics and Linkage Design", Prentice Hall. ISBN: 978-088-133-2728.

3. Hirchhorn J., (2017), "Kinematics and Dynamics of Machinery", McGraw Hill Book Co., ISBN: 978-935-134-0201

4. Todd D.J., (1986), Fundamentals of Robot Technology: An Introduction to Industrial Robots, Teleoperators and Robot Vehicles, Wiley Publications, ISBN: 978-047-020-3019.

5. Paul R., (1981), Robot Manipulators Mathematics Programming & Control: Mathematics, Programming and Control (Artificial Intelligence), MIT Press. ISBN: 978-026-216-0827.

6. Janakiraman P.A., (1995), Robotics and Image Processing, Tata McGraw Hill, ISBN:978-007-462-1677.

Savitribai Phule Pune University
Third Year of Engineering (2024Pattern)

Course Code: PEC-362-PEE

Course Name: Program Elective 3- a) Product Design and Development

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	03	CCE : 40Marks End-Semester: 60Marks

Prerequisite Courses: Basic Engineering Science - Physics, Chemistry, Material Science, Engineering Metallurgy, Manufacturing processes Etc.

Course Objectives:

To explain students about significance of

1. Product design and Product development
2. Market Survey & Product Specification Finalization
3. Concept Inception, Verification and selection
4. Concept Exploration & Development
5. Design Verification and Validation

Course Outcomes:

After successful completion of course student will be able to,

1. Understand Product design and Product development processes
2. Understand Processes, tools and techniques for Market Survey & Product Specification Finalization
3. Understand Processes, tools and techniques for Concept Inception, Verification and selection
4. Understand Processes, tools and techniques for Concept Exploration & Development
5. Understand Processes, tools and techniques for Design Verification and Validation

Course Contents

Unit I	Introduction to Product Design and Development	(07Hours)

Product design and Development definition, Objectives of Product design and development, Engineering Design Process, Engineering Development Process (Gateway System), Product Design Vs Product Development, Features of successful product design and development, Essential Factors for product design, The challenges of product development, ASIMOW Model/Morphology of product design, Who design and develops product-Concurrent engineering approach/CFT Approach, Reasons for new product failure, Product Life Cycle

Unit II	Market Survey & Product Specification Finalization	(07Hours)

Product definition, Types of products, Customer Population and Market segmentation- Types of customers and Needs, Customer need Models- Introduction to Kano Model, Triz Method/Altshuller Matrix, Design Thinking, etc. Types of Design information and the Various Sources of information, Product planning and its Phases, Mission statement and Technical Questioning, Technology forecasting and S-curve, Tools for gathering Customer needs, QFD and House of quality

Unit III	Concept Inception, Verification and selection	(07Hours)

Idea generation and Idea generation approaches-TRIZ Method, Benchmarking, Brainstorming, Alternate thinking, Reverse Engineering etc, Product Policy of an organization, Selection of Profitable Concept-SWOT Analysis, Concept Selection Process, Pugh's Concept selection process, Concept Analysis-Marketing aspect, Product characteristics (Functional/ Operational/Durability/Aesthetic/Ergonomic

Aspects), Economic analysis, Production aspect, functional Modelling and decomposition- Functional analysis system technique, Subtract and operate procedure

Unit IV	Concept Exploration & Development	(07Hours)

Solid Modelling of part and assembly, Product architecture, Digital product design of part and assembly with respect to Engineering drawing definition, Classification of engineering drawing, Elements of production drawing, Bill of material, Types of dimensions, Arrangement of dimensions, Principles of dimensioning, Limits, Fits and Tolerances, Geometric Tolerances, Datum System, Design for Assembly, Design for manufacturing, Design for processes, Product design Steps, Introduction of Ergonomics in product design, Design Review/Part Print Analysis

Unit V	Design Verification and Validation	(07Hours)

FEA-CFD-MBD-FSI, Simulation driven design, Additive manufacturing, Policy and Homologation certification by National and International agencies, Introduction to Break Even analysis and Production capacity planning, Make VS buy Decision, Business case Preparation, Facility tooling and gauges design and Development- Vendor Development, Letter of Intent, Purchase order, Product costing, Product Testing and Validation, Introduction to Production part approval process tools (PPAP)

Learning Resources

Text Books:

1Karl T. Ulrich & Steven D. Eppinger., Product Design & Development, McGraw Hill, 3rd Edition
2. Dieter and Schmidt, Engineering Design, McGraw – Hill Higher education, ISBN: 978–0– 07–283703–2
3. John Stark, Product Life Cycle Management, 21st Century Paradigm for Product Realization, Springer

Reference Books:

1Tim Jones, Butterworth Heinmann, New Product Development by Oxford, TAC- 1997.
2. Roland EngeneY., Inetoviez, New Product Development: Design & Analysis, John Wiley and Sons Inc., N.Y. 1990.
3. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight. Product Design for Manufacture and Assembly, Amherst, 1983.
4. Bill Hollins, Stwout Pugh, Butterworth, Successful Product Design by London 1990.
5. Boothroyd & Dewburst P. Design for Assembly, a Designer's Handbook, University of Massachusetts, Amherst, 1983.
6. Keyinotto and Kristini Wood, Product Design Pearson Education 2004.
7. Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill Pub. 1986 8. ISO Standard: 9001:2008: Clauses 7.1, 7.2, 7.3
8. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education Inc.
9. Grieves, Michael, Product Lifecycle Management McGraw Hill

Savitribai Phule Pune University
Third Year of Engineering(2024Pattern)

Course Code: PEC-362-PEE

Course Name: Program Elective 3- b) Precision Manufacturing

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	03	CCE : 40Marks End-Semester: 60Marks

Prerequisite Courses: Fundamentals of manufacturing, advanced manufacturing and micro machining.,

Course Objectives:

1. To give awareness of different techniques used in micro-nano machining
2. To give in-depth idea of the conventional techniques used in micro-nano manufacturing
3. To introduce Non-conventional micro-nano manufacturing and finishing approaches
4. To introduce Nanofabrication Techniques and other processing routes micro-nano manufacturing
5. To know different metrology tools used in micro-nano manufacturing

Course Outcomes:

After successful completion of course student will be able to,

1. Model and Analyze 1-D problem.
2. Model and Analyze Truss subjected to loading
3. Model and Analyze Two-Dimensional Problem Using Constant Strain Triangles
4. Perform finite element modeling of triangular element and 2-D iso-parametric elements
5. Analyze steady state heat transfer - 1D and 2D heat conduction and convection

Course Contents

Unit I	**Ultra-precision Machining Processes**	**(07Hours)**

Introduction to nanoscale material removal process analysis, Ductile Mode Cutting of Brittle Materials, Advances and recent developments in material removal processes, Precision (micro and nano) machining processes, Applications of precision Turning, Drilling, Milling and Grinding processes, cutting tools and instrumentation used in precision (micro and nano)
machining processes, use of Diamond Tools in Micromachining,

Unit II	**Ultra-precision Forming Processes**	**(07Hours)**

Introduction to precision (micro and nano) forming processes, Applications of precision forging, Plastic forming and Roller Imprinting, extrusion, sheet metal forming and hydroforming, tools and instrumentation used in precision (micro and nano) forming processes

Unit III	**Non-conventional micro-nano machining**	**(07Hours)**

Introduction to Non-conventional micro-nano manufacturing Processes, principle and applications of – Abrasive Jet Micro Machining, WAJMM, Micro EDM, Micro WEDM, Micro EBM, Micro ECM, Micro LBM, Fundamentals of lasers, Laser microfabrication, Laser nanofabrication.

Unit IV	**Nano Finishing Processes**	**(06Hours)**

Introduction to Nano Finishing Processes, Magneto-rheological Finishing (MRF) processes, Magneto-rheological abrasive flow finishing processes (MRAFF) – process principle and applications, Elastic Emission Machining (EEM) – machine description, applications, Ion Beam Machining (IBM) – principle, mechanism of material removal, applications, Chemical Mechanical Polishing (CMP) – Schematic diagram, principle and applications.

Unit V	Micro-nano Fabrication and Micro-nano Measurements	(06Hours)

Introduction to Micro and Nano Fabrication: basics, flowchart, basic chip making processes, Introduction to Nanofabrication, Nanofabrication using soft lithography– principle, applications, Introduction to Carbon nano materials – CN Tubes properties and applications

Introduction to micro and nano measurements, defining the scale, uncertainty Scanning Electron Microscopy – description, principle, Optical Microscopy– description, application, Scanning Probe Microscopy, scanning tunneling microscopy description, application, Introduction to On-Machine Metrology

Learning Resources

Text Books:

1. Mark. J. Jackson, Micro and Nano-manufacturing, Springer, 2006.
2. Mark. J. Jackson, Micro-fabrication and Nano-manufacturing - Pulsed water drop micromachining CRC Press 2006.
3. Nitaigour Premchand Mahalik, Micro-manufacturing and Nanotechnology, Springer, 2006.
4. V.K. Jain, Micro-manufacturing Processes, CRC Press, 2012.

Reference Books:

1. J. Paulo Davim, Mark J. Jackson Nano and Micro Machining, John Wiley & Sons, 2013
2. Yi Qin, Micro-manufacturing Engineering and Technology, William Andrew, 2015
3. Kapil Gupta, Micro and Precision Manufacturing, Springer, 2017

Savitribai Phule Pune University
Third Year of Engineering (2024 Pattern)

Course Code: PEC-362-PEE

Course Name: Program Elective 3- c) Statistics and Numerical Methods

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	03	CCE : 40Marks End-Semester: 60Marks

Prerequisite Courses: Engineering Mathematics- I and II, Basics of manufacturing

Course Objectives:

1. To demonstrate potential of numerical methods for solving complex algebraic & transcendental equation, simultaneous equations, curve fitting, interpolation, optimization, integration & differentiation.
2. To present the applications of computational tools & techniques to the real life case studies in production engineering
3. To analyses errors & approximations.
4. To develop ability of students to formulate curve fitting and to solve production engineering problems
5. To develop Numerical Differentiation and Numerical Integration

Course Outcomes:

After successful completion of course student will be able to,

1. Apply numerical methods to production engineering problems
2. Develop mathematical model of physical problem and subsequent solutions by appropriate optimization method
3. Develop errors & approximations b using various methods
4. Developcurve fitting methods and to solve production engineering problems
5. Develop Numerical Differentiation and Numerical Integration and apply multiple optimizations in manufacturing.

Course Contents

Unit I	Statistical hypothesis and tests	(07Hours)

Testing of Hypothesis Sampling distributions - Estimation of parameters, Statistical hypothesis, large sample tests based on Normal distribution for single mean and difference of means, -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

Unit II	Design and Analysis of Experiments	(07Hours)

Design and Analysis of Experiments: Importance of experiments, Experimental strategies, Basic Principles of Design
Terminology, ANOVA, steps in experimentation, two and three full Factorial experiments, Taguchi Methods, Design using Orthogonal Arrays, S/N ratios, Data Analysis

Unit III	Errors & approximations analysis	(07Hours)

Errors & approximations: types of errors, error propagation. Numerical solution of algebraic and transcendental equations by bisection method.

Newton Raphson Method. Numerical solution of Linear Simultaneous Equations by Gauss Elimination Method, Gauss-Siedel Method

Unit IV	Methods of curve fitting	(06Hours)

Numerical methods - Curve Fitting, methods of curve fitting. Least square criterion- 1st and 2nd order Interpolation:

Lagrange's formula, Newton forward difference method. Methods of moment for curve fitting. .

Unit V	Numerical Differentiation and Optimization Methods	(06Hours)

Interpolation, Newton's forward and backward difference interpolation, Numerical Differentiation and Numerical Integration, Lagrange's and Newton's divided difference, Approximation of derivatives using interpolation, polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules,

Manufacturing Optimization- Method of Lagrange multipliers, steepest descent method, Introduction of classical optimization and multiple optimization. Generalized reduced gradient Method. Introduction to GA and SA. Case studies

Learning Resources

Text Books:

1. Douglas C. Montgomery, Design and analysis of experiments, John Wiley and sons inc. New York 8th edition.
2. S.C. Chapra, R.P. Canale, —Numerical Methods for engineers with programming and software applications, Tata
McGraw Hill Co. Ltd, New Delhi, ISBN 0071158952.

Reference Books:

1. Dr. Sadhu Singh, Computer aided Design and Manufacturing, Khanna Publication, New Delhi.
2. Ramin S. Esfandiari, Numerical Methods for Engineers and Scientists Using MATLAB, CRC press, Taylor and
Francis group.
3. Jaan Kiusalaas, Numerical Methods in Engineering with Matlab, Cambridge University press
4. S. Moaveni, Finite element analysis, theory and application with Ansys,

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Course Code: PEC-362-PEE

Course Name: Program Elective 3- d) Financial Management

Teaching Scheme	Credit	Examination Scheme
Theory : 3Hours/Week	03	CCE : 40Marks End-Semester: 60Marks

Prerequisite Courses: Industrial Engineering & Management, Production Management

Course Objectives:

1. To develop fundamental understanding of financial management concepts including financial functions, financial statements, ratio analysis, and leverage for effective decision-making.
2. To provide understanding of working capital management, time value of money, cost of capital, and funds flow analysis for effective financial planning and control.
3. To develop understanding of methods of costing, elements of cost, material pricing methods, labour cost systems, and incentive schemes for cost control.
4. To impart knowledge of working capital management, time value of money, cost of capital, and funds flow analysis for sound financial decision-making.
5. To develop understanding of standard costing, variance analysis, and marginal costing for cost control and managerial decision-making.

Course Outcomes:

After successful completion of course student will be able to,

1. Analyze financial statements and apply ratio analysis and leverage techniques to evaluate financial performance.
2. Evaluate working capital requirements, apply time value of money and cost of capital concepts, and prepare and interpret funds flow statements.
3. Apply costing methods, compute material and labour costs, and evaluate wage and incentive plans for effective cost management.
4. Assess working capital needs, apply time value and cost of capital concepts, and prepare and analyze funds flow statements.
5. Compute and analyze cost variances and apply marginal costing techniques in profit planning and decision-making.

Course Contents

Unit I	Introduction	(07Hours)

Financial function, Scope, goals and tools. Sources of finance, corporate planning and financial management. Financial Statements: Balance sheet, profit and loss account. Ratio Analysis: Classification, Use of Ratio Analysis and its limitations. Operating and Financial Leverage

Unit II	Working Capital Management	(07Hours)

Concept and design of Working Capital, types of working capital, sources of working capital, time value of money, cost and capital, cost of capital. Funds Flow Analysis: Concepts, Objectives, and Techniques of Funds Flow Statement

Unit III	Costing	(07Hours)
Methods of costing and elements of cost. Material Cost: Different methods of pricing of issue of materials. Material losses - Wastage and its consideration. Labour Cost: Different methods wages and incentive plans. Principles of good remunerating system, labour turnover and its methods.		
Unit IV	**Working Capital Management**	**(06Hours)**
.Concept and design of Working Capital, types of working capital, sources of working capital, time value of money, cost, and capital, cost of capital. Funds Flow Analysis: Concepts, Objectives, and Techniques of Funds Flow Statement.		
Unit V	**Type of Costing Methods**	**(06Hours)**
Concept, development & use of standard costing. Material, Labour, Overhead, Sales. Profit, Product-mix and Yield Variance, Marginal Costing: Concept, Use of Marginal Costing in decision-making		

Learning Resources

Text Books:

1. N. K. Prasad, “Principles and Practice of Cost Accounting”, Syndicate Pvt. Ltd., Calcutta
2. M. Pandy, “Financial Management”, New Delhi Vikas Publication House Pvt. Ltd., ISBN 81-259-0638-X
3. M. Y. Khan, P. K. Jain, “Financial Management”, Tata McGraw Hill Publishing Ltd.
4. B. K. Bhar, “Cost Accounting Methods and Problems”, Academic Publishers, Calcutta

Reference Books:

1. Henry M. Steiner, “Engineering Economics Principles”, McGraw Hill Publication.
2. C.B. Gupta, “Fundamentals of Business”, Sultan Chand & Co.,
3. P. A. Samualson, “Economics”, McGraw Hill International.
4. K. K. Dewett, “Modem Economic Theory”, Sultan Chand & Co., ISBN 81-219-0331-1
5. Colin Drury, “Management and Cost Accounting”, English Language Book Society, Chapman & Hall London.

Savitribai Phule Pune University
Third Year of Engineering(2024Pattern)

Course Code: PEC-363-PEE

Course Name: Program Elective 2 -Lab - a) Advanced Manufacturing Processes

Teaching Scheme	Credit	Examination Scheme
Practical : 2Hours/Week	**02**	**Or : 25Marks** **TW : 25Marks**

Term work will be based following demonstration / assignment.

1) Demonstration / assignment on Abrasive jet machining (AJM), Water jet machining (WJM),Abrasive Water jet machining (AWJM), Ultrasonic machining (USM)
2) Demonstration / assignment on Electrochemical machining (ECM), Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM) processes, working principal of Plasma arc machining.
3) Demonstration and assignment on Metal mould casting and Continuous casting.
4) Demonstration and assignment on any 3 welding processes
5) Demonstration / assignment on Magnetic Abrasive Finishing (MAF), Magneto Rheological Abrasive Finishing (MRAF). Gear manufacturing and thread manufacturing

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Course Code: PEC-363-PEE

Course Name: Program Elective 2 -Lab - b) Mechatronics

Teaching Scheme	Credit	Examination Scheme
Practical : 2Hours/Week	**02**	**OR : 25Marks** **TW : 25Marks**

Term work will be based on following assignments.

1. Measurement of Temperature
2. Measurement of Force using Strain Gauges
3. Measurement of Angular Velocity using proximity pickup/ encoders
4. Measurement of Displacement using LVDT
5. Demonstration of Op-Amps for Summing and Inverting Amplifier
6. PLC program for any real time example e.g. elevator, conveyor, bottle filling plant

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Course Code: PEC-363-PEE

Course Name: Program Elective 2 -Lab - c) Production Tooling

Teaching Scheme	Credit	Examination Scheme
Practical : 2Hours/Week	**02**	**OR : 25Marks** **TW : 25Marks**

Term work will be based on following Assignments

1. Design & Drawing of Press tool dies (Progressive/Compound)
2. Design and drawing of drawing and bending dies
3. Design and drawing of Forging die.
4. Design and drawing of casting die
5. Design and drawing of injection mold.
6. Industrial visit and report

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Course Code: PEC-363-PEE

Course Name: Program Elective 2 -Lab - d) Industrial Robotics

Teaching Scheme	Credit	Examination Scheme
Practical : 2Hours/Week	**02**	**OR : 25Marks** **TW : 25Marks**

The term work shall be based on the following assignments

1. Study of configuration of robots and motion of robot manipulator
2. Study of robot drive systems
3. Selection of gripper & sensors for any one application
4. Programming the robot for pick and place operation using any robot
5. Detail report on any one standard configuration viz. PUMA, SCARA, Stanford etc.
6. Industrial visit report on industrial applications of robots.

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Third Year of Engineering(2024Pattern)
Course Code: MDM-371-PEE
Course Name: MDM-4-Materials Management

Teaching Scheme	Credit	Examination Scheme
Theory: 1Hours/Week Practical: 2Hours/Week	02	Pr : 25Marks TW: 25Marks

Prerequisite Courses: Fundamentals of Production Engineering, Industrial Engineering concepts, Basics of Economics and Costing, Basic management principles

Course Objectives:

1. To understand the concept, scope, importance of material management and study functions and integration with other departments
2. To understand the purchasing cycle and procedures, develop skills in vendor selection and evaluation, learn negotiation and procurement strategies
3. To understand inventory concepts and cost factors, and apply inventory control techniques like EOQ, ABC analysis
4. To understand storekeeping functions and layout, learn material handling and storage systems, maintain records and control stock effectively

Course Outcomes:

After successful completion of course student will able to,

1: Explain the concepts, functions, and importance of material management in industry.

2: Apply purchasing procedures and evaluate vendors effectively

3: Analyze and control inventory using scientific techniques

4: Manage stores operations, material handling, and documentation systems efficiently

Course Contents

Unit I	Introduction to Material Management	(06Hours)

Definition, scope, and objectives of Material Management, Importance in production systems , Functions of material management , Relationship with other departments (Production, Finance, Marketing) , Types of materials: Raw materials, WIP, Finished goods, Consumables , Integrated material management concept

Unit II	Purchasing Management	(06Hours)

Objectives and functions of purchasing, Purchasing cycle and procedures, Vendor selection and evaluation, Make-or-buy decision, Tendering process and negotiation techniques, Purchase documentation (RFQ, PO, etc.),Ethical issues in purchasing

Unit III	Inventory Management and Stores Management	(06Hours)

Meaning and types of inventories, Inventory costs (ordering, carrying, shortage), Techniques of inventory control:-EOQ (Economic Order Quantity), ABC analysis, VED analysis, FSN analysis,

Safety stock and reorder level, Just-In-Time (JIT) concept

Store keeping principles, Codification and classification of materials Store records (Bin card, Stores ledger), Material handling systems and equipment, Stock verification and auditing,

Tutorials (5–6 suggested topics)

Case study: Implementation of quality management in a manufacturing company
Control chart problems (X-bar, R, P, C charts)
Process capability calculation exercises (Cp, Cpk)
Acceptance sampling exercises using single and double sampling plans
Six Sigma, DMAIC, case study for a process improvement scenario

Analysis of quality award winners (Deming Prize / ISO certified companies)

Assignments / Practical Exercises (6 suggested)

Prepare a quality manual for a small manufacturing setup (unit 1 application)
Construct control charts using sample data from lab or hypothetical process (unit 2)
Calculate process capability indices (Cp, Cpk) for given production data
Perform a failure mode and effect analysis (FMEA) for a simple product or process (unit 3)
Conduct a mini audit of a lab or workshop process for compliance with ISO 9001 standards
Analyze a real-life case study for TQM implementation and prepare a report with recommendations

Learning Resources

Text Books:

1. P. Gopalakrishnan, M. Sundaresan, Materials Management: An Integrated Approach, Publisher: PHI Learning,2024
2. Nasiruzzaman Ayoun, Materials and Inventory Management, Publisher: Toronto Academic Press,2024
3. Rohit Manglik, Materials Management, Publisher: Edu Gorilla Publication,2024
4. Martin Christopher, Logistics & Supply Chain Management, Pearson UK,

Reference Books:

1. P. Gopalakrishnan, M. Sundaresan, Purchasing and Materials Management, Publisher: McGraw-Hill,2001
2. S. Chatterjee, Applied Materials Management, Publisher: SAGE Publications,2004
3. W.C. Benton Jr. Purchasing and Supply Chain Management (4th Edition), Publisher: SAGE Publication,2020
4. Nita H. Shah, Mandeep Mittal, Sustainable Inventory Management: Perspectives from India, Publisher: Springer,2025

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Course Code: MDM-372-PEE

Course Name: VSEC-CNC Programming

Teaching Scheme	Credit	Examination Scheme
Practical : 2Hours/Week	**02**	**Practical : 25Marks** **TW : 25Marks**

Practical consists of following jobs and assignments.
1.Assignements on CNC programming using G and M code.
2. One job on CNC turner.
3. One job on CNC milling machine.
4. One job VMC / Industrial visit to VMC factory.

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Course Code: ELC381-PEE

Course Name: Experiential Learning Course (Internship/OJT)

Teaching Scheme	Credit	Examination Scheme
Practical : 16 Hours/Week	04	Oral : 50 Marks

Prerequisite Courses, if any:

- Fundamental Knowledge of Core Subjects, Programming Skills, Workshop and Laboratory Skills, Professional Readiness.

Course Objectives:

The course aims to

1. To provide practical exposure to industrial environments related to Robotics and Automation systems, enabling students to understand real-time operations, safety practices, and workflow management.
2. To bridge the gap between theory and practice by applying classroom knowledge of robotics, automation, control systems, PLC, sensors, actuators, and industrial communication in real-world applications.
3. To develop professional skills such as teamwork, technical documentation, problem-solving, ethics, and communication required in industrial and research organizations.
4. To enhance technical competency in installation, programming, troubleshooting, maintenance, and optimization of automated systems and robotic equipment.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1. Apply theoretical concepts of robotics, automation, control systems, and mechatronics to solve real industrial problems.

CO2. Analyze and interpret industrial processes, automation workflows, and robotic applications in manufacturing and service sectors.

CO3. Demonstrate hands-on skills in programming, interfacing, testing, and troubleshooting of automation equipment such as PLCs, sensors, actuators, and robotic manipulators.

CO4. Prepare comprehensive technical reports and present internship work effectively while demonstrating professional ethics and teamwork.

Experiential Learning Course Guidelines

1. Industrial Orientation and Safety Practices

- Introduction to organization structure and industrial workflow
- Industrial safety standards and hazard identification
- Use of PPE and compliance with safety norms
- Exposure to automation shop floor / production line
- Understanding quality standards and documentation practices

2. Study of Robotics and Automation Systems

- Study of industrial robotic systems and configurations
- Overview of PLC, SCADA, HMI, and industrial controllers
- Study of sensors, actuators, drives, and control panels
- Industrial communication protocols
- Automation architecture in manufacturing or service systems

3. Hands-on Training and Technical Contribution

- PLC programming and troubleshooting
- Robot programming (pick-and-place, welding, material handling, etc.)
- Installation and calibration of sensors and actuators
- Maintenance practices (preventive & predictive)
- Participation in real-time industrial projects / problem-solving tasks
- Data collection, performance analysis, and optimization activities

4. Documentation, Presentation and Professional Skills

- Preparation of daily logbook and activity reports
- Preparation of comprehensive internship report
- Technical drawing, system block diagrams, and process flow charts
- Industrial ethics, teamwork, and communication skills
- Final seminar presentation and viva-voce

Savitribai Phule Pune University, Pune

Task Force for Curriculum Design and Development

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