POSTGRADUATE DEGREE COURSE

M. Tech. I to IV Semester

Mechanical Engineering

(Production Engineering)

University of Technology

Vatika Road, Jaipur Rajasthan 303903

UNIVERSITY OF TECHNOLOGY, JAIPUR

Program Outcomes (POs)

PO 1 Engineering Knowledge: Apply knowledge of mathematics, science, and Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering to solve numerical techniques problems.

PO 2 Problem Analysis: Identify, formulate, and solve Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering problems.

PO 3 Design/Development of Solutions: Design and develop Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering systems, components, or processes.

PO 4 Conduct Investigations: Conduct experiments and simulations to analyze Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering problems.

PO 5 Modern Tool Usage: Use modern tools and software to analyze and solve Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering problems.

PO 6 The Engineer and Society: Apply Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering solutions to societal problems.

PO 7 Environment and Sustainability: Understand the impact of Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering solutions on the environment.

PO 8 Ethics: Apply ethical principles to civil engineering practice.

PO 9 Individual and Team Work: Work effectively as an individual and in teams to solve civil engineering problems.

PO 10 Communication: Communicate Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering ideas and solutions effectively.

PO 11 Project Management: Manage civil engineering projects and resources effectively.

PO 12 Lifelong Learning: Engage in lifelong learning to stay current with Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering developments.

Program Specific Outcomes (PSOs)

1. **PSO 1:** Ability to apply advanced concepts in production systems, design, and optimization, utilizing cutting-edge tools and technologies for effective and efficient production management in diverse industries.
2. **PSO 2:** Competence in managing and improving production processes using lean manufacturing principles, automation, and sustainable practices, ensuring enhanced productivity, quality, and cost-efficiency.
3. **PSO 3:** Proficiency in conducting research, development, and innovation in the field of production engineering, including the ability to integrate modern software, simulation, and data analytics for advanced manufacturing solutions.

Program Educational Objectives (PEOs)

1. **PEO 1:** To equip students with advanced knowledge and technical skills in production engineering to tackle complex manufacturing challenges and contribute to the innovation and optimization of production processes in industries.
2. **PEO 2:** To prepare graduates for leadership roles in production planning, manufacturing design, and optimization, emphasizing research and development in industrial applications.
3. **PEO 3:** To develop students' ability to work effectively in multidisciplinary teams, demonstrating excellent communication, problem-solving, and critical thinking skills while managing diverse production engineering projects.
4. **PEO 4:** To foster a mindset of continuous learning and professional development, enabling graduates to stay updated with emerging technologies, industry trends, and sustainable practices in the field of production engineering.

Course Overview and Objectives:

The specialization in Production Engineering provides in-depth knowledge and hands-on expertise in advanced manufacturing technologies, process optimization, production management, and quality control. The course aims to develop a comprehensive understanding of modern production systems, including automation, robotics, lean manufacturing, and sustainable practices, preparing students for leadership roles in industries focused on manufacturing efficiency, innovation, and continuous improvement. It emphasizes research-driven solutions, critical analysis of production challenges, and the application of cutting-edge technologies to enhance the productivity, quality, and sustainability of manufacturing processes.

UNIVERSITY OF TECHNOLOGY, JAIPUR

Scheme of

POSTGRADUATE DEGREE

COURSE

M. Tech

Mechanical Engineering

(Production Engineering)

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 1st Year, I Sem: Production Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Machining Science- I	5	0	0	3	25	100	125	5
2	Machining Science- II	5	0	0	3	25	100	125	5
3	Metal Forming	5	0	0	3	25	100	125	5
4	Metrology & Computer Aided Inspection	5	0	0	3	25	100	125	5
5	Manufacturing Lab	0	0	4		60	40	100	2
	Total	**20**	**0**	**4**		**160**	**440**	**600**	**22**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*
ETE: *End Term Exam,* ***IA:*** *Internal Assessment*
**: Not to be considered for award of division*

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 1st Year, II Sem: Production Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Advanced Optimization Techniques	5	0	0	3	25	100	125	5
2	Mechatronics	5	0	0	3	25	100	125	5
3	Machine Tool Design	5	0	0	3	25	100	125	5
4	Computer Integrated Manufacturing Systems	5	0	0	3	25	100	125	5
5	CAM Lab	0	0	4		60	40	100	2
	Total	**20**	**0**	**4**		**160**	**440**	**600**	**22**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*
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UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 2nd Year, III Sem: Production Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Micro Electrical and Mechanical Systems (MEMS)	5	0	0	3	25	100	125	5
2	Nano Technology	5	0	0	3	25	100	125	5
3	Seminar	0	0	0		90	60	150	6
4	Dissertation– I	0	0	0		100	0	100	4
	Total					**240**	**260**	**500**	**20**

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UNIVERSITY OF TECHNOLOGY, JAIPUR

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 2nd Year, IV Sem: Production Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Dissertation-II	0	0	0		500	0	500	16
	Total					**500**	**0**	**500**	**16**

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UNIVERSITY OF TECHNOLOGY, JAIPUR

Syllabus of

POSTGRADUATE DEGREE

COURSE

M. Tech

Mechanical Engineering

(Production Engineering)

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 1st Year, I Sem: Production Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Machining Science- I	5	0	0	3	25	100	125	5
2	Machining Science- II	5	0	0	3	25	100	125	5
3	Metal Forming	5	0	0	3	25	100	125	5
4	Metrology & Computer Aided Inspection	5	0	0	3	25	100	125	5
5	Manufacturing Lab	0	0	4		60	40	100	2
	Total	**20**	**0**	**4**		**160**	**440**	**600**	**22**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*
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UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - I Semester: M. Tech. (Production Engineering)

Sub: Machining Science-I

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Fundamentals of Machining**: Mechanics of chip formation, types of chips, orthogonal and oblique cutting, Merchant's theory, force and stress analysis in cutting, cutting fluids and lubrication, heat generation and cutting temperature, effects on surface quality, and tool life.	07
3.	**Tool Design and Materials**: Properties of cutting tool materials, coatings for wear resistance, tool geometry, tool wear and tool failure mechanisms, Taylor's tool life equation, design principles for single-point and multi-point tools, and tool manufacturing processes.	07
4.	**Machine Tools and Machining Processes**: Classification of machine tools, working principles of lathe, milling, drilling, and grinding machines, introduction to high-speed and high-precision machining, CNC machining and programming basics, jigs and fixtures, work-holding techniques, and process capabilities of machining operations.	08
5.	**Machining Economics and Optimization**: Cost components in machining, time analysis, selection of optimum cutting conditions, economic and productive tool life, optimization of machining parameters for productivity, and analysis of costs and energy consumption in machining operations.	07
6.	**Advanced Topics in Machining Science**: Non-traditional machining processes (EDM, ECM, ultrasonic, laser machining), abrasive jet machining, micro-machining, surface integrity and quality control, hard turning and superfinishing, green manufacturing techniques in machining, and recent trends in machining technology (such as additive manufacturing).	10

Text/Reference Books:

1. Kalpakjian, S., and Schmid, S.R., *Manufacturing Processes for Engineering Materials*.
2. Boothroyd, G., and Knight, W.A., *Fundamentals of Machining and Machine Tools*.
3. Jain, V.K., *Advanced Machining Processes*.
4. Rao, P.N., *Manufacturing Technology: Metal Cutting and Machine Tools*.
5. Shaw, M.C., *Metal Cutting Principles*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Understand the mechanics of machining processes and analyze the influence of cutting parameters on surface quality and productivity.
CO2	Examine cutting tool materials, geometries, and wear mechanisms to improve tool design and lifespan.
CO3	Assess various machine tools, setup techniques, and precision machining processes for diverse applications.
CO4	Optimize machining parameters and understand the economic and environmental implications of machining operations.
CO5	Investigate advanced machining processes and modern trends for high-precision and sustainable manufacturing.

Course Description

This course provides an in-depth understanding of machining processes, cutting tools, and machine tool operations. The course emphasizes the influence of cutting parameters on surface quality, tool design, and productivity, with a focus on precision machining techniques and their application in real-world manufacturing settings.

Course Objectives

1. To explore the mechanics of machining processes and their impact on surface quality and productivity.
2. To study cutting tool materials, geometries, and wear mechanisms for enhanced tool performance and lifespan.
3. To analyse machine tools, setup techniques, and precision machining for diverse industrial applications.
4. To optimize machining parameters and understand their economic and environmental implications in manufacturing.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	2	2	-	-	1	-	2
CO2	3	2	3	2	2	2	1	-	-	-	1	2
CO3	3	3	3	3	3	-	1	-	-	1	-	1
CO4	2	2	3	2	2	3	2	-	-	-	-	3
CO5	3	3	3	3	3	3	3	-	-	-	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	2	3	2
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - I Semester: M. Tech. (Production Engineering)

Sub: Machining Science-II

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Advanced Cutting Theory**: Analysis of oblique cutting, chip formation mechanics, temperature distribution in cutting, thermodynamics of machining, force models, and modeling of cutting forces using FEM and other analytical methods. Influence of tool geometry and tool material on force and temperature.	08
3.	**Vibration in Machining**: Types of vibrations (free, forced, and self-excited), dynamics of the cutting process, chatter mechanisms, stability analysis, methods for controlling chatter, and vibration isolation techniques in high-precision machining environments.	07
4.	**Tool Wear and Failure Analysis**: Types and mechanisms of wear (abrasion, adhesion, diffusion, oxidation, fracture), factors affecting tool wear, tool life modeling, wear measurement techniques, predictive models of tool wear, and failure analysis for carbide, ceramic, and coated tools.	06
5.	**Machining of Hard-to-Cut Materials**: Characteristics of hard-to-machine materials (superalloys, composites, ceramics), challenges in machining, cutting tool selection and coatings, effects of work-hardening, machining strategies, and cooling/lubrication techniques to improve machinability.	08
6.	**High-Speed, Micro-, and Nano-Machining**: Principles and challenges of high-speed machining, micro- and nano-machining processes, effects on surface integrity, ultra-precision machining, applications in electronics and biomedical manufacturing, machine tool requirements, and effects of heat and residual stresses on micro and nano-scales.	10

Text/Reference Books:

1. Shaw, M.C., *Metal Cutting Principles*.
2. Kalpakjian, S., and Schmid, S.R., *Manufacturing Processes for Engineering Materials*.
3. Tlusty, J., *Manufacturing Processes and Equipment*.
4. Astakhov, V.P., *Geometry of Single-point Turning Tools and Drills*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Analyze cutting theory in depth, including force modeling and the influence of machining parameters.
CO2	Identify and control machining vibrations to enhance surface quality and machine tool life.
CO3	Evaluate tool wear mechanisms and apply predictive models for tool life under various conditions.
CO4	Develop machining strategies for hard-to-machine materials using advanced tooling and cooling methods.
CO5	Investigate applications of high-speed, micro-, and nano-machining in precision industries.

Course Description

The course *Machining Science-II* delves into advanced machining concepts, focusing on the dynamics of cutting theory, vibration control, tool wear mechanisms, and strategies for machining hard-to-process materials. It also explores applications in high-speed, micro-, and nano-machining for precision industries.

Course Objectives

1. To understand and analyze cutting theories and machining parameters.
2. To identify and mitigate machining vibrations for improved performance.
3. To evaluate and predict tool wear and tool life in diverse machining conditions.
4. To develop machining strategies for challenging materials using innovative techniques.
5. To explore modern machining technologies for precision engineering applications.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	-	-	-	-	-	-	1
CO2	2	3	3	3	2	-	-	-	2	-	-	2
CO3	3	3	2	3	3	-	-	-	-	-	2	1
CO4	3	3	3	3	2	2	2	-	-	2	2	2
CO5	3	3	3	3	3	-	2	-	-	2	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	2	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - I Semester: M. Tech. (Production Engineering)

Sub: Metal Forming

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Fundamentals of Metal Forming**: Stress-strain curves, Yield criteria (Tresca, von Mises), plasticity, Deformation theory, Formability Tests, Flow Rule, and work-hardening models.	07
3.	**Bulk Deformation Processes**: Analysis of forging (open-die, closed-die, and precision forging), Rolling (hot and cold rolling), extrusion (direct, indirect, impact), wire and tube drawing, and defects in bulk deformation.	08
4.	**Sheet Metal Forming**: Bending operations, Spring-back analysis, Deep drawing, Stretch forming, progressive die processes, Tooling considerations, formability of advanced materials, and FEM simulation of sheet metal forming.	08
5.	**Plasticity and Forming Analysis**: Slip-line field theory, upper-bound theorem, lower-bound theorem, limit analysis, strain rate effects, and finite element modeling techniques for complex metal forming applications.	08
6.	**Advanced Metal Forming Techniques**: Superplastic forming, hydroforming, explosive forming, electro-magnetic forming, incremental forming, laser-assisted forming, and applications of smart materials in forming processes.	09

Text/Reference Books:

1. Hosford, W.F., and Caddell, R.M., *Metal Forming: Mechanics and Metallurgy*.
2. Dieter, G.E., *Mechanical Metallurgy*.
3. Altan, T., *Metal Forming: Fundamentals and Applications*.
4. Wagoner, R.H., and Chenot, J.L., *Fundamentals of Metal Forming*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Understand the fundamentals of metal forming and assess material behavior under different forming conditions.
CO2	Analyze bulk deformation processes and predict potential defects in various forming applications.
CO3	Apply advanced formability testing and analysis methods in sheet metal operations.
CO4	Use theoretical and computational approaches to model plastic deformation in forming processes.
CO5	Investigate advanced forming techniques and explore their use in manufacturing complex geometries.

Course Description

Metal Forming is a specialized course focusing on the principles and applications of deformation processes used in manufacturing. It covers material behavior under various forming conditions, analysis of bulk deformation and sheet metal processes, and the application of advanced techniques in forming complex geometries.

Course Objectives

1. To understand the fundamental principles of metal forming processes and their applications.
2. To analyze the material behavior and deformation mechanisms in various forming operations.
3. To explore advanced formability tests and theoretical approaches to predict and solve forming challenges.
4. To investigate cutting-edge forming technologies and their role in modern manufacturing systems.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	-	-	-	-	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-
CO3	2	3	2	2	2	-	-	-	-	-	-	-
CO4	2	2	3	3	3	-	-	-	-	-	-	-
CO5	2	2	2	2	3	2	2	-	-	-	-	1

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	2	-
CO2	3	3	2
CO3	2	3	3
CO4	3	2	3
CO5	3	3	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - I Semester: M. Tech. (Production Engineering)

Sub: Metrology & Computer-Aided Inspection

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Basics of Metrology**: Introduction to metrology, importance of standards, accuracy, precision, calibration, types of tolerances and fits, and error analysis in measurements.	07
3.	**Linear and Angular Measurements**: Principles of linear measurement tools (Vernier calipers, micrometers, dial gauges), angle measurement tools (sine bars, angle gauges, protractors), and applications in precision manufacturing.	06
4.	**Surface Texture and Measurement**: Surface finish and roughness measurement, surface roughness parameters, contact and non-contact profilometers, interferometry, stylus and optical methods for surface inspection.	07
5.	**Coordinate Measuring Machines (CMM)**: Types of CMMs (bridge, gantry, portable), probe types, software integration, CMM programming, error sources in CMM, accuracy and repeatability, and quality control applications.	09
6.	**Advanced Inspection Techniques**: Non-contact measurement techniques (laser scanning, structured light, 3D scanning), machine vision systems, automatic defect detection, inspection robotics, and applications in modern manufacturing quality control.	10

Text/Reference Books:

1. Gupta, I.C., *Engineering Metrology*.
2. Jain, R.K., *Engineering Metrology*.
3. Hume, K.J., *Engineering Metrology*.
4. Ahuja, B.B., *Metrology and Instrumentation*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Understand fundamental concepts in metrology and apply error analysis for accurate measurements.
CO2	Perform precise linear and angular measurements to ensure dimensional accuracy in manufacturing.
CO3	Analyze surface characteristics using advanced methods for assessing surface quality.
CO4	Operate and program CMMs for effective dimensional quality control in engineering applications.
CO5	Implement non-contact and automated inspection methods for high-precision and high-throughput applications.

Course Description

Metrology & Computer-Aided Inspection focuses on the principles and practices of measurement science, error analysis, and quality assurance in manufacturing processes. The course explores advanced techniques like Coordinate Measuring Machines (CMM) and non-contact inspection methods for precise dimensional and surface quality evaluation.

Course Objectives

1. To understand the fundamentals of measurement science and error analysis.
2. To perform linear, angular, and surface measurements with precision.
3. To explore advanced tools like CMM and automated inspection systems for quality control.
4. To integrate modern inspection techniques into manufacturing processes for efficiency and reliability.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	3	-	-	-	-	-	-	-	2
CO2	3	3	3	3	-	-	-	-	-	-	-	-
CO3	3	2	-	3	-	-	-	-	-	-	-	2
CO4	3	3	3	3	3	-	-	-	-	-	-	2
CO5	3	2	-	3	3	-	-	-	-	-	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	3	3	-
CO3	-	3	-
CO4	-	3	3
CO5	3	3	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - I Semester: M. Tech. (Production Engineering)

Lab: Manufacturing Lab

Credit: 2 **Max. Marks**: 100 (IA:60, ETE:40)

0L+0T+4P

S. No.	Experiment
1	Introduce and demonstrate the fundamental manufacturing processes such as casting, machining, and welding.
2	Study different types of casting methods and their applications, focusing on sand molding techniques.
3	Study the principles of metal cutting, and practice operating a lathe machine for various processes.
4	Explore different welding techniques including arc welding, MIG, and TIG, and their uses in manufacturing.
5	Study the operations of a milling machine, including surface milling, slotting, and contouring.
6	Perform the drilling and tapping processes, and how to apply them for precise manufacturing.
7	Study the surface grinding methods, including abrasive tools, and their role in achieving high-precision finishes.
8	Develop the skills in inspecting and measuring manufactured parts using tools like micrometers and calipers.

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 1st Year, II Sem: Production Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Advanced Optimization Techniques	5	0	0	3	25	100	125	5
2	Mechatronics	5	0	0	3	25	100	125	5
3	Machine Tool Design	5	0	0	3	25	100	125	5
4	Computer Integrated Manufacturing Systems	5	0	0	3	25	100	125	5
5	CAM Lab	0	0	4		60	40	100	2
	Total	**20**	**0**	**4**		**160**	**440**	**600**	**22**

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UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - II Semester: M. Tech. (Production Engineering)

Sub: Advanced Optimization Techniques

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Classical Optimization Techniques**: Overview of optimization, single-variable optimization, multivariable optimization with and without constraints, Lagrange multipliers, and Kuhn-Tucker conditions.	07
3.	**Linear and Nonlinear Programming**: Formulation of linear programming (LP) problems, graphical and simplex methods, duality theory, sensitivity analysis, nonlinear programming (NLP) methods, quadratic programming, and penalty function methods.	08
4.	**Integer, Dynamic, and Stochastic Programming**: Integer programming, branch and bound techniques, dynamic programming principles, applications of dynamic programming, Markov decision processes, and stochastic programming for decision-making under uncertainty.	08
5.	**Metaheuristic Optimization Techniques**: Genetic algorithms, particle swarm optimization, simulated annealing, ant colony optimization, differential evolution, tabu search, and applications in engineering design.	08
6.	**Multi-objective Optimization and Applications**: Pareto optimality, multi-objective optimization methods (weighted sum, ε-constraint, NSGA-II), real-world applications in engineering, transportation, and supply chain management.	08

Text/Reference Books:

1. Deb, K., *Optimization for Engineering Design: Algorithms and Examples*.
2. Rao, S.S., *Engineering Optimization: Theory and Practice*.
3. Taha, H.A., *Operations Research: An Introduction*.
4. Michalewicz, Z., *Genetic Algorithms + Data Structures = Evolution Programs*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Apply classical optimization techniques for solving single and multi-variable problems with and without constraints.
CO2	Formulate and solve linear and nonlinear programming problems using advanced methods.
CO3	Implement integer, dynamic, and stochastic programming techniques in decision-making processes.
CO4	Utilize metaheuristic techniques for complex engineering problems.
CO5	Conduct multi-objective optimization analysis and apply it to real-world engineering applications.

Course Description

Advanced Optimization Techniques explores methods and strategies for optimizing engineering systems and processes. The course covers classical and modern optimization methods, including metaheuristic techniques, and their applications in solving complex, real-world engineering problems.

Task 2: Course Objectives

1. To understand classical optimization methods for single and multi-variable problems.
2. To formulate and solve linear, nonlinear, and dynamic programming problems.
3. To utilize metaheuristic techniques for addressing complex engineering challenges.
4. To conduct multi-objective optimization and apply advanced techniques in engineering applications.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	2
CO2	3	3	3	3	3	-	-	-	-	-	-	-
CO3	3	3	3	3	3	-	-	-	-	-	-	2
CO4	3	3	3	3	3	2	2	-	-	-	-	2
CO5	3	3	3	3	3	2	2	-	-	2	2	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	3	3	-
CO3	3	3	-
CO4	3	3	3
CO5	3	3	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - II Semester: M. Tech. (Production Engineering)

Sub: Mechatronics

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Sensors and Actuators**: Types of sensors (temperature, pressure, proximity, accelerometers, gyroscopes), signal conditioning, stepper motors, servo motors, DC/AC motors, hydraulic and pneumatic actuators, selection and application of actuators in mechatronic systems.	08
3.	**Microcontrollers and Programmable Logic Controllers (PLCs)**: Introduction to microcontrollers, architecture, programming basics, interfacing of sensors and actuators, PLC programming, ladder diagrams, and applications in industrial automation.	07
4.	**Modeling and Simulation of Mechatronic Systems**: System modeling principles, transfer functions, block diagrams, mechanical, electrical, and hydraulic systems modeling, and use of software tools (e.g., MATLAB, Simulink) for simulation.	08
5.	**Control Systems and Feedback Mechanisms**: PID control, fuzzy logic control, adaptive control, feedforward control, design and analysis of control systems, and applications in robotics and automated systems.	08
6.	**Design of Mechatronic Systems**: Mechatronic design process, integration of mechanical and electrical systems, sensors and actuators integration, case studies in automotive, aerospace, and industrial automation.	08

Text/Reference Books:

1. Bolton, W., *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*.
2. Bishop, R.H., *The Mechatronics Handbook*.
3. Alciatore, D., and Histand, M., *Introduction to Mechatronics and Measurement Systems*.
4. Necsulescu, D.S., *Mechatronics*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Select appropriate sensors and actuators for specific mechatronic applications.
CO2	Develop and program microcontrollers and PLCs for automated systems.
CO3	Model and simulate mechatronic systems using appropriate mathematical and software tools.
CO4	Design control systems with feedback mechanisms to maintain stability in mechatronic devices.
CO5	Integrate mechanical and electronic components in the design of functional mechatronic systems.

Course Description

The course "Mechatronics" integrates principles from mechanical, electrical, and computer engineering to design intelligent systems and automation solutions. It covers the selection of sensors, actuators, microcontrollers, and software tools for the development, simulation, and control of mechatronic systems.

Course Objectives

1. To understand and select appropriate components such as sensors and actuators for mechatronic systems.
2. To develop and program microcontrollers and PLCs for effective automation.
3. To model, simulate, and analyze mechatronic systems using mathematical and computational tools.
4. To design stable control systems with integrated feedback mechanisms.
5. To synthesize mechanical and electronic components for creating functional mechatronic solutions.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	3	-	-	-	-	-	-	-
CO2	3	3	3	3	3	-	-	-	-	-	-	3
CO3	3	3	3	3	2	-	-	-	-	-	-	2
CO4	3	3	3	3	3	-	-	-	2	-	-	3
CO5	3	3	3	3	3	-	2	-	-	-	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	3	3	-
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - II Semester: M. Tech. (Production Engineering)

Sub: Machine Tool Design

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Design of Machine Tool Elements**: Basics of machine tool design, design of beds, columns, bases, spindles, bearings, and guides, types of guides (linear, anti-friction, hydrostatic), and considerations for stiffness and damping.	08
3.	**Kinematics and Dynamics of Machine Tools**: Gear trains, transmission systems, feed mechanisms, cam mechanisms, machine tool vibration, dynamic stability, and chatter reduction.	08
4.	**Control and Automation in Machine Tools**: Introduction to CNC systems, drives and controls, motion control, interpolators, feedback systems, adaptive control, and integration of sensors for automation.	08
5.	**Ergonomics and Aesthetics in Machine Tool Design**: Human factors in design, user interface design, safety considerations, ergonomic layout, and aesthetics in industrial design of machine tools.	07
6.	**Advanced Topics in Machine Tool Design**: High-speed machining, design for reliability and maintainability, modular design of machine tools, precision engineering, and applications in robotics.	08

Text/Reference Books:

1. Mehta, N.K., *Machine Tool Design and Numerical Control*.
2. Basu, S.K., and Pal, D.K., *Design of Machine Tools*.
3. Yoram Koren, *Computer Control of Manufacturing Systems*.
4. Ghosh, A., and Malik, A.K., *Theory of Mechanisms and Machines*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Design essential elements of machine tools with emphasis on stability and precision.
CO2	Analyze the kinematics and dynamics of machine tool operations.
CO3	Implement CNC systems and automation techniques in machine tools.
CO4	Apply ergonomic and aesthetic principles in the design of user-friendly machine tools.
CO5	Explore advanced machine tool design principles for high-speed, modular, and precision applications.

Course Description

Machine Tool Design focuses on the principles and methodologies for designing machine tools with an emphasis on stability, precision, and efficiency. It covers kinematics, dynamics, CNC systems, automation, and advanced design principles for modern manufacturing applications.

Course Objectives

1. To understand the design principles of machine tools with an emphasis on stability and precision.
2. To analyze kinematics and dynamics of machine tool operations for improved functionality.
3. To implement CNC and automation systems for enhanced productivity.
4. To integrate ergonomic and aesthetic considerations into machine tool design.
5. To explore advanced design techniques for high-speed, modular, and precision machine tools.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	-	-	-	-	-	-	-	2
CO2	3	3	-	3	-	-	-	-	-	-	-	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2
CO4	3	2	3	2	2	-	-	-	2	2	-	-
CO5	3	3	3	3	3	2	2	-	-	-	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	3	2	-
CO3	3	3	2
CO4	2	3	3
CO5	3	3	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - II Semester: M. Tech. (Production Engineering)

Sub: Computer Integrated Manufacturing Systems

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Fundamentals of CIM**: Introduction to CIM systems, CAD/CAM integration, types of manufacturing systems, flexible manufacturing systems (FMS), lean manufacturing principles, agile manufacturing, overview of Industry 4.0, and smart manufacturing.	08
3.	**Computer-Aided Process Planning (CAPP)**: Process planning techniques, generative and variant CAPP, hybrid CAPP, process planning for CNC, group technology in process planning, optimization of CAPP, and computer-aided scheduling, sequencing, and process optimization.	08
4.	**Manufacturing Information Systems (MIS)**: ERP systems, manufacturing resource planning (MRP II), production planning and control (PPC), shop floor data collection, inventory control systems, CIM database management, real-time data acquisition and monitoring, and decision support systems (DSS) for manufacturing.	08
5.	**Robotics and Automated Material Handling**: Robotics in CIM environments, robot kinematics and control, material handling automation, automated guided vehicles (AGVs), automated storage and retrieval systems (ASRS), robotic assembly, flexible robotic work-cell design, and programmable logic controllers (PLCs) for material handling.	08
6.	**Quality Control and Advanced Inspection in CIM**: Statistical process control (SPC), automated inspection and testing systems, computer-aided quality control (CAQC), machine vision systems for inspection, coordinate measuring machines (CMM), real-time process monitoring, manufacturing execution systems (MES), and total quality management (TQM) integration in CIM.	08

Text/Reference Books:

1. Groover, M.P., *Automation, Production Systems, and Computer Integrated Manufacturing*.
2. Rao, P.N., Tewari, N.K., and Kundra, T.K., *Computer Integrated Manufacturing.*
3. Vajpayee, S. Kant, *Principles of Computer Integrated Manufacturing*.
4. Rembold, U., *Computer Integrated Manufacturing and Engineering*.
5. Kalpakjian, S., *Manufacturing Engineering and Technology*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Understand the core components and principles of CIM and their impact on modern manufacturing practices.
CO2	Utilize advanced CAPP methods to optimize process planning and manufacturing sequences.
CO3	Apply MIS, ERP, and MRP II systems for effective planning and control of manufacturing resources and operations.
CO4	Implement robotic systems and automated material handling for enhanced efficiency in CIM environments.
CO5	Integrate automated quality control and inspection methods, including real-time monitoring, for improved product quality.

Course Description

Computer Integrated Manufacturing (CIM) Systems explores the integration of automation, robotics, and digital tools in modern manufacturing environments. The course emphasizes advanced planning, production control, and quality assurance methodologies to streamline production processes and enhance efficiency.

Task 2: Course Objectives

1. To understand the principles and components of CIM and their role in manufacturing systems.
2. To apply advanced process planning techniques for optimizing manufacturing operations.
3. To utilize enterprise resource systems (MIS, ERP, MRP II) for effective resource management.
4. To explore the use of robotics, automation, and real-time quality monitoring for enhanced manufacturing efficiency.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	2
CO2	3	3	3	-	2	-	-	-	-	-	-	3
CO3	3	3	3	3	3	-	-	-	-	-	2	3
CO4	2	3	3	3	3	2	-	-	-	-	-	3
CO5	3	3	3	3	3	2	2	-	-	-	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	3	2	-
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - II Semester: M. Tech. (Production Engineering)

Lab: CAM Lab

Credit: 2 **Max. Marks**: 100 (IA:60, ETE:40)

0L+0T+4P

S. No.	Objective
1	Study the fundamentals of Computer-Aided Manufacturing (CAM) and its integration with CAD systems.
2	CNC programming using G-codes and M-codes for various machining operations.
3	Simulate machining operations using CAM software and verify the tool paths for accuracy.
4	Study the process of tool selection and tool life management in CNC machining.
5	Explore the process of post-processing for generating machine-readable code from CAM software.
6	Study the working and operation of CNC lathes and practice programming for turning operations.
7	Develop CNC milling programs for multi-axis machines and verify their performance using simulation tools.
8	Study about the integration of robots with CAM systems for automated manufacturing processes.

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 2nd Year, III Sem: Production Engineering

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Micro Electrical and Mechanical Systems (MEMS)	5	0	0	3	25	100	125	5
2	Nano Technology	5	0	0	3	25	100	125	5
3	Seminar	0	0	0		90	60	150	6
4	Dissertation– I	0	0	0		100	0	100	4
	Total					**240**	**260**	**500**	**20**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*
ETE: *End Term Exam,* ***IA:*** *Internal Assessment*
**: Not to be considered for award of division*

UNIVERSITY OF TECHNOLOGY, JAIPUR

2nd Year - III Semester: M. Tech. (Production Engineering)

Sub: Micro Electrical and Mechanical Systems (MEMS)

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Fundamentals of MEMS**: Introduction to MEMS, microsystems, and micromachining processes; key applications in automotive, biomedical, and communications. Overview of scaling laws, microfabrication techniques, lithography, etching, deposition, and substrate bonding techniques.	07
3.	**Micro-sensors and Actuators**: Types and principles of MEMS sensors and actuators; capacitive, piezoelectric, thermal, and optical sensors; microfluidic devices, micromotors, and micromirrors. Applications in pressure, temperature, and chemical sensing.	08
4.	**MEMS Materials and Properties**: Materials used in MEMS (silicon, polymers, metals, ceramics), their mechanical and electrical properties, material selection criteria, and impact on device performance. Study of mechanical properties at microscale, including elasticity, plasticity, and fracture.	06
5.	**MEMS Design and Simulation**: Principles of MEMS design; CAD for MEMS, introduction to FEM-based simulation software, and modeling of MEMS devices using tools like COMSOL and ANSYS. Study of stress, deformation, and failure analysis in MEMS design.	08
6.	**MEMS Packaging and Applications**: Packaging techniques (wafer-level, chip-level, and system-in-package), hermetic sealing, and stress effects on MEMS devices. Applications in biomedical devices, inertial measurement units (IMUs), RF MEMS, and optical MEMS.	10

Text/Reference Books:

1. Trimmer, W., *Microsystems Engineering*.
2. Maluf, N., *An Introduction to Microelectromechanical Systems Engineering*.
3. Senturia, S.D., *Microsystem Design*.
4. Gad-el-Hak, M., *MEMS: Design and Fabrication.*

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Understand the basic principles and fabrication techniques in MEMS technology.
CO2	Identify and analyze different types of MEMS sensors and actuators for various applications.
CO3	Examine materials used in MEMS and their properties relevant to microscale devices.
CO4	Utilize design and simulation tools to model MEMS devices for targeted performance criteria.
CO5	Apply MEMS packaging techniques and explore their use in cutting-edge applications across various industries.

Course Description

The course **Micro Electrical and Mechanical Systems (MEMS)** introduces the principles, fabrication techniques, and applications of MEMS technology. It focuses on microscale sensors, actuators, materials, and packaging techniques, enabling learners to design, analyze, and apply MEMS in various engineering domains.

Course Objectives

1. To understand the fundamental principles and fabrication techniques in MEMS technology.
2. To explore MEMS sensors, actuators, and their applications in engineering fields.
3. To analyze material properties and design MEMS devices using simulation tools.
4. To examine packaging techniques and their role in the functionality of MEMS systems.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	2
CO2	3	3	2	3	-	-	-	-	-	-	-	-
CO3	3	2	-	2	3	-	-	-	-	-	-	2
CO4	3	3	3	3	3	-	-	-	-	-	-	3
CO5	3	2	3	3	3	-	-	-	-	-	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	3	3	-
CO3	2	3	-
CO4	3	3	3
CO5	3	3	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

2nd Year - III Semester: M. Tech. (Production Engineering)

Sub: Nano Technology

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction**: Objective, scope, and outcome of the course.	01
2.	**Fundamentals of Nanotechnology**: Nanoscale properties, surface-to-volume ratio, quantum effects, van der Waals forces, and introduction to nanomaterials. Overview of top-down and bottom-up fabrication techniques, including nanopatterning and self-assembly.	08
3.	**Synthesis of Nanomaterials**: Chemical vapor deposition (CVD), physical vapor deposition (PVD), sol-gel methods, ball milling, electrodeposition, and wet chemical synthesis. Study of nanoparticles, nanowires, nanotubes, and nanocomposites.	08
4.	**Characterization Techniques**: Scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM), X-ray diffraction (XRD), Raman spectroscopy, and dynamic light scattering (DLS). Applications of spectroscopy in nanoscale analysis and sample preparation techniques.	07
5.	**Applications of Nanotechnology**: Nanotechnology in electronics (transistors, quantum dots), medicine (drug delivery, cancer therapy), energy (solar cells, batteries), and environmental science (pollutant removal, water purification).	08
6.	**Ethics, Safety, and Environmental Impact**: Ethical considerations in nanotechnology, safety guidelines, environmental impact, regulations, nanotoxicology, and responsible development of nanotechnologies.	08

Text/Reference Books:

1. Bhushan, B., *Springer Handbook of Nanotechnology*.
2. Poole, C.P., and Owens, F.J., *Introduction to Nanotechnology*.
3. Ratner, M., and Ratner, D., *Nanotechnology: A Gentle Introduction to the Next Big Idea*.
4. Wilson, M., Kannangara, K., Smith, G., et al., *Nanotechnology: Basic Science and Emerging Technologies*.

Course Outcomes (COs)

CO Number	Course Outcome Description
CO1	Understand the basic principles and unique properties at the nanoscale.
CO2	Explain the synthesis techniques of various nanomaterials and their applications in diverse fields.
CO3	Utilize advanced characterization tools to analyze nanomaterials for scientific and industrial applications.
CO4	Explore applications of nanotechnology in fields like electronics, medicine, and environmental science.
CO5	Assess the ethical, safety, and environmental aspects of nanotechnology for sustainable development.

Course Description

Nano Technology explores the fundamental principles and unique behaviors of materials at the nanoscale. The course covers synthesis techniques, characterization tools, and diverse applications, emphasizing sustainable and ethical practices in nanotechnology.

Course Objectives

1. To understand the fundamental principles and unique properties at the nanoscale.
2. To explore synthesis methods and advanced characterization techniques for nanomaterials.
3. To evaluate the applications of nanotechnology in various domains like electronics, medicine, and environmental science.
4. To assess the ethical, safety, and sustainability implications of nanotechnology.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	-	-	2	-	-	-	-	2
CO2	3	3	2	3	2	-	-	-	-	-	-	-
CO3	3	3	-	3	3	-	-	-	-	-	-	3
CO4	3	3	3	3	2	3	3	-	-	-	-	3
CO5	-	2	-	-	-	3	3	3	-	-	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	3	3	-
CO3	3	3	3
CO4	3	3	3
CO5	-	3	3