Curriculum Structure and Evaluation Scheme for M. Tech. in Mechanical Design Engineering and Multidisciplinary Minor

(To be implemented for 2025-2027 Batch)

HOD
DEPT. OF MACHANICAL ENGINEERING
SHRI BALASAHEB MANE SHIKSHAN PRASARAK MANDAL'S
ASHOKRAO MANE GROUP OF INSTITUTIONS

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ABBREVIATIONS

- **L:** Lecture
- **T:** Tutorial
- **P:** Practical
- **ISE-I**- In Semester Evaluation I
- **ISE-II**- In Semester Evaluation II
- **MSE:** Mid Semester Examination
- **ESE:** End Semester Exam
- **VEC-** Value Education Course
- **ELC-** Experiential Learning Course
- **AC:** Audit Course
- **RM:** Research Methodology
- **OE**: Open Elective
- **PCC**: Program Core Course
- **PEC**: Program Elective Course
- **MDM-** Multidisciplinary Minor
- **FP**- Field Project

PG Program: Mechanical Design Engineering

Semester: I

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
PCC	P25MD101	Advanced Engineering Design	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD102	Design for Piping System	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD103	Advanced Vibrations and Acoustics	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PEC	P25MD104	Program Elective-I	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
RM	P25MD105	Research Methodology and IPR	2	-	-	2	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
ELC	P25MD106	Seminar	-	-	2	1	ISE	50	20	40
							ESE (OE)	50		
PCC	P25MD107	PG Lab- I	-	-	4	2	ISE	50	20	40
							ESE (POE)	50	20	
AC	P25MD108	Yoga and Meditation	1	-	-	-	-	-	AU	
	Total		**15**	**3**	**06**	**20**		700		
Total Contact Hours- 24							**Total Credits- 20**			

PG Program: Mechanical Design Engineering
Semester: II

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
PCC	P25MD201	Finite Element Method in Design	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD202	Integrated Product Development	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD203	Design for Manufacturing and Assembly	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PEC	P25MD204	Program Elective-II	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
OE	P25MD205	Open Elective-I	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
VEC	P25MD206	Technologies for Industrial Evolution	2	-	-	2	ISE-I	25		20
							ISE-II	25		
ELC	P25MD207	Mini Project	-	-	2	1	ISE-I	25		40
							ISE-II	25		
							ESE (POE)	50	20	
PCC	P25MD208	PG Lab- II	-	-	4	2	ISE	50	20	40
							ESE (POE)	50	20	
ELC	P25MD209	Internship/Field Training	-	-	-	-	Will be Evaluated in Sem-III	-	-	
	Total		**18**	**0**	**06**	**22**		**750**		
Total Contact Hours- 24							**Total Credits- 22**			

PG Program: Mechanical Design Engineering
Semester: III

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
OE	P25MD301	Open Elective-II[$]	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
MDM	P25MD302	Multi-Disciplinary Minor[$]	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
ELC	P25MD303	Dissertation Phase-I*	-	-	20	10	ISE-I	25		40
							ISE-II	25		
							ESE (POE)	50	20	
ELC	P25ET209	Internship/Field Training[#]	-	-	-	2	ISE	50	-	40
Total			**6**	**-**	**20**	**18**	**350**			
Total Contact Hours- 26 Total Credits- 18										

$ It is mandatory to opt these courses certification from SWAYAM/NPTEL, MOOC platform.
* It is required to complete 30% work of Dissertation.
# It is required to do Four weeks domain specific industrial internship after completing first year of the program evaluated in Semester-III

PG Program: Mechanical Design Engineering
Semester: IV

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
Project	P25MD401	Dissertation Phase-II*	-	-	40	20	ISE-I	50	40	
							ISE-II	50		
							ESE (POE)	100	40	80
Total			**-**	**-**	**40**	**20**	**200**			
Total Contact Hours- 40							**Total Credits- 20**			

* It is required to publish/present two papers out of which at least one paper should be in a SCI/ SCIE/ SCOPUS/ Web of Science/ Peer-Reviewed Journal before Thesis Submission.

PROGRAM ELECTIVE

(Students have to select any one Program Elective course out of 03, for each applicable semester, of their interest, offered by the PG Program from the table below)

Program Elective – I			
Sr. No.	**Course Code**	**Course Name**	**Semester**
1	P25MD 104A	Composite Materials and Mechanics	I
2	P25MD 104B	Advance Engineering Materials	
3	P25MD 104C	Optimization Techniques in Design	

Program Elective – II			
Sr. No.	**Course Code**	**Course Name**	**Semester**
1	P25MD 204A	Tribology in Design	II
2	P25MD 204B	Theory of Elasticity and Plasticity	
3	P25MD 204C	Engineering computing	

MULTIDISCIPLINARY MINOR (MDM)

(Students have to select any one course of their interest (other than a courses offered by their program) for the award of Minor Degree from the table below)

Sr.	Course Code	Course Name (MDM)	Semester	Offered by the Department
1	P25MD302	Introduction to Industry 4.0 and Industrial Internet of Things	III	Mechanical Engineering -Design

OPEN ELECTIVE COURSES

(Students have to select any one Open Elective course, for each applicable semester, of their interest from the basket below.)

Open Elective – I Semester II			Open Elective – II Semester III		
Sr.	**Course Code**	**Course Name (OE)**	**Sr.**	**Course Code**	**Course Name (OE)**
1	P25MD205A	Environment and Development	1	P25MD301A	Labour Welfare and Industrial Relations
2	P25MD205B	Engineering Economics	2	P25MD301B	Sustainable Technology
3	P25MD205C	Project Management	3	P25MD301C	Entrepreneurship Development
4	P25MD205D	Healthcare Engineering	4	P25MD301D	Industrial Automation

Exit Courses after Semester– II - P.G. Diploma

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme		
			L	T	P	Cr	Components	Max	Min. for Passing
AEC	P25ET109	Employability Skill Development*	4		-	4	ISE	50	40
							ESE	50	
ELC	P25ET110	Internship/Field Training#	-	-	-	2	ISE-I	50	40
							ESE	50	
	Total		**02**	**00**	**00**	**6**		**200**	
Total Contact Hours- 04 Total Credits- 06									

*It is mandatory to opt this course certification from SWAYAM/NPTEL MOOC platform
Four weeks domain specific industrial internship after successfully completing first year of the program.

PG Program: Mechanical Design Engineering
Semester: I

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
PCC	P25MD101	Advanced Engineering Design	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD102	Design for Piping System	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD103	Advanced Vibrations and Acoustics	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PEC	P25MD104	Program Elective-I	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
RM	P25MD105	Research Methodology and IPR	2	-	-	2	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
ELC	P25MD106	Seminar	-	-	2	1	ISE	50	20	40
							ESE (OE)	50	20	
PCC	P25MD107	PG Lab- I	-	-	4	2	ISE	50	20	40
							ESE (POE)	50	20	
AC	P25MD108	Yoga and Meditation	1	-	-	-	-	-	AU	
	Total		**15**	**3**	**06**	**20**		700		
Total Contact Hours- 24							**Total Credits- 20**			

Title of the Course Name: **Advanced Engineering Design** Course Code: P25MD101	**L**	**T**	**P**	**Credits**
	3	1	--	4
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Basic knowledge of mechanics, strength of materials, machine design, and manufacturing processes**.**

Course Objectives: The course aims to:

1. To develop a comprehensive understanding of design philosophies and models
2. To equip students with the ability to apply design strategies.
3. To analyze and apply failure theories.
4. To evaluate economic and ergonomic factors.

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify and recall key concepts involved in product and mechanical design including the design process, product strategies, static and fatigue failure theories, surface failures, manufacturing considerations, and economic factors.
CO2	Classify and relate various product design approaches, failure theories, material selection techniques, manufacturing methods, and ergonomic aspects by applying suitable models, principles, and safety standards.
CO3	Apply design techniques such as creative thinking, value engineering, failure analysis, and fatigue design to solve engineering problems involving product development, manufacturability, reliability, and cost-effectiveness.
CO4	Evaluate and justify optimal design decisions by analyzing complex interactions between materials, geometry, loading conditions, and user-centric requirements to enhance performance, safety, and economics of engineering systems

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Design Philosophy:** Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations - standardization. Creativity, Creative techniques, Material selections, Notches and stress concentration, design for safety and Reliability.	**06**
2	**Product Design:** Product strategies, value, planning and specification, concept generation, concept selection, concept testing.	**06**
3	**Design for Manufacturing:** Forging design, casting design, Design process for non- metallic parts, Plastics, Rubber, Ceramic, Wood and Glass parts. Material selection in machine design.	**06**
4	**Failure theories:** Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics theory, Fatigue mechanisms, Fatigue failure models, Design for fatigue strength and life, creep: Types of stress variation, design for fluctuating stresses, design for limited cycles, multiple stress cycles, Fatigue failure theories, cumulative fatigue damage, thermal fatigue and shock, harmful and beneficial residual stresses, Yielding and transformation.	**06**
5	**Surface failures:** Surface geometry, mating surfaces, oil film and their effects, design values and procedures, adhesive wear, abrasive wear, corrosion wear, surface fatigue, different contacts, dynamic contact stresses, surface fatigue failures, surface fatigue strength.	**06**
6	**Economic factors influencing design:** Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, and Modern approaches in design.	**06**

Text Books:

1. R. G. Budynas and J. K. Nisbett, "Shigley's Mechanical Engineering Design", McGraw-Hill, 10th edition, 2015.
2. G. E. Dieter and L. C. Schmidt, "Engineering Design: A Materials and Processing Approach", McGraw-Hill, 5th edition, 2013.
3. K. T. Ulrich and S. D. Eppinger, "Product Design and Development", McGraw-Hill, 6th edition, 2015.

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Reference Books:

1. G. Pahl and W. Beitz, *"Engineering Design: A Systematic Approach"*, Springer, 3rd edition, 2007.
2. V. B. Bhandari, *"Design of Machine Elements"*, Tata McGraw-Hill, 3rd edition, 2010.
3. D. M. Anderson, *"Design for Manufacturability and Concurrent Engineering"*, CRC Press, 1st edition, 2004.

Title of the Course Name: **Design for Piping System**	**L**	**T**	**P**	**Credits**
Course Code: **P25MD102**	3	1	--	4
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Basic Electronics

Course Objectives: The course aims to:

1. To identify and recall basic components of process piping such as pipes, valves, fittings, materials, and layout symbols along with applicable codes and standards.
2. To understand and describe the principles of piping layout, pipe installation methods, flexibility analysis, and system design for fluid flow and stress.
3. To apply design methodologies for selecting pipe sizes, designing steam/oil piping, pressure relief systems, and analyzing different mechanical and application-specific systems.
4. To evaluate and recommend piping solutions considering reliability, cost-effectiveness, material selection, stress handling, safety, and application-specific criteria.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and define key elements of process piping systems including codes, standards, materials, fittings, piping layouts, installation methods, auxiliary components, and application-specific systems.
CO2	Illustrate and explain piping system layouts, flow sheets, pipe installation steps, and mechanical design fundamentals for process piping.
CO3	Design and analyze piping systems for different applications such as steam, oil, refrigeration, cryogenics, and underground pipelines considering flow, stress, and safety.
CO4	Evaluate and recommend appropriate piping materials, sizing techniques, joining methods, and safety features for specific industrial applications, ensuring reliability and performance.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**PROCESS PIPING:** Scope of Piping; Code and Standards; Mechanical Design Fundamentals; Mechanical design of piping system; Wall thickness; Piping size selection; Steel and cast iron pipe; Steel and wrought iron pipe; Light wall pipe; Tubing; Pipe connection and fittings; Rail fittings; Piping elements and specialties; Pipe representation; Welded and flanged fittings; Valves.	**06**
2	**PIPING SYSTEM LAYOUT AND DESIGN:** Piping layout; Equipment Layout; Process Piping Layout; Utility Piping Layout; Pipe flow sheets; Tube fastening and attachment; Non- ferrous tube fittings; Ducts and elbows; Pipe and tube design data; Design of steam piping; Design of oil piping; Design of cast iron pipe; Miscellaneous design and applications: Pipeline; Flexibility expansive forces in pipelines; Expansion stresses and reaction pipelines.	**06**
3	**PIPE INSTALLATION:** Selection of materials; Piping design; Basic principle; Piping sketches; Steam reducing and regulating valves; Selection of pipe size; Pipe hydraulics and sizing; Flow of water in pipes; Economical pipe selection; Selection of steam pipe size; Determination of steam pipe size; Development of plot plan; Flexibility analysis.	**06**
4	**PROCESS AUXILIARIES:** Piping; Explanation of code; Methods of fabrication; Nominal pipe size; Non-metallic piping and tubing; Pipe sizing by internal diameter; Choosing the final pipe size; Process steam piping; Pressure relief system; Pressure relief devices; Design of pressure relief system; Layout by scale model method.	**06**
5	**MECHANICAL PIPING DESIGN:** Piping drawings; Piping stress design; Internal or external fluid pressure stresses; Design of overhead piping; Design of underground piping; Erection of piping and support; Insulation; Drainage piping design; Design of natural gas pipeline.	**06**
6	**DESIGN OF PIPING SYSTEM FOR THE FOLLOWING APPLICATIONS:** Refrigeration piping system, Cryogenic piping system, Transmission piping system, Steam power plant piping system, Underground steam-piping system, Underground petroleum piping, Submerged piping for petroleum products, Piping system sprinklers, Non-metallic piping; Selection and joining techniques; Cross Country Pipe Technology.	**06**

Text Books:

1. J. M. Coulson, R. K. Sinnott, and J. F. Richardson, *"Chemical Engineering, Volume 6: Design"*, Maxwell Macmillan International, 1st edition, 1993.
2. Mohinder L. Nayyar, *"Piping Handbook"*, McGraw-Hill, 7th edition, 2000.
3. G. K. Sahu, *"Handbook of Piping Design"*, New Age International Publishers, 1st edition, 1998.

Reference Books:

1. J. Philip Ellenberger, *"Piping Systems Manual"*, McGraw-Hill Professional, 1st edition, 2010.
2. John G. Kujawa and Philip Ellenberger, *"Pressure Relief Devices: ASME and API Code Simplified"*, McGraw-Hill, 1st edition, 2014.
3. Ronald C. Penno and Robert O. Parmley, *"Pipe Drafting and Design"*, Gulf Publishing Company, 2nd edition, 2001.

Title of the Course Name: **Advanced Vibrations and Acoustics** Course Code: **P25MD103**	**L**	**T**	**P**	**Credits**
	3	1	--	4
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Basic knowledge of Dynamics and Vibrations, Engineering Mathematics

Course Objectives: The course aims to:

1. To recall and describe the fundamental principles of vibration and acoustics, including SDOF and MDOF systems, wave transmission, and speech mechanisms.
2. To interpret and model mechanical and acoustic systems using mathematical tools such as Lagrange's equations, mode analysis, and wave equations.
3. To apply analytical and numerical methods such as Rayleigh-Ritz, Dunkerley's, and Holzer's methods for solving problems related to vibrations and acoustics.
4. To evaluate the performance and response of dynamic and acoustic systems and propose control and attenuation methods for specific vibration and sound problems.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall fundamental vibration and acoustics concepts including response of SDOF and MDOF systems, sound propagation, and human hearing mechanisms.
CO2	Formulate mathematical models for continuous and discrete vibratory systems and interpret the behavior of acoustic wave transmission and resonance.
CO3	Apply numerical and analytical methods to solve multi-degree and continuous vibration problems and analyze acoustic attenuation and resonance filters.
CO4	Evaluate vibration control methods and psychoacoustic principles to address engineering problems in vibration suppression and acoustic optimization.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Response of SDOF Systems and Convolution Integral**: Transient Vibrations, Response of a single degree of freedom system to step and any arbitrary excitation, convolution (Duhamel's) integral, impulse response function	**06**
2	**Vibrations of MDOF Systems and Mode Analysis:** Free, damped and forced vibrations of two degree of freedom systems, use of Lagrange's equations to derive the equations of motion, normal modes and their properties, multi degree of freedom systems, Eigen values and Eigen vectors, mode summation method.	**06**
3	**Continuous Systems and Approximate Methods**: Continuous Systems, Vibrations of strings, bars, shafts and beams, discretised models of continuous systems and their solutions using Rayleigh – Ritz method, Mode summation method,	**06**
4	**Vibration Control and Numerical Techniques:** Vibration Control, Methods of vibration control, principle of superposition, Numerical and computer methods in vibrations: Rayleigh, Rayleigh-Ritz and Dunkerley's methods, matrix iteration method for Eigen-value calculations, Stodola method, Holzer's method,	**06**
5	**Acoustic Wave Transmission and Attenuation**: Plane and Spherical acoustic waves, Transmission Phenomena, transmission from one fluid medium to another, normal incidence, reflection at the surface of a solid, standing wave patterns, transmission through three media, Resonators and filters, Absorption of sound waves in fluids : Phase log between pressure and condensation, viscous absorption of plane waves, heat conduction as a source of acoustic attenuation,	**06**
6	**Speech, Hearing and Psychoacoustics** Speech, Hearing and Noise, The voice mechanism, acoustic power output of a speech, anatomy of the ear, mechanism of hearing, thresholds of the ear, loudness, pitch and timbre, beats, aural harmonics and combination tones, masking by pure tones, masking by noise.	**06**

Text Books:

1. D. J. Inman, "Engineering Vibration", Pearson Education, 4th edition, 2014.
2. W. T. Thomson and M. D. Dahleh, "Theory of Vibration with Applications", PHI Learning, 5th edition, 2008.
3. Michael Rettinger, "Acoustic Design and Noise Control", Vol. I & II. , Chemical Publishing Co., New York, 1977.

Reference Books:

1. D. J. Ewins, "Modal Testing: Theory, Practice and Application", Wiley-Blackwell, 2nd edition, 2000.
2. R. B. Randall, "Vibration-based Condition Monitoring: Industrial, Aerospace and Automotive Applications", John Wiley & Sons, 1st edition, 2011.
3. Lawrence E. Kinsler and Austin R.Frey, "Fundamentals of acoustics", Wiley Eastern Ltd., 1987.

Title of the Course Name: **Composite Materials and Mechanics** Course Code: P25MD104A	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Material Science and Metallurgy, Stress Analysis

Course Objectives: The course aims to:

1. To recall fundamental definitions, classifications, material behaviors, and characteristics of composite materials including lamina and laminates under various loading conditions.
2. To understand the stress-strain behavior, transformation relations, hygro-thermal effects, and failure mechanisms of composite materials and structures.
3. To apply micromechanical and macromechanical models to evaluate stiffness, strength, and failure response of composite laminates in structural applications.
4. To evaluate the structural integrity, residual stresses, and progressive failure in composite systems and develop design methodologies for their safe and effective use.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and classify the basic concepts, material types, structural behavior, and classification of composite materials, lamina, laminates, and their applications under mechanical and thermal loading.
CO2	Interpret and analyze the elastic response, stress transformation, strain-displacement relations, and hygro-thermal behavior of composite laminates and their structural implications.
CO3	Apply micromechanics, failure theories, and hygro-thermoelastic models to evaluate performance, reliability, and failure progression in composite structural elements.
CO4	Evaluate laminate strength, failure mechanisms, safety factors, and develop systematic design strategies for structural composite applications under various environmental and loading conditions.

Course Content		
Unit No	**Unit title and Content**	**Hrs**
1	**Introduction, basic concepts and characteristics:** Definition and characteristics, Overview of advantage and limitations of composite materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus, Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials.	**06**
2	**Elastic behavior of unidirectional lamina:** Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters.	**06**
3	**Strength of unidirectional lamina:** Micromechanics of failure; failure mechanisms, Macro-mechanical strength parameters, Macro-mechanical failure theories, Applicability of various failure theories.	**06**
4	**Elastic behavior of laminate:** Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, general load–deformation relations, Analysis of different types of laminates.	**06**
5	**Hygro-thermal effects:** Hygro-thermal effects on mechanical behavior, Hygro- thermal stress-strain relations, Hygro-thermoelastic stress analysis of laminates, Residual stresses, Warpage.	**06**
6	**Stress and failure analysis of laminates:** Types of failures, Stress analysis and safety factors for first ply failure of symmetric laminates, Micromechanics of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials	**06**

Texts Books:

1. Isaac M. Daniels, Orilshai, "*Engineering Mechaincs of Composite Materials*", Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, "*Analysis and Performance of fiber composites"*, John Wiley and Sons, Inc. 1990.
3. Mathews, F. L. and Rawlings, R. D., "*Composite Materials: Engineering and Science*", CRC Press, Boca Raton, 2003.

References Books:

1. M. Mukhopadhyay, "*Mechanics of Composite Materials and Structures*", University Press, 1st edition, 2004.
2. S. K. Mazumdar, "*Composite Manufacturing – Materials, Product and Processing Engineering"*, CRC Press, 1st edition, 2002.
3. K. K. Chawla, "*Composite Materials: Science and Engineering*", Springer, 3rd edition, 2012.

Title of the Course Name: **Advance Engineering Materials** Course Code: **P25MD104B**	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Metallurgy and Phase Diagrams, Mechanical Properties of Materials

Course Objectives: The course aims to:

1. To identify and recall the classifications, compositions, properties, and applications of special steels, cast irons, light metals, superalloys, nanomaterials, and biomaterials.
2. To understand the metallurgical behavior, strengthening mechanisms, and functional characteristics of advanced materials for industrial and biomedical applications.
3. To apply the knowledge of composition–property relationships to select suitable materials for specific engineering, high-performance, or bio-functional applications.
4. To evaluate and compare the performance of special steels, cast irons, lightweight alloys, smart materials, and biomaterials based on their mechanical, thermal, and functional properties.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and classify advanced materials such as special steels, superalloys, nanomaterials, smart materials, and biomaterials along with their compositions and applications.
CO2	Explain the strengthening mechanisms, metallurgical aspects, functional properties, and requirements of materials used in structural, thermal, and biomedical environments.
CO3	Apply material selection principles to recommend appropriate advanced materials for specific applications in high-temperature, wear-resistant, lightweight, or bio-compatible contexts.
CO4	Evaluate the suitability of various advanced materials based on mechanical, thermal, electrical, or biological performance for engineering design and technological innovations.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Special Steels:** Metallurgical aspects, Composition, Properties and applications of: different types of Stainless steels, Dual phase steels, TRIP steels, Maraging steels, High speed steels, Hadfield steels, Free cutting steels, Ausformed steels, Tool Steels, manganese steels, chrome steels, electrical steels, bearing steels, spring steels, heat resistant steels, creep steels, HSLA steels etc.	**06**
2	**Alloy cast iron:** Need of alloying. Silal, Nicrosilal, High silicon cast iron, Ni-hard, Heat resistant cast iron: Composition, Properties and their applications.	**06**
3	**Light metals and their alloys:** Aluminum, magnesium and titanium alloys: Metallurgical aspects, Properties and applications	**06**
4	**Super alloys:** Iron base, nickel base and cobalt base super alloys: Strengthening mechanism, Composition, Properties and their applications.	**06**
5	**Nano materials:** Definition, Types, Properties and applications, Carbon nano tubes, Methods of production. Smart materials: Shape memory alloys, Piezoelectric materials, Electro-rheological fluid, Magneto- rheological fluids.	**06**
6	**Biomaterials:** Property requirement, biocompatibility, bio-functionality, Important bio metallic alloys like: Ni-Ti alloy and Co-Cr-Mo alloys. Applications	**06**

Texts Books:

1. D. R. Askeland and P. P. Phulé, "*The Science and Engineering of Materials*", Thomson Publication, 6th edition, 2006.
2. R. K. Dogra and A. K. Sharma, *"Advances in Material Science*", S. Chand & Company, 1st edition, 2013.
3. C. P. Sharma, "*Engineering Materials: Properties and Applications of Metals and Alloys*", PHI Learning, 2nd edition, 2010.

References Books:

1. R. A. Flinn and P. K. Trojan, *"Engineering Materials and Applications*", John Wiley & Sons, 4th edition, 1995.
2. R. A. Lindberg and S. D. Sehgal, "*Materials: Their Nature, Properties and Fabrication"*, S. Chand & Company, 1st edition, 2008.
3. I. J. Polmear, "*Light Alloys: Metallurgy of Light Metals*", Elsevier, 4th edition, 2006.

Title of the Course Name: **Optimization Techniques in Design** Course Code: P25MD104C	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Metallurgy and Phase Diagrams, Mechanical Properties of Materials

Course Objectives: The course aims to:

1. To introduce the fundamentals and classification of optimization problems and classical optimization techniques.
2. To develop analytical understanding of linear and non-linear programming methods for single and multi-variable functions.
3. To apply optimization techniques such as geometric programming and genetic algorithms for engineering design problems.
4. To evaluate and interpret solutions using modern optimization tools, multi-objective frameworks, and engineering applications.

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify and explain various optimization methods including linear, non-linear, geometric, and evolutionary approaches used in engineering problems.
CO2	Formulate and solve optimization problems using classical, linear programming, and modern computational techniques across multiple engineering domains.
CO3	Analyze optimization results by performing sensitivity analysis, constraint handling, and design evaluations for mechanical components and systems.
CO4	Evaluate multi-objective optimization problems using genetic algorithms and justify the choice of methodology for optimal engineering design.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Introduction to Optimization:** Introduction to optimization, scope and applications, classification of optimization problems, classical optimization techniques, single and multi-variable cases.	**06**
2	**Linear Programming and Duality:** Formulation of linear programming models, simplex method, duality in linear programming, sensitivity (post-optimality) analysis, Karmarkar's interior point method.	**06**
3	**Non-Linear Programming** Unconstrained optimization, one-dimensional minimization methods, direct and indirect methods, constrained optimization with equality and inequality constraints.	**06**
4	**Geometric Programming and Engineering Design** Introduction to geometric programming, optimum design applications in mechanical components like beams, shafts, gears, and columns.	**06**
5	**Multi-objective Optimization and Genetic Algorithms** Basics of multi-objective optimization, principles and operators of genetic algorithms, applications to real-world engineering problems.	**06**
6	**Recent Advances and Applications** Introduction to dynamic programming, decision-making in energy systems and other domains, optimization in complex systems, emerging tools and techniques.	**06**

Text Books:

1. Kalyanmoy Deb, "Optimization for Engineering Design", Prentice Hall of India, New Delhi, 2005.
2. J. S. Arora, "Introduction to Optimum Design", McGraw Hill, New York, 1989.
3. R.C. Johnson, "Optimum Design of Mechanical Elements", Wiley, New York, 1980.

References Books:

1. R.J. Duffin, E.L. Peterson, C. Zener, Geometric Programming: Theory and Applications, Wiley, New York, 1967.
2. Kalyanmoy Deb, Evolutionary Multi-objective Optimization, Wiley, New York.
3. G.B. Dantzig, Linear Programming and Extensions, Princeton University Press, Princeton, N.J., 1963.

Title of the Course Name: **Research Methodology and IPR**	**L**	**T**	**P**	**Credits**
	2	--	--	2
Course Code:P25MD105	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Basic knowledge of research methodology

Course Objectives: The course aims:

1. To recall the fundamental concepts of research methodology and intellectual property rights, including types of research, data sources, and IPR categories.
2. To understand the research process, research design, ethical responsibilities, and IPR frameworks through analysis of principles, processes, and legal guidelines.
3. To apply appropriate methods for identifying research problems, collecting data, conducting hypothesis testing, and understanding patent filing and dispute cases.
4. To evaluate the quality of research design, ethical compliance, and IPR procedures for contributing to original and responsible academic or industrial research.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and classify core concepts of research methodology, types of research, data sources, ethics, and intellectual property rights.
CO2	Explain the process of research design, data analysis, ethical standards, and the significance of IPR in academic and industrial research.
CO3	Apply systematic research techniques, including data collection, sampling, hypothesis testing, and patent filing processes with reference to real-world examples.
CO4	Evaluate research integrity, quality of research output, and the effectiveness of IPR strategies by assessing case studies, legal frameworks, and ethical practices.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Introduction to Research Methodology** Meaning, Objectives, Motivation, Types of Research, Research Approaches, Research Process, Criteria of Good Research	**6**
2	**Research Problem and Design** Identifying Research Problem, Literature Survey, Research Objectives, Research Design Concepts, Features of Good Design	**6**
3	**Data Collection and Analysis** Sources of Data, Sampling Methods, Data Processing, Statistical Techniques, Hypothesis Testing, Report Writing	**6**
4	**Ethics in Research** Ethical Principles, Plagiarism, Impact of Misconduct, Ethical Committees, Publishing Ethics	**6**
5	**Introduction to IPR** Overview of Intellectual Property, Importance of IPR, Types: Patents, Trademarks, Copyrights, Industrial Designs	**6**
6	**IPR Procedures and Case Studies** Patent Filing Procedure, Patentable and Non-patentable Items, Patent Search, Licensing, Case Studies on IPR Disputes	**6**

Text Books:

1. C. R. Kothari, "Research Methodology: Methods and Techniques", New Age International, 2nd edition, 2004.
2. P. Pandey and S. Pandey, "Research Methodology: Tools and Techniques", Bridge Center, 1st edition, 2015.
3. Neeraj Pandey and Khushdeep Dharni, "Intellectual Property Rights", PHI Learning, 1st edition, 2014.

Reference Books:

1. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide", Sage Publications, 4th edition, 2014.
2. T. Ramakrishna, "Basic Principles and Acquisition of Intellectual Property Rights", CIPRA, NLSIU, 1st edition, 2005.
3. V. Scaria, "Intellectual Property Rights in the Global Era", LexisNexis, 1st edition, 2012.

MOOC/NPTEL Platform:

1. NPTEL Course: Research Methodology – Prof. Rajat Agarwal (IIT Roorkee)

Title of the Course Name: **Seminar** Course Code: **P25MD106**	**L**	**T**	**P**	**Credits**
	--	--	2	1
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Previously studied courses

Course Objectives: The course aims to:

1. To assess the student's ability to research, analyze, and present technical topics effectively through seminars.
2. To develop public speaking skills, confidence, and clarity in addressing technical audiences.
3. To encourage independent learning, critical thinking, and exposure to real-world problems in manufacturing systems management.
4. To enhance communication skills and professionalism through structured presentations, written reports, and case-based discussions.

Course Outcomes: At the end of the course, students will be able to:

CO1	Demonstrate the ability to research, analyze, and organize technical content related to manufacturing systems management.
CO2	Present technical information clearly and confidently to a professional audience, using appropriate verbal and visual communication skills.
CO3	Prepare a well-structured, concise seminar report that meets academic and professional standards.
CO4	Exhibit self-confidence, critical thinking, and active participation during technical discussions and peer evaluations.

Sr.No.	Guidelines
1	Topic Selection: • The topic should be recent, innovative, and relevant to the mechanical design engineering • Finalize in consultation with a Guide.
2	**Literature Survey:** • Use, Springer, Elsevier, ScienceDirect, ACM, etc. • Minimum 15–20 references from recent publications (preferably last 5 years). • Maintain a citation style (Elsevier preferred)
3	Report Writing: • Cover Page with title, student name, guide name, institution. • Abstract (150–250 words). • Introduction. • Literature Review. • Technical Discussion / Methodology. • Challenges and Research Gaps. • Conclusion and Future Scope. • References (Elsevier format).
4	Presentation: • **Duration**: 12–15 minutes + 5 minutes Q&A. • Use professional PowerPoint slides: o 12–20 slides covering title, abstract, objectives, literature review, analysis, conclusion. • Include diagrams, block diagrams, or simulation results if applicable.
6	Submission Requirements: • **Final seminar report** (spiral bound and PDF). • **Presentation files** (PPT/PDF).

Title of the Course Name: **PG Lab-1**	**L**	**T**	**P**	**Credits**
Course Code: **P25MD107**	--	--	4	2
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Previously studied courses

Course Objectives: The course aims to:

1. To provide hands-on experience in analyzing different types of vibrations and their impact on mechanical systems.
2. To understand and investigate failure mechanisms in mechanical components through experimental analysis.
3. To design and implement basic mechatronic systems for mechanical applications.
4. To explore the principles of process control using PID controllers for various physical parameters (temperature, level, flow, etc.).

Course Outcomes: At the end of the course, students will be able to:

CO1	Analyze various types of vibrations and assess their effects on mechanical systems through experimental methods.
CO2	Investigate mechanical component failures using practical testing and failure analysis techniques.
CO3	Design and implement basic mechatronic systems for real-world mechanical engineering applications.
CO4	Apply principles of process control using PID controllers to regulate physical parameters like temperature, flow, and level.

Course Contents:	
1	Experiment on damped vibration
2	Torsional vibration analysis
3	Experiment based on failure analysis of mechanical component.
4	Design of mechatronic system for mechanical application
5	Demonstration of process control such as temp, level, flow, etc control using PID controller
6	2D element problem linear static analysis

Title of the Course Name: **Yoga and Meditation** Course Code: P25MD108	**L**	**T**	**P**	**Credits**
	1	--	--	AU
	ISE	MSE	ESE	Total
	--	**--**	**--**	**--**

Pre-Requisite: No formal pre-requisites.

Course Objectives: The course aims to:

1. To explore the philosophical and psychological foundations of Yoga and Meditation through Patanjali's Yoga Sutras.
2. To introduce and practice the Eight Limbs of Yoga (*Ashtanga Yoga*) for holistic self-regulation.
3. To train students in meditation, breathing, and ethical practices for enhancing clarity, focus, and emotional balance.
4. To help students integrate yogic wisdom and mindfulness into their academic and personal lives.

Course Outcomes: At the end of the course, students will be able to:

CO1	Comprehend the core teachings of Patanjali's Yoga Sutras.
CO2	Practice foundational yogic techniques such as asana, pranayama, and dhyana.
CO3	Apply principles of *Yama* and *Niyama* for improved discipline, ethics, and self-awareness.
CO4	Develop concentration and mindfulness for stress reduction and productivity.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Foundations of Yoga Philosophy** Origin and evolution of Yoga; Introduction to Patanjali and Yoga Sutras. Definition of Yoga – "Yogas Chitta Vritti Nirodha". The five Vrittis (mental fluctuations) and their control.	03
2	**Ethical and Personal Discipline (Yama & Niyama)** The five Yamas – Ahimsa, Satya, Asteya, Brahmacharya, Aparigraha. The five Niyamas – Shaucha, Santosha, Tapas, Svadhyaya, Ishwar Pranidhana. Relevance of Yama-Niyama in academic and professional life.	03
3	**Physical & Mental Purification (Asana, Pranayama, Pratyahara)** *Asana* – Role of posture; stability and comfort in the body Pranayama – Breath control techniques; calming the nervous system Pratyahara – Withdrawal of senses; mastering inner awareness	03
4	**Concentration, Meditation, and Liberation (Dharana, Dhyana, Samadhi)** Dharana – Developing concentration and focus Dhyana – The process and practice of meditation Samadhi – State of absorption; experiencing inner peace and unity	**03**

References:

1. The Yoga Sutras of Patanjali – Swami Satchidananda
2. Light *on the Yoga* Sutras *of* Patanjali – B.K.S. Iyengar
3. Four *Chapters* on Freedom – Swami Satyananda Saraswati
4. Raja Yoga – Swami Vivekananda

PG Program: Mechanical Design Engineering
Semester: II

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
PCC	P25MD201	Finite Element Method in Design	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD202	Integrated Product Development	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD203	Design for Manufacturing and Assembly	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PEC	P25MD204	Program Elective-II	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
OE	P25MD205	Open Elective-I	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
VEC	P25MD206	Technologies for Industrial Evolution	2	-	-	2	ISE-I	25		20
							ISE-II	25		
ELC	P25MD207	Mini Project	-	-	2	1	ISE-I	25		40
							ISE-II	25		
							ESE (POE)	50	20	
PCC	P25MD208	PG Lab- II	-	-	4	2	ISE	50	20	40
							ESE (POE)	50	20	
ELC	P25MD209	Internship/Field Training	-	-	-	-	Will be Evaluated in Sem-III	-	-	
	Total		**18**	**0**	**06**	**22**		**750**		
Total Contact Hours- 24							**Total Credits- 22**			

Title of the Course Name: **Finite Element Method in Design** Course Code: **P25MD201**	**L**	**T**	**P**	**Credits**
	3	1	--	4
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Theory of Structures and Strength of Materials

Course Objectives: The course aims to:

1. To recall the principles of elasticity, finite element formulations, and numerical methods relevant to structural mechanics problems.
2. To understand and interpret finite element techniques such as isoparametric formulation, plate bending, shell modeling, and dynamic analysis.
3. To apply appropriate FEM procedures to solve 1D, 2D, axisymmetric, plate, and shell structures under various loads and boundary conditions.
4. To evaluate the structural response and stability using finite element analysis techniques in both static and dynamic contexts for engineering components.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and summarize key concepts of elasticity, FEM formulation, numerical integration, structural modeling, dynamic analysis, and stability methods used in finite element analysis.
CO2	Interpret and formulate finite element models for beams, plates, axisymmetric solids, and shells, incorporating plane stress/strain, dynamic effects, and boundary conditions.
CO3	Apply FEM concepts such as isoparametric elements, numerical techniques, plate/shell modeling, and structural dynamics to analyze real-world structural systems.
CO4	Evaluate structural behavior and stability under static and dynamic conditions by integrating convergence checks, stress recovery, plate bending theories, and stability assessment methods.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Fundamentals of 1D Finite Element Formulation** Principles of linear elastic mechanics, virtual displacement, and minimum potential energy; introduction to Rayleigh-Ritz method; comparison between exact and approximate solutions; formulation and application of beam elements in 1D problems.	**06**
2	**Analysis of 2D Problems – Plane Stress and Plane Strain** Formulation of 2D finite element problems under plane stress and plane strain conditions; use of triangular elements such as Constant Strain Triangle (CST) and Linear Strain Triangle (LST); application of quadrilateral elements; incorporation of body forces, stress recovery, and boundary conditions.	**06**
3	**Isoparametric Elements and Numerical Integration Techniques** Development of Lagrange and Serendipity shape functions; isoparametric formulation for 2D problems; numerical integration using Gauss quadrature; modeling with isoparametric elements; convergence requirements, patch test, reduced integration, and treatment of nonconforming elements.	**06**
4	**Axisymmetric Solids and Plate Bending using Kirchhoff Theory** Governing equations and finite element formulation for axisymmetric solids; introduction to axisymmetric elements and their applications; mixed formulations; plate bending analysis using Kirchhoff plate theory; continuity conditions and boundary requirements for bending elements.	**06**
5	**Thick Plates, Shells, and Structural Assemblages** Discrete Kirchhoff elements for bending analysis; thick plate formulations and applications; modeling of shell structures as assemblage of flat plates; finite element modeling strategies for complex shell geometries and their structural responses.	**06**
6	**Dynamic Analysis and Elastic Stability in FEM** Formulation of finite element models for dynamic problems; derivation and use of consistent and lumped mass matrices; introduction to structural dynamics; elastic stability concepts in frames and plates; preliminary assessment of buckling behavior in FEM.	**06**

Text books

1. R. D. Cook, *"Concepts and Applications of Finite Element Analysis"*, John Wiley and Sons, 2nd edition, 1981.
2. C. S. Krishnamurti, *"Finite Element Method"*, Tata McGraw-Hill Publication, 1st edition, 2005.
3. T. R. Chandrupatla, *"Finite Elements in Engineering"*, PHI Publication, 1st edition, 2001.

References Books:

1. O. C. Zienkiewicz, R. L. Taylor, and J. Z. Zhu, *"The Finite Element Method: Its Basis and Fundamentals"*, Butterworth-Heinemann, 7th edition, 2013.
2. Klaus-Jürgen Bathe, *"Finite Element Procedures"*, Prentice Hall, 1st edition, 1996.
3. Robert D. Cook, David Malkus, Michael Plesha, and Robert Witt, *"Concepts and Applications of Finite Element Analysis"*, John Wiley and Sons, 4th edition, 2001.

Title of the Course Name: **Integrated Product Development** Course Code: **P25MD202**	**L**	**T**	**P**	**Credits**
	3	1	--	4
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Product Lifecycle Concepts, Project Management

Course Objectives: The course aims to:

1. To introduce a structured approach to new product design and development by aligning customer needs with business objectives.
2. To understand key stages of product development, including concept generation, evaluation, testing, and specification.
3. To explore product architecture, industrial design, and design for manufacturability principles.
4. To learn rapid prototyping, robust design practices, and project/economic management in the product development cycle.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall fundamental concepts of product development, customer need identification, specification setting, product architecture, prototyping, and project planning.
CO2	Interpret and analyze techniques for concept generation, industrial design, DFM, robust design, and economic tools used throughout the product development cycle.
CO3	Apply structured methods to design, test, prototype, and plan product development activities while ensuring usability, cost-effectiveness, and manufacturability.
CO4	Evaluate product development projects for performance, feasibility, economic return, and cross-functional integration using structured and robust design strategies.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Product Development Fundamentals and Customer Needs** Overview of successful product development characteristics, timelines, and cost factors; understanding development challenges; types of development processes and organizational structures; product planning stages; techniques for identifying and prioritizing customer needs.	**06**
2	**Specification Development and Concept Creation** Establishing target and final specifications; methods for systematic concept generation; concept screening and scoring; evaluating concepts through structured testing methodologies.	**06**
3	**Product Architecture and Industrial Design Management** Concept of product architecture and its implications; delayed differentiation, platform planning, and system-level design issues; importance of industrial design, managing the design process, and evaluating design aesthetics, usability, and branding.	**06**
4	**Design for Manufacture and Cost Estimation** Principles of Design for Manufacture (DFM); estimation and breakdown of manufacturing costs; methods for reducing component, assembly, and overhead costs; evaluating DFM decisions for cross-functional impact.	**06**
5	**Prototyping Strategies and Robust Design** Introduction to prototyping; planning, principles, and types of prototyping technologies; robust design concepts and process steps to improve reliability and performance under variation.	**06**
6	**Economic Analysis and Project Execution** Tools and elements of economic analysis in product development; project task breakdown and scheduling; strategies for planning, accelerating, and executing product development projects; postmortem evaluation for continuous improvement.	**06**

Texts Books:

1. Karl T. Ulrich and Steven D. Eppinger, *"Product Design and Development"*, McGraw-Hill, 6th edition, 2015.
2. Edward B. Magrab and Ronald G. Askin, *"Integrated Product and Process Design and Development: The Product Realization Process"*, CRC Press, 2nd edition, 2009.
3. Mohan M. Rao, *"Concurrent Engineering: Automation, Tools, and Techniques"*, Springer, 1st edition, 1996.

References Books:

1. Douglas D. Caldwell, *"Product Development: A Structured Approach to Consumer Product Development"*, CRC Press, 1st edition, 1998.
2. Benjamin S. Blanchard and Wolter J. Fabrycky, *"Systems Engineering and Analysis"*, Pearson, 5th edition, 2010.
3. Lucy C. Morse and Daniel L. Babcock, *"Managing Engineering and Technology"*, Pearson, 6th edition, 2016.

Title of the Course Name: **Design for Manufacturing and Assembly** Course Code: P25MD203	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Engineering Mechanics and Product Design

Course Objectives: The course aims to:

1. To impart knowledge of manufacturing-aware design methodologies that optimize cost, quality, and production feasibility.
2. To develop an understanding of material and process selection for various manufacturing techniques.
3. To equip students with the skills to analyze, modify, and enhance product designs considering manufacturing and assembly constraints.
4. To promote integration of design and manufacturing for rapid, automated, and economical production.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and describe the key concepts of design for manufacturing, casting, welding, material selection, and assembly automation.
CO2	Explain the interrelationships between manufacturing processes, design decisions, material selection, and process ranking for effective product development.
CO3	Apply design for manufacturing and assembly principles to real-world problems, including selection of materials and process optimization across various production techniques.
CO4	Evaluate product designs based on manufacturability, process constraints, automation potential, and economic performance using cross-functional DFM strategies.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**DESIGN FOR MANUFACTURING:** Reduce the cost of manufacturing process, understanding the process and constraints, standard components and process, consider the impact of DFM decisions and other factors.	**06**
2	**DESIGN CONSIDERATION IN METAL CASTING:** Mold and Gating System Design, Directional Solidification, and Troubleshooting.	**06**
3	**DESIGN FOR WELDING:** selection of materials for joining, welding defects, minimize the residual stresses etc. Design for forging and sheet metal and powder metal process.	**06**
4	**SELECTION OF MATERIALS:** choice of materials, organizing material and processes.	**06**
5	**Design Application** Application of Design for manufacture and assembly with selection of materials and ranking of processes like casting, injection moulding, sheet metal working, die casting, powder metal process, investment casting and hot forging,	**06**
6	Design for assembly and automation	**06**

Texts Books:

1. J. M. Coulson, R. K. Sinnott, and J. F. Richardson, *"Chemical Engineering, Volume 6: Design"*, Maxwell Macmillan International Edition, 1st edition, 1993.
2. Sabin Crocker, *"Piping Handbook"*, McGraw-Hill Publication, 5th edition, 1990.
3. G. K. Sahu, *"Handbook of Piping Design"*, New Age International, 1st edition, 1998.

References Books:

1. Mohinder L. Nayyar, *"Piping Handbook"*, McGraw-Hill Education, 7th edition, 2000.
2. Becht Charles, *"Process Piping: The Complete Guide to ASME B31.3"*, ASME Press, 3rd edition, 2012.
3. Kiran D. Patil, *"Piping Design Handbook"*, Gulf Professional Publishing, 1st edition, 2008.

Title of the Course Name: **Tribology in Design** Course Code: **P25MD204A**	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Machine Design, Fluid Mechanics

Course Objectives: The course aims to:

1. To provide a comprehensive understanding of surface interactions, friction, and wear mechanisms in tribological systems.
2. To introduce the principles and regimes of lubrication, including fluid film and advanced lubrication techniques.
3. To study the design, analysis, and performance of fluid film and rolling element bearings.
4. To familiarize students with tribological testing methods and international standards for surface and bearing evaluation.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and describe core concepts of tribology including friction, wear mechanisms, lubrication types, bearing designs, and measurement systems.
CO2	Interpret tribological behavior in fluid film bearings, rolling element systems, and surface-modified materials under mechanical loading and environmental conditions.
CO3	Apply theoretical and empirical models to design and analyze lubrication regimes, bearing life, surface coatings, and failure diagnostics for tribo-systems.
CO4	Evaluate tribological performance using design parameters, failure analysis, instrumentation techniques, and international standards in real engineering applications.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Surfaces, friction and wear:** Topography of Surfaces, Surface features, Surface interaction, Theory of Friction, Sliding and Rolling Friction, Friction properties of metallic and non -metallic materials, Friction in extreme conditions, Wear, types of wear, Mechanism of wear, wear resistance materials, Surface treatment, Surface modifications, Surface coatings.	**06**
2	**Lubrication theory:** Lubricants and their physical properties lubricants standards, Lubrication Regimes in Hydrodynamic lubrication, Reynolds Equation, Thermal, inertia and turbulent effects.	**06**
3	**Other types of lubrication:** Electro-hydrodynamic (EHD), Magneto hydrodynamic lubrication, Hydro static lubrication, Gas lubrication, Solid lubrication.	**06**
4	**Design of fluid film bearings:** Design and performance analysis of thrust and journal bearings, Full, Partial, Fixed and pivoted journal bearings design, Lubricant flow and delivery, Power loss, Heat and temperature of steady and dynamically loaded journal bearings, Special bearings, Hydrostatic Bearing design.	**06**
5	**Rolling element bearings:** Geometry and kinematics, Materials and manufacturing processes, contact stresses, Hertzian stress equation, Load divisions, Stresses and deflection, Axial loads and rotational effects, bearing life capacity and variable loads, ISO standards, Oil films and their effects, Rolling Bearings Failures.	**06**
6	**Tribo measurement and Instrumentation:** Surface Topography measurements, Electron microscope and friction and wear measurements, Laser method, Instrumentation, International standards, Bearings performance measurements, bearing vibration measurement	**06**

Texts Books:

1. Cameron A., "*Basic Lubrication Theory*", Ellis Horwood Ltd., UK, 1981
2. Halling J. (Editor) "*Principles of Tribology* ", Macmillian, 1984.
3. Williams J.A., "*Engineering Tribology*", Oxford Univ. Press, 1994.

References Books:

1. ASM International, *"ASM Handbook Volume 18: Friction, Lubrication, and Wear Technology"*, ASM International, 1st edition, 1992.
2. Michael J. Neale, David Dowson, and Clifford M. Taylor, *"The Tribology Handbook"*, Butterworth-Heinemann, 2nd edition, 2001.
3. R. K. Singal, *"Tribology in Mechanical Design"*, I K International Publishing House, 1st edition, 2010.

Title of the Course Name: **Theory of Elasticity and Plasticity** Course Code: **P25MD204B**	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Stress and Strain Concepts, **Advanced Mathematics**

Course Objectives: The course aims to:

1. To establish a fundamental understanding of stress and strain transformations in 2D and 3D elastic bodies.
2. To develop analytical skills to solve classical elasticity problems using different coordinate systems and geometries.
3. To introduce bending, torsion, and energy methods within the context of 3D elasticity.
4. To provide a foundational understanding of plasticity theory, including yield criteria, flow rules, and elastoplastic behavior.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and define fundamental principles of stress-strain transformation, 2D and 3D elasticity problems, plasticity theory, and energy theorems.
CO2	Solve classical elasticity problems in Cartesian, cylindrical, and spherical coordinate systems.
CO3	Apply elasticity theory, torsion models, plasticity rules, and stress functions to analyze prismatic bars, rods, beams, and structural members under axial, bending, and torsional loads.
CO4	Evaluate the structural behavior and safety of elastic and elastoplastic components using principles of superposition, uniqueness, shear center, limit analysis, and energy theorems.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Introduction**: Stress transformation and Strain transformation at a point in an elastic body, 3D Problems, Rigid body translation and rotation of an element in space. Generalized, Hook law, Separation of Elastic Strains and rigid body displacement for a general displacement field u, v, w. Principal Stress and Strains.	**06**
2	**Two dimensional problems in elasticity:** Plane Stress and Plane Strain Problems. Differential equations of equilibrium and compatibility equations. Boundary Conditions & Stress Functions. Problems in Rectangular coordinates, Polynomial solutions, Cantilever loaded at the end, simply supported load beam under uniformly distributed load, linear loading, Two dimensional problems in polar coordinated, stress distribution symmetrical about an axis, pure bending of curved bar, Displacement for symmetric loaded cases, Bending of curved bar by forces at end. Effect of circular hole in plate under in plane loading. Concentrated load at point of Straight boundary. Stresses in circular disk. Forces acting on end of wedge.	**06**
3	**Three dimensional problems in elasticity:** Differential equation of equilibrium in 3D, Condition of Compatibility, Determination of Displacement, Principal of superposition, Uniqueness theorem, Problems of Rods under axial stress, Bar under its own weight, Pure bending of Prismatic roads, Torsion of Prismatic bars of Elliptical, rectangular, triangular and other sections, Membrane Analogy-Torsion of narrow rectangular bars. Torsion of hollow shaft and thin tubes.	**06**
4	**Bending of prismatic bars as a problem of elasticity in 3D:** Bending of a cantilever, Stress function, Circular and rectangular sections, Non-symmetrical cross section. Shear Centre for different cross sections of bars, Calculation of deflections.	**06**
5	**Energy theorems:** Applications of complimentary energy theorems to the problems of elasticity	**06**
6	**Introduction to Plasticity:** Criteria of yielding, strain hardening, rules of plastic flow, different stress strains relations. Total Strain theory, theorems of limit analysis. Elastoplastic bending and torsion of bars.	**06**

Texts Books:

1. Wang, *"Applied Elasticity"*, McGraw-Hill Book Co., 1st edition,
2. S. P. Timoshenko, *"Theory of Elasticity"*, McGraw-Hill Book Co., 3rd edition, 1970.
3. J. Chakrabarti, *"Theory of Plasticity"*, McGraw-Hill Book Co., 1st edition,

References Books:

1. R. A. C. Slater, *"Engineering Plasticity: Theory and Applications to Metal Forming"*, Macmillan Press, 1st edition, 1977.
2. C. R. Calladine, *"Plasticity for Engineers: Theory and Applications"*, Horwood Publishing, 1st edition, 2000.
3. S. P. Timoshenko and J. N. Goodier, *"Theory of Elasticity"*, McGraw-Hill Book Co., 3rd edition, 1970.

Title of the Course Name: **Engineering computing**	**L**	**T**	**P**	**Credits**
Course Code: **P25MD204C**	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Basic understanding of Calculus**,** Linear Algebra and Differential Equations

Course Objectives: The course aims to:

1. To develop proficiency in numerical techniques for data analysis, curve fitting, and interpolation.
2. To equip students with efficient numerical methods for solving linear systems and differential equations.
3. To introduce numerical approaches for boundary value and eigenvalue problems.
4. To develop skills in mathematical modeling of engineering systems using differential equations.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and describe fundamental numerical methods for interpolation, curve fitting, solving equations, ODEs, PDEs, and mathematical modeling.
CO2	Interpret and formulate numerical algorithms for solving algebraic systems, differential equations, eigenvalue problems, and model-based computations.
CO3	Apply numerical methods such as finite difference, spline interpolation, Runge-Kutta, and matrix-based approaches to solve engineering problems computationally.
CO4	Evaluate numerical solutions in terms of convergence, accuracy, efficiency, and applicability to engineering modeling using differential equations and iterative methods.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Data Analysis and Curve Fitting:** Errors in numerical calculations, Interpolation by central differences, sterling Bessel & Everett Formulae, Interpolation Formula for unequal Intervals, Spline Interpolation, Cubic Splines. Least square method for linear & non-linear functions, weighted least square methods.	**06**

2	**Solution of Linear System of Equations:** Gauss Elimination with Pivoting, LU Decomposition method, Iterative methods, Eigen vectors-Jacobi method, Jacob's method, Gauss Siedel method.	**06**
3	**Solution of Ordinary Differential Equation, Numerical Differentiation & Integration:** Differentiation by Finite Differences, Numerical Integration by Newton-Cotes formula & Gauss Quadrature. Picard's Method, Euler's & Modified Euler's Method, Runge-KuttaMethod (up to fourth order), Predictor-Corrector Methods, Milne Sompson, Adams Bashforth Moulten Methods.	**06**
4	**Boundary value and Eigen value problems:** Shooting method, finite difference method to solve boundary value problems, Polynomial method, power method to solve Eigen value problems.	**06**
5	**Solution of Partial differential equations:** Finite difference method, solution of Laplace & Parabolic equations.	**06**
6	**Mathematical Modeling:** Mathematical Modeling of Physical Problems, modeling Concept, Modeling of Linear Differential Equations of Second order.	**06**

Texts Books:

1. Dr. B. S. Grewal, *"Numerical Methods for Science & Engineering"*, Khanna Publications, 1st edition, Year not specified.
2. M. K. Jain, *"Numerical Methods for Scientific & Engineering Computation"*, New Age International Publication, 1st edition, Year not specified.
3. E. Balagurusamy, *"Numerical Methods"*, Tata McGraw Hill Publications, 1st edition,

References books:

1. Steven C. Chapra and Raymond P. Canale, *"Numerical Methods for Engineers"*, McGraw Hill Education, 7th edition, 2015.
2. David M. Smith, *"Engineering Computation with MATLAB"*, Pearson Education, 1st edition,
3. Steven C. Chapra, *"Applied Numerical Methods with MATLAB for Engineers and Scientists"*, McGraw Hill Education, 4th edition, 2017.

Title of the Course Name: Environment and Development	**L**	**T**	**P**	**Credits**
	3	--	--	3
Course Code: P25MD205A	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Basic knowledge of environmental science and sustainable practices

Course Objectives:

1. To understand the interrelationship between environment and development.
2. To assess the impact of development activities on ecosystems, biodiversity, and natural resources.
3. To analyze sustainable development concepts, environmental ethics, and green technologies.
4. To explore national and international environmental policies and enhance awareness on climate change and mitigation strategies.

Course Outcomes:

CO1	Recall and summarize the core concepts of environmental science, sustainable development, climate change, resource degradation, and ecological ethics.
CO2	Interpret the interrelationships between environment, development, governance policies, and technological strategies for sustainability.
CO3	Apply the principles of sustainable development, green technologies, and environmental ethics.
CO4	Evaluate contemporary environmental issues and global case studies to assess the effectiveness of policies, renewable technologies, and sustainable practices.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Introduction to Environment and Development** Definition and Scope, Need for Sustainable Development, Historical Background, Environmental Movements.	**6**
2	**Natural Resources and Environmental Degradation** Types of Natural Resources, Resource Depletion, Land Degradation, Pollution and Biodiversity Loss.	**6**
3	**Sustainable Development and Environmental Ethics** Principles of Sustainability, Environmental Ethics, Ecological Footprint, Green and Clean Technologies.	**6**
4	**Climate Change and Global Concerns** Climate Change Causes and Impacts, Global Warming, Carbon Cycle, Adaptation and Mitigation Strategies.	**6**
5	**Policy and Governance** Environmental Policies, Acts and Protocols (India & Global), Role of Government and NGOs, Environmental Impact Assessment (EIA).	**6**
6	**Contemporary Issues and Case Studies** Urbanization and Environment, Renewable Energy, Case Studies on Sustainable Practices in India and Abroad.	**6**

Text Books:

1. R. Rajagopalan, *"Environmental Studies: From Crisis to Cure"*, Oxford University Press, 3rd edition, 2016.
2. Erach Bharucha, *"Textbook of Environmental Studies"*, UGC Publication, 1st edition, 2005.
3. P. D. Sharma, *"Ecology and Environment"*, Rastogi Publications, 11th edition, 2021.

Reference Books:

1. W. P. Cunningham and M. A. Cunningham, *"Principles of Environmental Science"*, Tata McGraw-Hill, 7th edition, 2014.
2. D. B. Botkin and E. A. Keller, *"Environmental Science: Earth as a Living Planet"*, Wiley India, 8th edition, 2011.
3. J. D. Sachs, *"The Age of Sustainable Development"*, Columbia University Press, 1st edition, 2015.

Course Name: **Engineering Economics**	**L**	**T**	**P**	**Credits**
	3	--	--	3
Course Code: P25MD205B	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Management Information Systems (MIS)

Course Objectives: The course aims,	
1	To understand fundamental economic concepts and cost analysis in engineering.
2	To apply interest formulas and cash flow techniques to evaluate alternatives.
3	To analyse depreciation and asset replacement decisions.
4	To evaluate public vs private projects with cost-benefit considerations.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and define key concepts in engineering economics such as cost elements, interest factors, cash flow models, depreciation techniques, and project financing.
CO2	Interpret and compare economic decision-making tools including present worth, future worth, annual equivalent, and rate of return across engineering applications.
CO3	Apply economic analysis techniques to evaluate material selection, make-or-buy decisions, equipment replacement, depreciation schedules, and project investments.
CO4	Evaluate engineering alternatives and public-private project outcomes using life-cycle costing, value engineering principles, and inflation-adjusted economic assessments.

Course Contents

Unit No.	Contents	Hours
1	**Introduction Engineering Economy:** Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering – Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis, P – V ratio, Elementary economic Analysis– Material selection for product, Design selection for a product, Process planning.	6
2	**Value Engineering:** Make or buy decision, Value engineering – Function, aims, Value engineering procedure.Interest formulae and their applications– Time value of money, Single payment compoundamount factor, Single payment present worth factor, Equal payment series sinking fundfactor,EqualpaymentseriespaymentPresentworthfactor– equalpaymentseriescapitalrecovery factor – Uniform gradient series annual equivalent factor, Effective interest rate,Examples in all the methods.	6
3	**Cash Flow:** Methods of comparison of alternatives – Present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, Cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, Cost dominated cash flow diagram), rate of return method, Examples in all methods.	6
4	**Replacement And Maintenance Analysis:** Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset– capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.	6
5	**Depreciation:** Depreciation – Introduction, Straight line method of depreciation, – Declining balance method of depreciation – Sum of the years digits method of depreciation, – Sinking fund method of depreciation/Annuity method of depreciation, service output method of depreciation – Evaluation of public alternatives – Introduction – Examples – Inflation adjusted decisions – Procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.	6
6	**Financing & Public vs Private Projects:** Financing sources, economic evaluation in public projects, social costs, and regulatory factors.	6

Text Books:

1. Panneer Selvam, R, "*Engineering Economics*", Prentice Hall of India Ltd, New Delhi,2001.
2. Suma Damodaran, " *Managerial economics*", Oxford university press2006
3. A Text book of Economic Theory: by stonier and hauge, pearson Publication.

Reference Books:

1. Sampat Mukherjee, *"Modern Economic Theory"*, New Age International Publisher, 1st edition.
2. DeGarmo, *"Engineering Economics"*, Prentice Hall, 1st edition.
3. Bo Sodersten, *"International Economics"*, Macmillan, 1st edition

Course Name: **Project Management**	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
Course Code: **P25MD205C**	**20**	**30**	**50**	**100**

Pre-Requisite: Knowledge of simple geometrical theories and their constructional procedure.

Course Objectives: The course aims,	
1	To impart basic concepts Project Management.
2	To impart and inculcate proper understanding of the Project Management.
3	To improve the visualization skill of Project Management.
4	To impart knowledge about standard principles of Project Management.

Course Outcomes: Students will be able to

CO1	Recall and summarize project management fundamentals, work breakdown structures, scheduling tools, resource allocation, and control strategies.
CO2	Interpret and explain the stages of project management, scheduling techniques, cost estimation, and contract and procurement processes.
CO3	Apply project planning, scheduling, resource optimization, and project execution techniques using tools like Gantt charts, CPM/PERT, and cost-time trade-offs.
CO4	Evaluate project success through monitoring, post-project evaluation, financial control, and risk analysis to improve future project outcomes.

Course Contents

Unit No.	Contents	Hours
1	**Introduction to Project management:** Definition and objectives of Project Management, Characteristics of projects, Stages of Project Management, Project Planning Process, Establishing Project organization. Work definition: Defining work content, Time Estimation Method, Project Cost Estimation and budgeting, Project Risk Management, Project scheduling and Planning Tools: Work Breakdown structure, LRC, Gantt charts, CPM/PERT Networks.	6
2	**Project Planning and Resource Optimization:** Developing Project Plan (Baseline), Project cash flow analysis, Project scheduling with resource constraints: Resource Leveling and Resource Allocation. Time Cost Trade off: Crashing Heuristic.	6
3	**Project Execution and Control Strategies:** Project Implementation: Project Monitoring and Control with PERT/Cost, Computers applications in Project Management, Contract Management, Project Procurement Management. Post-Project Analysis.	6
4	**Project Scheduling & Control:** Developing Project Plan (Baseline), Project cash flow analysis, Project scheduling with 28 resource constraints: Resource Leveling and Resource Allocation. Time Cost Trade off: Crashing Heuristic.	6
5	**Project Execution, Monitoring & Evaluation:** Project Implementation: Project Monitoring and Control with PERT/Cost, Computers applications in Project Management, Contract Management, Project Procurement Management. Post-Project Analysis.	6

Reference Books:

1. Shtub, A., Bard, J. F., & Globerson, S., *"Project Management: Engineering, Technology and Implementation"*, Prentice Hall India, 1st edition,
2. Lock, D., *"Project Management Handbook"*, Gower Publishing, 1st edition

Title of the Course Name: **Healthcare Engineering**	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
Course Code:**P25MD205D**	**20**	**30**	**50**	**100**

Pre-Requisite: Basics of Management, Market Research Fundamentals, Financial Accounting Basics.

Course Objectives: The course aims:

1. To understand how the healthcare system works and what challenges it faces.
2. To learn how to improve hospital services using planning and optimization methods.
3. To study how patient waiting lines and hospital processes can be modeled and improved.
4. To explore new technologies like AI, remote care, and digital tools in future healthcare.

Course Outcomes: Students will be able to	
CO1	Recall fundamental components of healthcare systems, including resource planning, queuing models, data flows, and innovations in digital health.
CO2	Interpret and formulate mathematical models for workforce optimization, facility layout, patient queuing, and healthcare delivery systems
CO3	Apply optimization, queuing theory, and simulation methods to enhance healthcare system efficiency, throughput, and patient experience.
CO4	Evaluate emerging healthcare technologies and simulation outcomes to improve clinical operations, policy design, and access to quality care.

Unit No.	**Unit title and Content**	**Hours**
1	**Introduction to Healthcare System** **Introduction:** Facets of a Healthcare System, Size of a Healthcare System, Health Insurance and Financing, Healthcare Services, Healthcare Ecosystem, Healthcare System Challenges, Access to Healthcare, Healthcare Systems Engineering,	**06**

	Understanding Delivery: Data and Processes: Types of Healthcare Data, National Datasets, Healthcare Delivery Process Data, Process Throughput	
2	**Healthcare Resource Workforce and Access to Care Optimization** **Workforce:** Optimization, Supply-Demand Matching, Assignment Models, Optimization : Facility Optimization, Developing Facility Layout to Minimize Travel Wastage, Considering Multiple Conflicting Objectives, Optimization using a Modeling Language	**06**
3	**Modeling Patient Queues** Kendall's Notation for Queuing Systems, Little's Law, Markovian Queuing Models: M/M/1, M/G/1 Queuing Model, Modeling Interconnected Services using Queuing Networks,	**06**
4	**Healthcare System Simulation** Building a Simulation Study Framework, Event Calendars in Discrete Event Simulation, Input Modeling in Simulation, Output Analysis in Simulation, Estimation in a Non-Terminating, Non-Stationary System: Emergency Department, Simulation of a Hospital Queuing Network	**06**
5	**Future of Healthcare** Shifting from Volume to Value, Evidence-Based Medicine, Personalized Medicine, Vision of the Future, Connected Medicine, Disease and Condition Management: Virtual Assistants, Remote Monitoring, Medication Adherence, Accessible Diagnostic Tests, Smart Implantable, Digital Health and Therapeutics, AI, Conversational AI, Making and rationalizing decisions: Drug discovery, 3-D printing, Personalized prosthetics, Bioprinting and tissue engineering, Pharmacology and devices, Education, Gene therapy, Virtual and Augmented Reality, Merged Reality, Pain Management, Physical Therapy, Nursing and Delivery of Medicine, Virtual Appointments and Classrooms, Blockchain, Patient Record Access., Applications of AI in Healthcare	**06**

Reference Books:

1. Sanjay Mehrotra, Kevin Bui, and Hari Balasubramanian, *"Healthcare Engineering"*, Springer, 1st edition, 2022.
2. Arjun Panesar, *"Machine Learning and AI for Healthcare"*, Apress, 1st edition, 2019.

Course Name: **Technologies for Industrial Evolution** **Course Code:** P25MD206	**L**	**T**	**P**	**Credits**
	2	--	--	2
	ISE	MSE	ESE	Total
	20	**--**	**--**	**50**

Pre-Requisite: Knowledge of Automation, IoT and Industrial Engineering

Course Objectives: The course aims:

1. To understand the key technologies & impact of technological evolution on modern industries.
2. To provide insight into the integration of AI, Big Data, and Cloud Computing in industrial operations.
3. To familiarize students with digital twin, predictive maintenance, and robotic process automation.
4. To enable students to analyze current trends and future directions in industrial digitization.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Recall the evolution, core technologies, digital tools, automation systems, predictive analytics, and future trends shaping Industry 4.0.
CO2	Interpret the role and integration of smart technologies such as IIoT, AI, cloud computing, and robotics in modern manufacturing ecosystems.
CO3	Apply digital transformation methods and smart manufacturing tools to solve real-world challenges in automation, condition monitoring, and fault diagnostics.
CO4	Evaluate the impact of Industry 4.0 initiatives using sustainability frameworks, case study insights, and advanced tools like digital twins and 5G networks.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Introduction to Industrial Evolution** Historical Industrial Revolutions, Key Drivers of Industry 4.0, Comparison of Industry 3.0 and 4.0, Global Trends and Indian Scenario.	**6**
2	**Core Technologies in Industry 4.0** IIoT, Smart Sensors, Embedded Systems, Cyber Physical Systems (CPS), Edge and Fog Computing.	**6**
3	**Digital Transformation Tools** Cloud Computing, Big Data Analytics, AI & Machine Learning for Industry, Blockchain in Supply Chain.	**6**
4	**Automation and Smart Manufacturing** Additive Manufacturing, Smart Factories, Industrial Robotics, Human-Machine Collaboration.	**6**
5	**Predictive Maintenance and Digital Twin** Condition Monitoring, Real-time Data Acquisition, Digital Twin Modeling, Fault Diagnosis.	**6**
6	**Future Trends and Case Studies** Green Manufacturing, Sustainable Technologies, 5G for Industry, Case Studies on Digital Transformation.	**6**

Text Books:

1. Alasdair Gilchrist, *"Industry 4.0: The Industrial Internet of Things"*, Apress, 1st edition, 2016.
2. Sabina Jeschke et al., *"Industrial Internet of Things: Cyber Manufacturing Systems"*, Springer, 1st edition, 2017
3. Brettel M., *"How Virtualization, Decentralization and Network Building Change the Manufacturing Landscape: An Industry 4.0 Perspective"*, Springer, 1st edition, 2014.

Reference Books:

1. Klaus Schwab, *"The Fourth Industrial Revolution"*, World Economic Forum, 1st edition, 2016.
2. Jay Lee, *"Smart Manufacturing"*, Springer, 1st edition, 2021.
3. Andrew Ng, *"Machine Learning Yearning"*, DeepLearning.ai, 1st edition, 2018.

Title of the Course Name: **Mini Project** Course Code: **P25MD207**	**L**	**T**	**P**	**Credits**
	--	--	2	1
	ISE	MSE	ESE	Total
	50	**--**	**50**	**50**

Pre-Requisite: Previously studied courses

Course Objectives: The course aims to:

1. To train students in identifying, analyzing, and solving real-world engineering or managerial problems.
2. To encourage students to take initiative in selecting research-oriented or industrially relevant topics.
3. To provide exposure to live problems through industrial visits, case studies, or field-based research.
4. To develop independent thinking, technical report writing, and effective presentation skills and group-based mini projects .

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify and define an engineering or industrial problem of practical relevance or research interest.
CO2	Analyze the problem systematically and apply domain knowledge to propose viable solutions.
CO3	Document the project findings clearly in a structured report and defend the work through oral presentation.
CO4	Demonstrate initiative, self-learning, and professional responsibility in executing project tasks individually or collaboratively.

Sr.No.	Guidelines
1	**Activities involved:** 1. Mini project should be undertaken individually. 2. Topic should be relevant to mechanical design engineering with focus on problem solving, innovation, or application 3. A detailed proposal should be submitted with problem statement, objectives, methodology, and timeline 4. Regular progress reviews should be conducted (at least two internal

	reviews) 5. Emphasis should be placed on originality, practical relevance, and feasibility 6. Maintain a project logbook detailing weekly progress, issues faced, and resolutions 7. Final submission must include a well-structured report, simulation/implementation files, and presentation 8. Viva-voce will be conducted to assess individual contribution and understanding
2	Format for Report (Spiral Bound & Soft Copy) 1. Cover Page 2. Certificate (Guide + Head of Department) 3. Declaration 4. Acknowledgement 5. Abstract 6. Table of Contents 7. List of Figures/Tables (if applicable) 8. Chapters: o Introduction o Literature Review o Problem Statement o Objectives o System Design and Methodologies o Implementation and Testing o Results and Discussions o Conclusion and Future Work 9. References (IEEE format) 10. Appendix (if applicable)
3	Deliverables • **Mini Project Proposal** (hard copy & soft copy – before implementation begins) • **Weekly Progress Logbook** signed by the guide • **Final Project Report** in hard copy and PDF (as per the given format) • **Working Model/Simulation Output** (if applicable) • **Presentation Slides (PPT)** • **Final Viva & Demonstration** before PRC • **Source Code/Design Files** on CD/pen drive or shared via link

Title of the Course Name: **PG Lab-II**	**L**	**T**	**P**	**Credits**
Course Code: **P25MD208**	--	--	4	2
	ISE	MSE	ESE	Total
	50	**--**	**50**	**50**

Pre-Requisite: Previously studied courses

Course Objectives: The course aims to:

1. To develop hands-on proficiency in using CATIA for 2D sketching, 3D part modeling, and surface design.
2. To train students in assembling mechanical components using appropriate constraints in CATIA.
3. To introduce surface modeling techniques and advanced solid modeling features like Boolean operations and sweeps.
4. To simulate motion and analyze the kinematics of mechanical assemblies using CATIA DMU Kinematics

Course Outcomes: At the end of the course, students will be able to:

CO1	Create fully constrained 2D sketches and generate 3D part models using CATIA Part Design tools.
CO2	Perform surface modeling using B-Spline curves and advanced surface features in the Generative Shape Design workbench.
CO3	Assemble multiple components and apply suitable mechanical constraints using CATIA Assembly Design.
CO4	Simulate kinematic motion of mechanical linkages and mechanisms using CATIA DMU Kinematics.

Lab Contents:

1. Creating 2D Profiles and Applying Geometric Constraints in CATIA Sketcher
2. 3D Part Modeling using Pad, Pocket, Shaft, and Groove Features in CATIA Part Design
3. Surface Modeling of a B-Spline Curve-Based Component in CATIA Generative Shape Design.
4. Assembly Modeling and Constraint Application in CATIA Assembly Design Workbench
5. Simulation of a Mechanism using CATIA

Title of the Course Name: **Internship/Field Training#**	**L**	**T**	**P**	**Credits**
	--	--	4	2
Course Code: **P25MD209**	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Previously studied courses

Course Objectives: The course aims to:

1. To expose students to real-time industry operations, tools, and technologies relevant to their domain of study.
2. To develop an understanding of organizational structure, workflows, safety standards, and professional ethics in the workplace.
3. To apply theoretical knowledge acquired during the first year to practical industrial challenges and problem-solving.
4. To encourage self-learning, teamwork, communication, and project documentation skills through active industry engagement.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall the functional processes, safety norms, and professional expectations observed in a domain-specific industrial setting.
CO2	Understand and explain the industrial practices, technology integration, organizational hierarchy, and role-specific responsibilities.
CO3	Apply engineering concepts and problem-solving techniques to complete assigned tasks or mini-projects during the internship.
CO4	Evaluate professional practices, identify gaps between theory and application, and prepare structured reports demonstrating industrial learning.

Contents:

A four-week domain-specific industrial internship is mandatory after the completion of the first year and is evaluated in Semester III. It provides students with practical exposure to real-world industrial environments aligned with their field of study. During the internship, students gain hands-on experience, understand organizational workflows, and apply theoretical knowledge to actual engineering problems. A detailed report, industry certificate, and viva voce are required for final evaluation.

It is required to do Four weeks domain specific industrial internship after completing first year of the program evaluated in Semester-III

PG Program: Mechanical Design Engineering
Semester: III

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
OE	P25MD301	Open Elective-II[$]	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
MDM	P25MD302	Multi-Disciplinary Minor[$]	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
ELC	P25MD303	Dissertation Phase-I*	-	-	20	10	ISE-I	25		40
							ISE-II	25		
							ESE (POE)	50	20	
ELC	P25ET209	Internship/Field Training[#]	-	-	-	2	ISE	50	-	40
Total			**6**	**-**	**20**	**18**	**350**			
Total Contact Hours- 26 Total Credits- 18										

$ It is mandatory to opt these courses certification from SWAYAM/NPTEL, MOOC platform.
* It is required to complete 30% work of Dissertation.
# It is required to do Four weeks domain specific industrial internship after completing first year of the program evaluated in Semester-III

Title of the Course Name: Labour Welfare and Industrial Relations **Course Code:**P25CM301A/ P25CS301A/ P25ET301A/ P25MD301A / P25MP301A	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Fundamentals of Human Resource Management, Basics of Organizational Behaviour, Indian Labour Laws (basic awareness preferred)

Course Objectives: The course aims:

1. Provide an in-depth understanding of labour welfare concepts and principles.
2. Study the evolution and framework of industrial relations in India.
3. Analyze the role of trade unions, collective bargaining, and dispute resolution mechanisms.
4. Evaluate labour policies, legislation, and welfare measures with real-world applications.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Define and explain the concepts of labour welfare and industrial relations.
CO2	Analyze the role of trade unions, employee participation, and dispute resolution mechanisms.
CO3	Examine labour laws and welfare measures applicable in industrial settings.
CO4	Evaluate the effectiveness of industrial relations strategies in promoting harmony and productivity.

Course Content		
Unit No.	**Contents**	**Hrs**
1	**Introduction to Labour Welfare:** Concept of labour welfare and its importance, Principles and types of labour welfare, Role of the government and employers in labour welfare, Statutory and non-statutory welfare measures	**6**

2	**Industrial Relations Framework:** Evolution and scope of industrial relations, Objectives and importance of industrial relations, Approaches to industrial relations, Role of stakeholders (government, employers, employees)	**6**
3	**Trade Unions in India:** Trade unions: concept, structure, and functions, Growth of trade union movement in India, Trade union legislation, Role of trade unions in industrial relations, Challenges faced by trade unions	**6**
4	**Collective Bargaining and Employee Participation:** Concept and process of collective bargaining, Types and importance of collective bargaining, Workers' participation in management, Joint management councils, Works committees	**6**
5	**Industrial Disputes and Resolution Mechanisms:** Causes and effects of industrial disputes, Methods of dispute resolution (conciliation, arbitration, adjudication), Role of grievance redressal systems, Disciplinary procedures	**6**
6	**Labour Legislation and Contemporary Issues:** Overview of key labour laws (Factories Act, Trade Unions Act, Industrial Disputes Act), Recent changes in Indian labour codes, Case studies on labour welfare and industrial relations, Emerging trends and challenges	**6**

Text Books:

1. **Sinha, P.R.N., Sinha, I.B., and Shekhar, S.P.** – *Industrial Relations, Trade Unions, and Labour Legislation*, Pearson Education
2. **Mamoria, C.B. and Mamoria, S.** – *Dynamics of Industrial Relations*, Himalaya Publishing House

Reference Books:

1. **Monappa A., Nambudiri R. &Selvaraj, P.** – *Industrial Relations and Labour Laws*, 2nd Edition ,McGraw Hill
2. **Srivastava, S.C.** – *Industrial Relations and Labour Laws*, Vikas Publishing
3. **Indian Labour Codes & Government Publications** – Ministry of Labour and Employment

MOOC/NPTEL Platform:

1. **NPTEL: https://onlinecourses.nptel.ac.in/noc25_mg159/preview**

Title of the Course Name: Sustainable Technology	**L**	**T**	**P**	**Credits**
Course Code:P25CM301B/ P25CS301B/ P25ET301B/ P25MD301B/ P25MP301B	3	--	--	3
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Basic knowledge of science, environment, and technological applications, Awareness of current environmental challenges and sustainability needs

Course Objectives: The course aims:

1. To introduce the concepts and principles of sustainable development and technology.
2. To evaluate the impact of current technologies on environmental, social, and economic systems.
3. To explore clean and green technologies that promote sustainability.
4. To enable students to design or adopt sustainable solutions for real-world applications.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Explain the core principles of sustainability and sustainable development
CO2	Analyze various sustainable technologies in energy, water, and waste sectors
CO3	Evaluate lifecycle and environmental impact of a given technology
CO4	Propose sustainable technology solutions for specific local/global issues

Course Content		
Unit No.	**Contents**	**Hrs**
1	**Introduction to Sustainable Development and Technology:** Sustainability principles, triple bottom line, SDGs, environmental degradation, ecological footprint, carbon emissions, circular economy	**6**
2	**Sustainable Energy Technologies:** **Renewable energy sources, solar PV, wind, hydropower, biomass, green hydrogen, energy efficiency, smart grids**	**6**
3	**Sustainable Water and Sanitation Technologies:** Rainwater harvesting, water purification technologies, wastewater treatment, greywater recycling, low-flow devices, SDG 6 focus	**6**
4	**Sustainable Waste Management:** **Waste hierarchy (Reduce-Reuse-Recycle), e-waste, composting, biodegradable packaging, plastic alternatives, waste-to-energy**	**6**
5	**Green Building and Smart Infrastructure:** Energy-efficient building materials, passive solar design, green rating systems (LEED, GRIHA), smart cities, sustainable transportation	**6**
6	**Life Cycle Assessment and Sustainable Innovation:** LCA tools and methods, carbon footprint tools, eco-design, green product innovation, sustainable entrepreneurship, case studies	**6**

Text Books:

1. Sustainable Engineering: Concepts, Design and Case Studies – D. Allen, D. Shonnard
2. Sustainability Principles and Practice – Margaret Robertson

Reference Books:

1. Green Technologies and Environmental Sustainability – R. Raveendran
2. Reports from UNEP, NITI Aayog, MoEFCC

MOOC/NPTEL Platform:

1. **NPTEL:** Sustainable Engineering Concepts and Life Cycle by ByProf.Brajesh Kumar Dubey, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc25_ce117/preview

Title of the Course Name: Entrepreneurship Development **Course Code:**P25CM303C/ P25CS301C/ P25ET301C/ P25MD301C/ P25MP301C	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Basics of Management, Market Research Fundamentals, Financial Accounting Basics.

Course Objectives: The course aims:

1. To introduce the fundamental concepts and evolution of entrepreneurship, including the role of creativity and innovation.
2. To enable students to recognize business opportunities and develop viable business models using structured techniques.
3. To equip students with knowledge of business planning, financial feasibility, legal structures, and institutional support for startups.
4. To explore funding strategies, growth management, and emerging trends in entrepreneurship and intrapreneurship.

Course Outcomes: At the end of the course, students will be able:

CO	Course Outcomes
CO1	Explain the concepts, types, and evolution of entrepreneurship along with the importance of innovation.
CO2	Apply opportunity recognition and business modeling techniques like BMC and lean startup.
CO3	Analyze the feasibility of a business idea considering financial, legal, and institutional frameworks.
CO4	Evaluate different funding options and growth strategies, including emerging trends in entrepreneurship.

Course Content		
Unit No.	**Contents**	**Hrs**
1	**Fundamentals of Entrepreneurship** Definition, types and evolution of entrepreneurship, Entrepreneur vs intrapreneur, Importance of creativity and innovation in venture creation.	**6**
2	**Opportunity Recognition & Business Models** Idea generation techniques - brainstorming, TRIZ, SCAMPER, Market research and feasibility analysis, Business Model Canvas and lean startup methodology.	**6**
3	**Business Planning and Project Feasibility** Components of a business plan, Cost–benefit analysis - NPV, IRR, ROI, Financial planning, budgeting, cost structures.	**6**
4	**Legal & Institutional Framework** Business entity types - sole proprietorship, LLP, Pvt. Ltd, Registration processes, IPR fundamentals - patents, trademarks, Schemes and support - Start-up India, SIDBI, NABARD.	**6**
5	**Financing and Growth Management** Funding sources - bootstrapping, angel investors, VC, loans, Scaling strategies, growth stages, risk management, Role of incubation, accelerators, and mentorship.	**6**
6	**Emerging Entrepreneurship Trends** Social, rural, digital entrepreneurship, Corporate intrapreneurship dynamics, Technology-driven ventures and ecosystem trends.	**6**

Text Books:

1. Engineering Entrepreneurship: From Idea to Business Plan – Paul Swamidass, Cambridge University Press, 2015.
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, Crown Business, 2011.
3. Entrepreneurship Development, S. Anil Kumar, Scientific Publishers, 2019.

Reference Books:

1. Disciplined Entrepreneurship: 24 Steps to a Successful Startup, Bill Aulet, Wiley, 2013.
2. Opportunity Recognition in Entrepreneurial Teams, Maureen McKelvey, Per Davidsson, Leif Wennberg, Springer, 2021.
3. Effectuation: Elements of Entrepreneurial Expertise, Saras D. Sarasvathy, Edward Elgar, 2008, 2nd ed. 2021.

Title of the Course Name: Industrial Automation **Course Code:**P25CM301D/ P25CS301D/ P25ET301D/ P25MD301D/ P25MP301D	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Electrical Networks and Control, Digital Electronics Basics.

Course Objectives: The course aims:

1. To familiarize students with the hierarchical structure of industrial automation systems and various sensing technologies used in the industry.
2. To impart knowledge of process control systems and tuning techniques including PID controllers and advanced control methods.
3. To train students in PLC programming, sequential control, and industrial networking protocols for automation.
4. To introduce advanced automation technologies including IIoT, CNC, robotics, and cyber-secure smart manufacturing systems.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Explain the structure of industrial automation systems and describe the working principles of common industrial sensors and actuators.
CO2	Apply PID tuning techniques to control processes using feedback loops, cascade control, and feed-forward methods.
CO3	Develop ladder and structured text programs for automation using PLCs and integrate industrial communication protocols (e.g., Modbus, Profibus).
CO4	Analyze and evaluate the integration of advanced automation systems like SCADA, IIoT, and robotics for Industry 4.0 implementations.

Course Content		
Unit No.	**Contents**	**Hrs**
1	**Architecture and Sensing in Industrial Automation** Overview of Automation Systems - Architecture, CPS, levels of automation, discrete vs process systems, Industrial Sensors and Signal Conditioning - Temperature, pressure, displacement, flow, force sensors; calibration, error analysis and conditioning circuits.	**6**
2	**Process Control and PID Techniques** Fundamentals of Control Systems - Feedback loops, stability, controller types, PID Controllers - P/PI/PID tuning methods Ziegler–Nichols, feed-forward, cascade, predictive control.	**6**
3	**Sequence Control and PLC Programming** Components of a business plan, PLC Basics - Hardware architecture, scan cycle, I/O interfacing, Programming in Ladder and Structured Control - Relay logic, timers, counter blocks, structured design.	**6**
4	**Fieldbus Protocols, SCADA and DCS** Industrial Communication Networks -Modbus, Profibus, HART, Fieldbus, Ethernet/IP,SCADA/DCS Architecture and HMI - Data acquisition, historian logs, alarms, cybersecurity, OPC UA.	**6**
5	**Actuators and Drive Systems** Actuator Technologies - Hydraulic, pneumatic valves, electric drives, stepper and servo motors, Drive Systems and VFDs - Variable frequency drives, speed control, energy-efficient operation.	**6**
6	**Advanced Automation and Industry 4.0 Integration** CNC & Robotics Basics - Machine tool control loops, robotic manipulators, grippers, kinematics, IIoT, Analytics and Cybersecurity - Edge computing, data analytics, smart manufacturing and automation system security.	**6**

Text Books:

1. Industrial Automation: Hands-On, Frank Lamb, McGraw-Hill, 1st ed., 2013
2. Industrial Automation Solutions for PLC, SCADA, Drive and Field Instruments – Sanjay B. Katariya, Notion Press, 2020..

Reference Books:

1. Standard Handbook of Industrial Automation – Douglas M. Considine & Glenn D. Considine, Springer, 1st ed., 1987.
2. Instrumentation for Process Measurement and Control – Norman A. Anderson, Chilton Company, 3rd ed., Circa 1990.
3. Industrial Automation from Scratch, Olushola Akande, Packt Publishing, 2023.

Title of the Course Name: Introduction to Industry 4.0 and Industrial Internet of Things **Course Code:** P25MD302	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Fundamentals of Sensors, Instrumentation, and Control Systems

Course Objectives: The course aims to:

1. To introduce the fundamental concepts of Industry 4.0, IoT, cyber-physical systems, and smart factories.
2. To understand the role of sensors, networking, data analytics, and cybersecurity in industrial IoT environments.
3. To apply IoT architectures, communication protocols, and AI/ML tools to industrial applications and case studies.
4. To evaluate real-world IIoT strategies, sustainability considerations, and future trends in smart manufacturing systems.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall the core concepts of Industry 4.0, IoT architectures, sensors, network protocols, cybersecurity, and industrial case studies.
CO2	Understand and interpret the functions of IoT layers, cloud-edge processing, big data tools, and smart systems integration in industrial setups.
CO3	Apply suitable IIoT architectures, networking models, and machine learning tools to solve problems in domains such as manufacturing, healthcare, and automation.
CO4	Evaluate IIoT solutions using real-time data handling, case study analysis, cost-benefit techniques, and strategy development for future-ready industrial systems.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Fundamentals of Industry 4.0 and IoT** Introduction to sensing and actuation, communication and networking fundamentals, overview of Industry 4.0, globalization and trends, lean to smart factories, connected business models, cyber-physical systems, collaborative platforms, and PLM.	**06**
2	**Advanced Technologies Enabling Industry 4.0** Next-generation sensors and devices, AR/VR applications in industry, basics of AI and ML, big data and predictive analytics, industrial internet systems, cybersecurity foundations, and industrial IoT overview.	**06**
3	**Architecture and Layers of IoT** IoT business models, reference architectures, sensing layer, edge devices, processing layer (edge vs cloud), communication layer protocols (MQTT, CoAP), network topologies, and challenges in industrial IoT networking.	**06**
4	**Data Analytics, Networking, and Security in IIoT** Big data storage and visualization, machine learning tools (R, Julia, Hadoop), software-defined networking (SDN), cloud computing, fog computing for real-time data handling, and cyber security practices in industrial systems.	**06**
5	**Application Domains and Industrial Case Studies** IoT in smart factories, assembly lines, food and beverage, healthcare, power plants, inventory and quality control, safety management, oil and pharma industries, UAVs in automation, Case Study I: Milk processing and packaging, Case Study II: Smart manufacturing systems.	**06**
6	**Strategy Development and Future Trends** Designing IoT strategies for smart manufacturing, integration with legacy systems, data-driven decision-making, scaling IoT solutions, cost-benefit analysis, sustainability and green IoT, upcoming trends in Industry 4.0 and digital transformation.	**06**

Text Books:

1. Alasdair Gilchrist, "*Industry 4.0: The Industrial Internet of Things"*, Apress, 1st Edition, 2016.
2. Rajkumar Buyya, Amir Vahid Dastjerdi, "*Internet of Things: Principles and Paradigms*, Elsevier", 1st Edition, 2016.
3. Uday Kamath, Krishna Choppella, Anand Deshpande, "*Industrial Digital Transformation: Accelerate digital transformation with business optimization, AI, and Industry 4.0"*, Packt Publishing, 2021.

References Books

1. Milan Milenkovic, "*Internet of Things: Concepts and System Design"*, Springer, 1st Edition, 2020.
2. William Stallings, "*Wireless Communications and Networks"*, Pearson, 2nd Edition, 2005.
3. Brett King ," *Augmented: Life in the Smart Lane"*, Marshall Cavendish, 1st Edition, 2016.

Title of the Course Name: **Dissertation Phase- I***	**L**	**T**	**P**	**Credits**
	--	--	20	10
Course Code: P25MD304	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

*Note –Minimum 30% work of Dissertation Phase- II should be completed.

Pre-Requisite:

- Understanding of core and elective subjects related to the chosen domain.
- Familiarity with research methodology, academic writing, and referencing.
- Knowledge of simulation tools, programming platforms, or hardware (as required by the topic).

Course Objectives: The course aims:

1. To identify a research problem relevant to Mechanical Design Engineering.
2. To conduct an in-depth literature survey and identify research gaps.
3. To formulate objectives, scope, and methodology of the proposed work.
4. To enhance research planning, time management, and technical writing skills.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Identify and define a research problem with appropriate scope and relevance.
CO2	Conduct a comprehensive literature survey and identify research gaps.
CO3	Formulate problem statements, objectives, and methodology.
CO4	Prepare and present a project proposal with justification and expected outcomes.
CO5	Demonstrate the ability to document and present research progress professionally

Sr.No.	Guidelines
1	Activities Involved 1. Selection of a relevant research topic in consultation with a guide. 2. Literature review using journals, conference papers, patents, and technical reports. 3. Identification of research gaps, problem statement formulation. 4. Planning of methodology, tools, datasets, and experimental setup (if applicable). 5. Partial implementation or simulation (as feasible). 6. Periodic presentations and documentation.
2	Format for Report (Spiral Bound & Soft Copy) 11. Cover Page 12. Certificate (Guide + Head of Department) 13. Declaration 14. Acknowledgement 15. Abstract 16. Table of Contents 17. List of Figures/Tables (if applicable) 18. Chapters: o Introduction o Literature Review o Problem Statement o Objectives o Proposed Methodology o Preliminary Work Done o Conclusion and Future Work 19. References 20. Appendix (if applicable)
3	Deliverables • Synopsis (approved by guide and PRC). • Interim progress report. • Final report of Dissertation Phase–I. • Presentation and viva before the department PRC.

PG Program: Mechanical Design Engineering
Semester: IV

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
Project	P25MD401	Dissertation Phase-II*	-	-	40	20	ISE-I	50	40	
							ISE-II	50		
							ESE (POE)	100	40	80
Total			**-**	**-**	**40**	**20**	**200**			
Total Contact Hours- 40							**Total Credits- 20**			

* It is required to publish/present two papers out of which at least one paper should be in a SCI/ SCIE/ SCOPUS/ Web of Science/ Peer-Reviewed Journal before Thesis Submission.

Title of the Course Name: Dissertation Phase-II	**L**	**T**	**P**	**Credits**
Course Code:P25MD401	--	--	40	20
	ISE	MSE	ESE	Total
	100	**--**	**100**	**200**

Pre-Requisite:

- Completion of Dissertation Phase–I with approved synopsis and partial implementation.
- Working knowledge of design tools, simulation software, or experimental hardware platforms.
- Familiarity with academic writing, plagiarism policies, and peer-reviewed publishing process.

Course Objectives: The course aims:

1. To implement the proposed methodology from Dissertation Phase–I using suitable tools and techniques.
2. To conduct detailed experimentation, simulation, or design, and critically analyze the results obtained.
3. To interpret research outcomes in the context of existing literature and assess their academic or practical impact.
4. To compile, document, and present the complete dissertation work through a formal report, presentation, and publication.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Apply the selected research methodology and tools to execute the project effectively.
CO2	Analyze and interpret the results from experimentation or simulation to derive meaningful insights.
CO3	Demonstrate problem-solving, innovation, and research skills through validated outcomes and academic publications.
CO4	Prepare and present a complete dissertation report, defend the work confidently, and adhere to academic and ethical standards.

Sr.No.	Guidelines
1	Activities Involved 1. Full implementation of the system/methodology. 2. Conduct simulations, hardware experiments, or data analysis. 3. Compare results with existing methods or baseline systems. 4. Write and submit research papers to suitable conferences or journals. 5. Prepare the final dissertation report. 6. Final seminar and viva-voce before internal and external examiners.
2	**Mandatory Paper Publication Requirements** • Each student must publish **a minimum of two research papers** based on their dissertation work **before submission**. • The papers must be: o **At least one in a SCI/ SCIE/ SCOPUS/ Web of Science/ Peer-Reviewed Journal.** o **The second can be in a national/international conference with review and proceedings.** • Proof of **acceptance or publication** must be submitted along with the final dissertation. • Co-authorship with guide or peer students is acceptable, but the student must be the primary contributor.
	Report Format (Hardbound Copy) 1. Cover Page 2. Certificate (Guide, HoD, External Examiner) 3. Declaration 4. Acknowledgement 5. Abstract 6. Table of Contents 7. List of Figures and Tables 8. Chapters: o Introduction o Literature Review o Gap Identification o Problem Statement o Objectives o Methodology o Implementation o Results and Discussion o Conclusion and Future Scope 9. References

	10. Appendices (if applicable) 11. Copies of Published Papers (as Annexure)
3	Deliverables • **Hardbound final dissertation report** (in prescribed format). • **Soft copy of report and presentation** (PDF and PPT). • **Plagiarism report** (Turnitin/Urkund ≤ 10%). • **Proof of 2 paper publications** (acceptance letters/certificates/published copy). • **Source code, design files, datasets** (if applicable). • **Final presentation and viva sheet** signed by the PRC.
	Mandatory Paper Publication Requirements • Each student must publish **a minimum of two research papers** based on their dissertation work **before submission**. • The papers must be: o **At least one in a SCI/ SCIE/ SCOPUS/ Web of Science/ Peer-Reviewed Journal.** o **The second can be in a national/international conference with review and proceedings.** • Proof of **acceptance or publication** must be submitted along with the final dissertation. • Co-authorship with guide or peer students is acceptable, but the student must be the primary contributor.

Exit Courses after Semester– II - P.G. Diploma

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme		
			L	T	P	Cr	Components	Max	Min. for Passing
ELC	P25MD209	Internship/Field Training#	-		-	2	ISE	50	40
							ESE	50	
AEC	P25MD210	Employability Skill Development*	4	-	-	4	ISE	50	40
							ESE	50	
	Total		**04**	**00**	**00**	**6**		**200**	
Total Contact Hours- 04 Total Credits- 06									

*It is mandatory to opt this course certification from SWAYAM/NPTEL MOOC platform
Four weeks domain specific industrial internship after successfully completing first year of the program.

Title of the Course Name: Internship/Training	L	T	P	Credits
	--	--	2	2
Course Code:P25MD209	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite:

- Completion of core PG coursework in Electronics and Telecommunication
- Basic technical and communication skills
- Awareness of industrial tools, platforms, or technologies relevant to the chosen domain
- Readiness for professional work ethics and environment
- Resume and basic documentation (cover letter, academic transcripts)

Course Objectives: The course aims:

1. To bridge the gap between academic learning and industrial practices through exposure to real-world engineering environments.
2. To develop domain-specific technical competencies and hands-on skills via industrial participation.
3. To enhance students' understanding of project workflows, tools, standards, and collaborative teamwork in professional settings.
4. To strengthen interpersonal communication, reporting skills, and awareness of innovation and regulatory practices in industry.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Identify industry-relevant problems and apply classroom knowledge to practical situations.
CO2	Demonstrate technical proficiency and professional behavior through active participation in industrial tasks.
CO3	Analyze industrial systems, workflows, and project execution practices effectively.
CO4	Compile and present a structured internship report with observations, learning's, and contributions.

Sr. No.	Guidelines
1	Activities Involved 1. Identifying and applying to companies or R&D organizations 2. Completion of internship spanning 4 weeks 3. Hands-on work under assigned industry mentors 4. Weekly task updates and feedback sessions 5. Final presentation and submission of training report
2	**Requirements** • Internship should be in a core or allied domain: Telecom, Embedded, Signal Processing, Networking, VLSI, IoT, AI, etc. • Prior approval must be taken from the Internship/Training Coordinator • Maintain a **daily logbook** recording work done, observations, and reflections • Internship certificate must be obtained from the industry at the end of the training • Students are required to submit: a) Internship Completion Certificate b) Internship Report (format below) c) Logbook or Weekly Activity Sheet d) Presentation and Viva before Evaluation Panel.
3	Internship Report Format (Hardbound Copy) 1. **Cover Page** (Institute, Title, Student Name, Industry Name, Duration) 2. **Certificate from Institute** 3. **Certificate from Company** 4. **Acknowledgment** 5. **Table of Contents** 6. **Chapter 1: Introduction** – Overview of the organization and objectives 7. **Chapter 2: Training Activities** – Tasks performed, tools used, departments visited 8. **Chapter 3: Technical Learning** – Concepts, skills, technologies learned 9. **Chapter 4: Analysis and Outcomes** – Contributions made, learnings, challenges 10. **Chapter 5: Conclusion** – Summary and future scope 11. **References** (if applicable) 12. **Appendices** – Screenshots, tools used, code samples (if allowed)

Title of the Course Name: Employability Skill Development **Course Code:**P25MD210	**L**	**T**	**P**	**Credits**
	4	--	--	4
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Basic English communication

Course Objectives: The course aims:

1. To develop effective communication, teamwork, and interpersonal skills
2. To enhance professional readiness through resume building and interview practice
3. To build leadership qualities and critical thinking for workplace adaptability
4. To inculcate ethics, etiquette, and time management in professional settings

Course Outcomes: At the end of the course, students will be able:

CO	Course Outcomes
CO1	Demonstrate effective communication and interpersonal skills
CO2	Apply leadership and teamwork principles in professional settings
CO3	Prepare resumes and participate effectively in interviews and group discussions
CO4	Practice workplace etiquette, time management, and ethical behavior

Course Content		
Unit No.	**Contents**	**Hrs**
1	**Communication Skills** Verbal and non-verbal communication, active listening, barriers to communication, clarity and coherence, email and business	**6**

	communication, public speaking, presentation skills	
2	**Personality Development and Interpersonal Skills** Positive attitude, self-confidence, grooming and body language, self-awareness, empathy, emotional intelligence, teamwork and collaboration, conflict resolution	**6**
3	**Resume and Cover Letter Writing** Types of resumes, components of an effective resume, tailoring resumes to job roles, cover letter writing, common errors in resumes, creating a LinkedIn profile	**6**
4	**Interview Preparation and Group Discussion** Types of interviews, interview etiquette, commonly asked questions, STAR technique, mock interviews, types of group discussions, do's and don'ts in GD, communication in a group setting	**6**
5	**Professional Skills and Workplace Etiquette** Workplace behavior, ethics and integrity, corporate etiquette, professionalism, time management, goal setting, stress management, adaptability	**6**
6	**Career Planning and Employability Readiness** Career planning techniques, self-assessment and SWOT analysis, decision-making skills, building confidence, job search strategies, facing challenges in the workplace	**6**

Text Books:

1. Barun K. Mitra , Personality Development and Soft Skills, Oxford University Press
2. Andrews, Sudhir , How to Succeed at Interviews, Tata McGraw Hill

Reference Books:

1. **Dr. K. Alex** – *Soft Skills: Know Yourself & Know the World*, S. Chand
2. **Wallace & Masters** – *Personal Development for Life and Work*, Cengage Learning
3. **Dale Carnegie** – *How to Win Friends and Influence People*, Simon & Schuster
4. NSDC / NASSCOM soft skills modules, National Skill Development Corporation resources.

MOOC/NPTEL Platform:

1. **Developing Soft Skills and Personality** by Prof. T Ravichandran (IIT Kanpur)]
   Link: https://nptel.ac.in/courses/109/104/109104115

ABBREVIATIONS

- **L:** Lecture
- **T:** Tutorial
- **P:** Practical
- **ISE-I**- In Semester Evaluation I
- **ISE-II**- In Semester Evaluation II
- **MSE:** Mid Semester Examination
- **ESE:** End Semester Exam
- **VEC-** Value Education Course
- **ELC-** Experiential Learning Course
- **AC:** Audit Course
- **RM:** Research Methodology
- **OE**: Open Elective
- **PCC**: Program Core Course
- **PEC**: Program Elective Course
- **MDM-** Multidisciplinary Minor
- **FP**- Field Project

PG Program: Mechanical Design Engineering

Semester: I

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
PCC	P25MD101	Advanced Engineering Design	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD102	Design for Piping System	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD103	Advanced Vibrations and Acoustics	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PEC	P25MD104	Program Elective-I	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
RM	P25MD105	Research Methodology and IPR	2	-	-	2	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
ELC	P25MD106	Seminar	-	-	2	1	ISE	50	20	40
							ESE (OE)	50		
PCC	P25MD107	PG Lab- I	-	-	4	2	ISE	50	20	40
							ESE (POE)	50	20	
AC	P25MD108	Yoga and Meditation	1	-	-	-	-	-	AU	
	Total		**15**	**3**	**06**	**20**		700		
Total Contact Hours- 24							**Total Credits- 20**			

PG Program: Mechanical Design Engineering
Semester: II

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
PCC	P25MD201	Finite Element Method in Design	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD202	Integrated Product Development	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD203	Design for Manufacturing and Assembly	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PEC	P25MD204	Program Elective-II	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
OE	P25MD205	Open Elective-I	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
VEC	P25MD206	Technologies for Industrial Evolution	2	-	-	2	ISE-I	25		20
							ISE-II	25		
ELC	P25MD207	Mini Project	-	-	2	1	ISE-I	25		40
							ISE-II	25		
							ESE (POE)	50	20	
PCC	P25MD208	PG Lab- II	-	-	4	2	ISE	50	20	40
							ESE (POE)	50	20	
ELC	P25MD209	Internship/Field Training	-	-	-	-	Will be Evaluated in Sem-III	-	-	
	Total		**18**	**0**	**06**	**22**		**750**		
Total Contact Hours- 24							**Total Credits- 22**			

PG Program: Mechanical Design Engineering
Semester: III

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
OE	P25MD301	Open Elective-II[$]	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
MDM	P25MD302	Multi-Disciplinary Minor[$]	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
ELC	P25MD303	Dissertation Phase-I*	-	-	20	10	ISE-I	25		40
							ISE-II	25		
							ESE (POE)	50	20	
ELC	P25MD209	Internship/Field Training[#]	-	-	-	2	ISE	50	20	
Total			**6**	**-**	**20**	**18**	**350**			
Total Contact Hours- 26 Total Credits- 18										

$ It is mandatory to opt these courses certification from SWAYAM/NPTEL, MOOC platform.
* It is required to complete 30% work of Dissertation.
# It is required to do Four weeks domain specific industrial internship after completing first year of the program evaluated in Semester-III

PG Program: Mechanical Design Engineering
Semester: IV

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
Project	P25MD401	Dissertation Phase-II*	-	-	40	20	ISE-I	50	40	
							ISE-II	50		
							ESE (POE)	100	40	80
Total			**-**	**-**	**40**	**20**	**200**			
Total Contact Hours- 40							**Total Credits- 20**			

* It is required to publish/present two papers out of which at least one paper should be in a SCI/ SCIE/ SCOPUS/ Web of Science/ Peer-Reviewed Journal before Thesis Submission.

PROGRAM ELECTIVE

(Students have to select any one Program Elective course out of 03, for each applicable semester, of their interest, offered by the PG Program from the table below)

Program Elective – I			
Sr. No.	**Course Code**	**Course Name**	**Semester**
1	P25MD 104A	Composite Materials and Mechanics	I
2	P25MD 104B	Advance Engineering Materials	
3	P25MD 104C	Optimization Techniques in Design	

Program Elective – II			
Sr. No.	**Course Code**	**Course Name**	**Semester**
1	P25MD 204A	Tribology in Design	II
2	P25MD 204B	Theory of Elasticity and Plasticity	
3	P25MD 204C	Engineering computing	

MULTIDISCIPLINARY MINOR (MDM)

(Students have to select any one course of their interest (other than a courses offered by their program) for the award of Minor Degree from the table below)

Sr.	**Course Code**	**Course Name (MDM)**	**Semester**	**Offered by the Department**
1	P25MD302	Introduction to Industry 4.0 and Industrial Internet of Things	III	Mechanical Engineering -Design

OPEN ELECTIVE COURSES

(Students have to select any one Open Elective course, for each applicable semester, of their interest from the basket below.)

Open Elective – I Semester II			Open Elective – II Semester III		
Sr.	**Course Code**	**Course Name (OE)**	**Sr.**	**Course Code**	**Course Name (OE)**
1	P25MD205A	Environment and Development	1	P25MD301A	Labour Welfare and Industrial Relations
2	P25MD205B	Engineering Economics	2	P25MD301B	Sustainable Technology
3	P25MD205C	Project Management	3	P25MD301C	Entrepreneurship Development
4	P25MD205D	Healthcare Engineering	4	P25MD301D	Industrial Automation

Exit Courses after Semester– II - P.G. Diploma

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme		
			L	T	P	Cr	Components	Max	Min. for Passing
ELC	P25MD209	Internship/Field Training#	-	-	-	2	ISE	50	40
							ESE	50	
AEC	P25MD210	Employability Skill Development*	4	-	-	4	ISE	50	40
							ESE	50	
	Total		**04**	**00**	**00**	**6**		**200**	
Total Contact Hours- 04 Total Credits- 06									

*It is mandatory to opt this course certification from SWAYAM/NPTEL MOOC platform
Four weeks domain specific industrial internship after successfully completing first year of the program.

PG Program: Mechanical Design Engineering
Semester: I

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
PCC	P25MD101	Advanced Engineering Design	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD102	Design for Piping System	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD103	Advanced Vibrations and Acoustics	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PEC	P25MD104	Program Elective-I	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
RM	P25MD105	Research Methodology and IPR	2	-	-	2	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
ELC	P25MD106	Seminar	-	-	2	1	ISE	50	20	40
							ESE (OE)	50	20	
PCC	P25MD107	PG Lab- I	-	-	4	2	ISE	50	20	40
							ESE (POE)	50	20	
AC	P25MD108	Yoga and Meditation	1	-	-	-	-	-	AU	
	Total		**15**	**3**	**06**	**20**		700		
Total Contact Hours- 24							**Total Credits- 20**			

Title of the Course Name: **Advanced Engineering Design** Course Code: P25MD101	**L**	**T**	**P**	**Credits**
	3	1	--	4
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Basic knowledge of mechanics, strength of materials, machine design, and manufacturing processes**.**

Course Objectives: The course aims to:

1. To develop a comprehensive understanding of design philosophies and models
2. To equip students with the ability to apply design strategies.
3. To analyze and apply failure theories.
4. To evaluate economic and ergonomic factors.

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify and recall key concepts involved in product and mechanical design including the design process, product strategies, static and fatigue failure theories, surface failures, manufacturing considerations, and economic factors.
CO2	Classify and relate various product design approaches, failure theories, material selection techniques, manufacturing methods, and ergonomic aspects by applying suitable models, principles, and safety standards.
CO3	Apply design techniques such as creative thinking, value engineering, failure analysis, and fatigue design to solve engineering problems involving product development, manufacturability, reliability, and cost-effectiveness.
CO4	Evaluate and justify optimal design decisions by analyzing complex interactions between materials, geometry, loading conditions, and user-centric requirements to enhance performance, safety, and economics of engineering systems

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Design Philosophy:** Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity, Creative techniques, Material selections, Notches and stress concentration, design for safety and Reliability.	**06**
2	**Product Design:** Product strategies, value, planning and specification, concept generation, concept selection, concept testing.	**06**
3	**Design for Manufacturing:** Forging design, casting design, Design process for non- metallic parts, Plastics, Rubber, Ceramic, Wood and Glass parts. Material selection in machine design.	**06**
4	**Failure theories:** Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics theory, Fatigue mechanisms, Fatigue failure models, Design for fatigue strength and life, creep: Types of stress variation, design for fluctuating stresses, design for limited cycles, multiple stress cycles, Fatigue failure theories, cumulative fatigue damage, thermal fatigue and shock, harmful and beneficial residual stresses, Yielding and transformation.	**06**
5	**Surface failures:** Surface geometry, mating surfaces, oil film and their effects, design values and procedures, adhesive wear, abrasive wear, corrosion wear, surface fatigue, different contacts, dynamic contact stresses, surface fatigue failures, surface fatigue strength.	**06**
6	**Economic factors influencing design:** Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, and Modern approaches in design.	**06**

Text Books:

1. R. G. Budynas and J. K. Nisbett, "Shigley's Mechanical Engineering Design", McGraw-Hill, 10th edition, 2015.
2. G. E. Dieter and L. C. Schmidt, "Engineering Design: A Materials and Processing Approach", McGraw-Hill, 5th edition, 2013.
3. K. T. Ulrich and S. D. Eppinger, "Product Design and Development", McGraw-Hill, 6th edition, 2015.

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Reference Books:

1. G. Pahl and W. Beitz, *"Engineering Design: A Systematic Approach"*, Springer, 3rd edition, 2007.
2. V. B. Bhandari, *"Design of Machine Elements"*, Tata McGraw-Hill, 3rd edition, 2010.
3. D. M. Anderson, *"Design for Manufacturability and Concurrent Engineering"*, CRC Press, 1st edition, 2004.

Title of the Course Name: **Design for Piping System**	**L**	**T**	**P**	**Credits**
Course Code: **P25MD102**	3	1	--	4
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Basic Electronics

Course Objectives: The course aims to:

1. To identify and recall basic components of process piping such as pipes, valves, fittings, materials, and layout symbols along with applicable codes and standards.
2. To understand and describe the principles of piping layout, pipe installation methods, flexibility analysis, and system design for fluid flow and stress.
3. To apply design methodologies for selecting pipe sizes, designing steam/oil piping, pressure relief systems, and analyzing different mechanical and application-specific systems.
4. To evaluate and recommend piping solutions considering reliability, cost-effectiveness, material selection, stress handling, safety, and application-specific criteria.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and define key elements of process piping systems including codes, standards, materials, fittings, piping layouts, installation methods, auxiliary components, and application-specific systems.
CO2	Illustrate and explain piping system layouts, flow sheets, pipe installation steps, and mechanical design fundamentals for process piping.
CO3	Design and analyze piping systems for different applications such as steam, oil, refrigeration, cryogenics, and underground pipelines considering flow, stress, and safety.
CO4	Evaluate and recommend appropriate piping materials, sizing techniques, joining methods, and safety features for specific industrial applications, ensuring reliability and performance.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**PROCESS PIPING:** Scope of Piping; Code and Standards; Mechanical Design Fundamentals; Mechanical design of piping system; Wall thickness; Piping size selection; Steel and cast iron pipe; Steel and wrought iron pipe; Light wall pipe; Tubing; Pipe connection and fittings; Rail fittings; Piping elements and specialties; Pipe representation; Welded and flanged fittings; Valves.	**06**
2	**PIPING SYSTEM LAYOUT AND DESIGN:** Piping layout; Equipment Layout; Process Piping Layout; Utility Piping Layout; Pipe flow sheets; Tube fastening and attachment; Non- ferrous tube fittings; Ducts and elbows; Pipe and tube design data; Design of steam piping; Design of oil piping; Design of cast iron pipe; Miscellaneous design and applications: Pipeline; Flexibility expansive forces in pipelines; Expansion stresses and reaction pipelines.	**06**
3	**PIPE INSTALLATION:** Selection of materials; Piping design; Basic principle; Piping sketches; Steam reducing and regulating valves; Selection of pipe size; Pipe hydraulics and sizing; Flow of water in pipes; Economical pipe selection; Selection of steam pipe size; Determination of steam pipe size; Development of plot plan; Flexibility analysis.	**06**
4	**PROCESS AUXILIARIES:** Piping; Explanation of code; Methods of fabrication; Nominal pipe size; Non-metallic piping and tubing; Pipe sizing by internal diameter; Choosing the final pipe size; Process steam piping; Pressure relief system; Pressure relief devices; Design of pressure relief system; Layout by scale model method.	**06**
5	**MECHANICAL PIPING DESIGN:** Piping drawings; Piping stress design; Internal or external fluid pressure stresses; Design of overhead piping; Design of underground piping; Erection of piping and support; Insulation; Drainage piping design; Design of natural gas pipeline.	**06**
6	**DESIGN OF PIPING SYSTEM FOR THE FOLLOWING APPLICATIONS:** Refrigeration piping system, Cryogenic piping system, Transmission piping system, Steam power plant piping system, Underground steam-piping system, Underground petroleum piping, Submerged piping for petroleum products, Piping system sprinklers, Non-metallic piping; Selection and joining techniques; Cross Country Pipe Technology.	**06**

Text Books:

1. J. M. Coulson, R. K. Sinnott, and J. F. Richardson, *"Chemical Engineering, Volume 6: Design"*, Maxwell Macmillan International, 1st edition, 1993.
2. Mohinder L. Nayyar, *"Piping Handbook"*, McGraw-Hill, 7th edition, 2000.
3. G. K. Sahu, *"Handbook of Piping Design"*, New Age International Publishers, 1st edition, 1998.

Reference Books:

1. J. Philip Ellenberger, *"Piping Systems Manual"*, McGraw-Hill Professional, 1st edition, 2010.
2. John G. Kujawa and Philip Ellenberger, *"Pressure Relief Devices: ASME and API Code Simplified"*, McGraw-Hill, 1st edition, 2014.
3. Ronald C. Penno and Robert O. Parmley, *"Pipe Drafting and Design"*, Gulf Publishing Company, 2nd edition, 2001.

Title of the Course Name: **Advanced Vibrations and Acoustics** Course Code: **P25MD103**	**L**	**T**	**P**	**Credits**
	3	1	--	4
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Basic knowledge of Dynamics and Vibrations, Engineering Mathematics

Course Objectives: The course aims to:

1. To recall and describe the fundamental principles of vibration and acoustics, including SDOF and MDOF systems, wave transmission, and speech mechanisms.
2. To interpret and model mechanical and acoustic systems using mathematical tools such as Lagrange's equations, mode analysis, and wave equations.
3. To apply analytical and numerical methods such as Rayleigh-Ritz, Dunkerley's, and Holzer's methods for solving problems related to vibrations and acoustics.
4. To evaluate the performance and response of dynamic and acoustic systems and propose control and attenuation methods for specific vibration and sound problems.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall fundamental vibration and acoustics concepts including response of SDOF and MDOF systems, sound propagation, and human hearing mechanisms.
CO2	Formulate mathematical models for continuous and discrete vibratory systems and interpret the behavior of acoustic wave transmission and resonance.
CO3	Apply numerical and analytical methods to solve multi-degree and continuous vibration problems and analyze acoustic attenuation and resonance filters.
CO4	Evaluate vibration control methods and psychoacoustic principles to address engineering problems in vibration suppression and acoustic optimization.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Response of SDOF Systems and Convolution Integral**: Transient Vibrations, Response of a single degree of freedom system to step and any arbitrary excitation, convolution (Duhamel's) integral, impulse response function	**06**
2	**Vibrations of MDOF Systems and Mode Analysis:** Free, damped and forced vibrations of two degree of freedom systems, use of Lagrange's equations to derive the equations of motion, normal modes and their properties, multi degree of freedom systems, Eigen values and Eigen vectors, mode summation method.	**06**
3	**Continuous Systems and Approximate Methods**: Continuous Systems, Vibrations of strings, bars, shafts and beams, discretised models of continuous systems and their solutions using Rayleigh – Ritz method, Mode summation method,	**06**
4	**Vibration Control and Numerical Techniques:** Vibration Control, Methods of vibration control, principle of superposition, Numerical and computer methods in vibrations: Rayleigh, Rayleigh-Ritz and Dunkerley's methods, matrix iteration method for Eigen-value calculations, Stodola method, Holzer's method,	**06**
5	**Acoustic Wave Transmission and Attenuation**: Plane and Spherical acoustic waves, Transmission Phenomena, transmission from one fluid medium to another, normal incidence, reflection at the surface of a solid, standing wave patterns, transmission through three media, Resonators and filters, Absorption of sound waves in fluids : Phase log between pressure and condensation, viscous absorption of plane waves, heat conduction as a source of acoustic attenuation,	**06**
6	**Speech, Hearing and Psychoacoustics** Speech, Hearing and Noise, The voice mechanism, acoustic power output of a speech, anatomy of the ear, mechanism of hearing, thresholds of the ear, loudness, pitch and timbre, beats, aural harmonics and combination tones, masking by pure tones, masking by noise.	**06**

Text Books:

1. D. J. Inman, "Engineering Vibration", Pearson Education, 4th edition, 2014.
2. W. T. Thomson and M. D. Dahleh, "Theory of Vibration with Applications", PHI Learning, 5th edition, 2008.
3. Michael Rettinger, "Acoustic Design and Noise Control", Vol. I & II. , Chemical Publishing Co., New York, 1977.

Reference Books:

1. D. J. Ewins, "Modal Testing: Theory, Practice and Application", Wiley-Blackwell, 2nd edition, 2000.
2. R. B. Randall, "Vibration-based Condition Monitoring: Industrial, Aerospace and Automotive Applications", John Wiley & Sons, 1st edition, 2011.
3. Lawrence E. Kinsler and Austin R.Frey, "Fundamentals of acoustics", Wiley Eastern Ltd., 1987.

Title of the Course Name: **Composite Materials and Mechanics** Course Code: P25MD104A	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Material Science and Metallurgy, Stress Analysis

Course Objectives: The course aims to:

1. To recall fundamental definitions, classifications, material behaviors, and characteristics of composite materials including lamina and laminates under various loading conditions.
2. To understand the stress-strain behavior, transformation relations, hygro-thermal effects, and failure mechanisms of composite materials and structures.
3. To apply micromechanical and macromechanical models to evaluate stiffness, strength, and failure response of composite laminates in structural applications.
4. To evaluate the structural integrity, residual stresses, and progressive failure in composite systems and develop design methodologies for their safe and effective use.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and classify the basic concepts, material types, structural behavior, and classification of composite materials, lamina, laminates, and their applications under mechanical and thermal loading.
CO2	Interpret and analyze the elastic response, stress transformation, strain-displacement relations, and hygro-thermal behavior of composite laminates and their structural implications.
CO3	Apply micromechanics, failure theories, and hygro-thermoelastic models to evaluate performance, reliability, and failure progression in composite structural elements.
CO4	Evaluate laminate strength, failure mechanisms, safety factors, and develop systematic design strategies for structural composite applications under various environmental and loading conditions.

Course Content		
Unit No	**Unit title and Content**	**Hrs**
1	**Introduction, basic concepts and characteristics:** Definition and characteristics, Overview of advantage and limitations of composite materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus, Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials.	**06**
2	**Elastic behavior of unidirectional lamina:** Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters.	**06**
3	**Strength of unidirectional lamina:** Micromechanics of failure; failure mechanisms, Macro-mechanical strength parameters, Macro-mechanical failure theories, Applicability of various failure theories.	**06**
4	**Elastic behavior of laminate:** Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, general load–deformation relations, Analysis of different types of laminates.	**06**
5	**Hygro-thermal effects:** Hygro-thermal effects on mechanical behavior, Hygro- thermal stress-strain relations, Hygro-thermoelastic stress analysis of laminates, Residual stresses, Warpage.	**06**
6	**Stress and failure analysis of laminates:** Types of failures, Stress analysis and safety factors for first ply failure of symmetric laminates, Micromechanics of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials	**06**

Texts Books:

1. Isaac M. Daniels, Orilshai, "*Engineering Mechaincs of Composite Materials*", Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, "*Analysis and Performance of fiber composites"*, John Wiley and Sons, Inc. 1990.
3. Mathews, F. L. and Rawlings, R. D., "*Composite Materials: Engineering and Science*", CRC Press, Boca Raton, 2003.

References Books:

1. M. Mukhopadhyay, "*Mechanics of Composite Materials and Structures*", University Press, 1st edition, 2004.
2. S. K. Mazumdar, "*Composite Manufacturing – Materials, Product and Processing Engineering"*, CRC Press, 1st edition, 2002.
3. K. K. Chawla, "*Composite Materials: Science and Engineering*", Springer, 3rd edition, 2012.

Title of the Course Name: **Advance Engineering Materials** Course Code: **P25MD104B**	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Metallurgy and Phase Diagrams, Mechanical Properties of Materials

Course Objectives: The course aims to:

1. To identify and recall the classifications, compositions, properties, and applications of special steels, cast irons, light metals, superalloys, nanomaterials, and biomaterials.
2. To understand the metallurgical behavior, strengthening mechanisms, and functional characteristics of advanced materials for industrial and biomedical applications.
3. To apply the knowledge of composition–property relationships to select suitable materials for specific engineering, high-performance, or bio-functional applications.
4. To evaluate and compare the performance of special steels, cast irons, lightweight alloys, smart materials, and biomaterials based on their mechanical, thermal, and functional properties.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and classify advanced materials such as special steels, superalloys, nanomaterials, smart materials, and biomaterials along with their compositions and applications.
CO2	Explain the strengthening mechanisms, metallurgical aspects, functional properties, and requirements of materials used in structural, thermal, and biomedical environments.
CO3	Apply material selection principles to recommend appropriate advanced materials for specific applications in high-temperature, wear-resistant, lightweight, or bio-compatible contexts.
CO4	Evaluate the suitability of various advanced materials based on mechanical, thermal, electrical, or biological performance for engineering design and technological innovations.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Special Steels:** Metallurgical aspects, Composition, Properties and applications of: different types of Stainless steels, Dual phase steels, TRIP steels, Maraging steels, High speed steels, Hadfield steels, Free cutting steels, Ausformed steels, Tool Steels, manganese steels, chrome steels, electrical steels, bearing steels, spring steels, heat resistant steels, creep steels, HSLA steels etc.	**06**
2	**Alloy cast iron:** Need of alloying. Silal, Nicrosilal, High silicon cast iron, Ni-hard, Heat resistant cast iron: Composition, Properties and their applications.	**06**
3	**Light metals and their alloys:** Aluminum, magnesium and titanium alloys: Metallurgical aspects, Properties and applications	**06**
4	**Super alloys:** Iron base, nickel base and cobalt base super alloys: Strengthening mechanism, Composition, Properties and their applications.	**06**
5	**Nano materials:** Definition, Types, Properties and applications, Carbon nano tubes, Methods of production. Smart materials: Shape memory alloys, Piezoelectric materials, Electro-rheological fluid, Magneto- rheological fluids.	**06**
6	**Biomaterials:** Property requirement, biocompatibility, bio-functionality, Important bio metallic alloys like: Ni-Ti alloy and Co-Cr-Mo alloys. Applications	**06**

Texts Books:

1. D. R. Askeland and P. P. Phulé, "*The Science and Engineering of Materials*", Thomson Publication, 6th edition, 2006.
2. R. K. Dogra and A. K. Sharma, *"Advances in Material Science*", S. Chand & Company, 1st edition, 2013.
3. C. P. Sharma, "*Engineering Materials: Properties and Applications of Metals and Alloys*", PHI Learning, 2nd edition, 2010.

References Books:

1. R. A. Flinn and P. K. Trojan, *"Engineering Materials and Applications*", John Wiley & Sons, 4th edition, 1995.
2. R. A. Lindberg and S. D. Sehgal, "*Materials: Their Nature, Properties and Fabrication"*, S. Chand & Company, 1st edition, 2008.
3. I. J. Polmear, "*Light Alloys: Metallurgy of Light Metals*", Elsevier, 4th edition, 2006.

Title of the Course Name: **Optimization Techniques in Design** Course Code: P25MD104C	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Metallurgy and Phase Diagrams, Mechanical Properties of Materials

Course Objectives: The course aims to:

1. To introduce the fundamentals and classification of optimization problems and classical optimization techniques.
2. To develop analytical understanding of linear and non-linear programming methods for single and multi-variable functions.
3. To apply optimization techniques such as geometric programming and genetic algorithms for engineering design problems.
4. To evaluate and interpret solutions using modern optimization tools, multi-objective frameworks, and engineering applications.

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify and explain various optimization methods including linear, non-linear, geometric, and evolutionary approaches used in engineering problems.
CO2	Formulate and solve optimization problems using classical, linear programming, and modern computational techniques across multiple engineering domains.
CO3	Analyze optimization results by performing sensitivity analysis, constraint handling, and design evaluations for mechanical components and systems.
CO4	Evaluate multi-objective optimization problems using genetic algorithms and justify the choice of methodology for optimal engineering design.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Introduction to Optimization:** Introduction to optimization, scope and applications, classification of optimization problems, classical optimization techniques, single and multi-variable cases.	**06**
2	**Linear Programming and Duality:** Formulation of linear programming models, simplex method, duality in linear programming, sensitivity (post-optimality) analysis, Karmarkar's interior point method.	**06**
3	**Non-Linear Programming** Unconstrained optimization, one-dimensional minimization methods, direct and indirect methods, constrained optimization with equality and inequality constraints.	**06**
4	**Geometric Programming and Engineering Design** Introduction to geometric programming, optimum design applications in mechanical components like beams, shafts, gears, and columns.	**06**
5	**Multi-objective Optimization and Genetic Algorithms** Basics of multi-objective optimization, principles and operators of genetic algorithms, applications to real-world engineering problems.	**06**
6	**Recent Advances and Applications** Introduction to dynamic programming, decision-making in energy systems and other domains, optimization in complex systems, emerging tools and techniques.	**06**

Text Books:

1. Kalyanmoy Deb, "Optimization for Engineering Design", Prentice Hall of India, New Delhi, 2005.
2. J. S. Arora, "Introduction to Optimum Design", McGraw Hill, New York, 1989.
3. R.C. Johnson, "Optimum Design of Mechanical Elements", Wiley, New York, 1980.

References Books:

1. R.J. Duffin, E.L. Peterson, C. Zener, Geometric Programming: Theory and Applications, Wiley, New York, 1967.
2. Kalyanmoy Deb, Evolutionary Multi-objective Optimization, Wiley, New York.
3. G.B. Dantzig, Linear Programming and Extensions, Princeton University Press, Princeton, N.J., 1963.

Title of the Course Name: **Research Methodology and IPR** **Course Code:**P25MD105	**L**	**T**	**P**	**Credits**
	2	--	--	2
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Basic knowledge of research methodology

Course Objectives: The course aims:

1. To recall the fundamental concepts of research methodology and intellectual property rights, including types of research, data sources, and IPR categories.
2. To understand the research process, research design, ethical responsibilities, and IPR frameworks through analysis of principles, processes, and legal guidelines.
3. To apply appropriate methods for identifying research problems, collecting data, conducting hypothesis testing, and understanding patent filing and dispute cases.
4. To evaluate the quality of research design, ethical compliance, and IPR procedures for contributing to original and responsible academic or industrial research.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and classify core concepts of research methodology, types of research, data sources, ethics, and intellectual property rights.
CO2	Explain the process of research design, data analysis, ethical standards, and the significance of IPR in academic and industrial research.
CO3	Apply systematic research techniques, including data collection, sampling, hypothesis testing, and patent filing processes with reference to real-world examples.
CO4	Evaluate research integrity, quality of research output, and the effectiveness of IPR strategies by assessing case studies, legal frameworks, and ethical practices.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Introduction to Research Methodology** Meaning, Objectives, Motivation, Types of Research, Research Approaches, Research Process, Criteria of Good Research	**6**
2	**Research Problem and Design** Identifying Research Problem, Literature Survey, Research Objectives, Research Design Concepts, Features of Good Design	**6**
3	**Data Collection and Analysis** Sources of Data, Sampling Methods, Data Processing, Statistical Techniques, Hypothesis Testing, Report Writing	**6**
4	**Ethics in Research** Ethical Principles, Plagiarism, Impact of Misconduct, Ethical Committees, Publishing Ethics	**6**
5	**Introduction to IPR** Overview of Intellectual Property, Importance of IPR, Types: Patents, Trademarks, Copyrights, Industrial Designs	**6**
6	**IPR Procedures and Case Studies** Patent Filing Procedure, Patentable and Non-patentable Items, Patent Search, Licensing, Case Studies on IPR Disputes	**6**

Text Books:

1. C. R. Kothari, "Research Methodology: Methods and Techniques", New Age International, 2nd edition, 2004.
2. P. Pandey and S. Pandey, "Research Methodology: Tools and Techniques", Bridge Center, 1st edition, 2015.
3. Neeraj Pandey and Khushdeep Dharni, "Intellectual Property Rights", PHI Learning, 1st edition, 2014.

Reference Books:

1. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide", Sage Publications, 4th edition, 2014.
2. T. Ramakrishna, "Basic Principles and Acquisition of Intellectual Property Rights", CIPRA, NLSIU, 1st edition, 2005.
3. V. Scaria, "Intellectual Property Rights in the Global Era", LexisNexis, 1st edition, 2012.

MOOC/NPTEL Platform:

1. NPTEL Course: Research Methodology – Prof. Rajat Agarwal (IIT Roorkee)

Title of the Course Name: **Seminar** Course Code: **P25MD106**	**L**	**T**	**P**	**Credits**
	--	--	2	1
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Previously studied courses

Course Objectives: The course aims to:

1. To assess the student's ability to research, analyze, and present technical topics effectively through seminars.
2. To develop public speaking skills, confidence, and clarity in addressing technical audiences.
3. To encourage independent learning, critical thinking, and exposure to real-world problems in manufacturing systems management.
4. To enhance communication skills and professionalism through structured presentations, written reports, and case-based discussions.

Course Outcomes: At the end of the course, students will be able to:

CO1	Demonstrate the ability to research, analyze, and organize technical content related to manufacturing systems management.
CO2	Present technical information clearly and confidently to a professional audience, using appropriate verbal and visual communication skills.
CO3	Prepare a well-structured, concise seminar report that meets academic and professional standards.
CO4	Exhibit self-confidence, critical thinking, and active participation during technical discussions and peer evaluations.

Sr.No.	Guidelines
1	Topic Selection: • The topic should be recent, innovative, and relevant to the mechanical design engineering • Finalize in consultation with a Guide.
2	**Literature Survey:** • Use, Springer, Elsevier, ScienceDirect, ACM, etc. • Minimum 15–20 references from recent publications (preferably last 5 years). • Maintain a citation style (Elsevier preferred)
3	Report Writing: • Cover Page with title, student name, guide name, institution. • Abstract (150–250 words). • Introduction. • Literature Review. • Technical Discussion / Methodology. • Challenges and Research Gaps. • Conclusion and Future Scope. • References (Elsevier format).
4	Presentation: • **Duration**: 12–15 minutes + 5 minutes Q&A. • Use professional PowerPoint slides: o 12–20 slides covering title, abstract, objectives, literature review, analysis, conclusion. • Include diagrams, block diagrams, or simulation results if applicable.
6	Submission Requirements: • **Final seminar report** (spiral bound and PDF). • **Presentation files** (PPT/PDF).

Title of the Course Name: **PG Lab-1**	**L**	**T**	**P**	**Credits**
Course Code: **P25MD107**	--	--	4	2
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Previously studied courses

Course Objectives: The course aims to:

1. To provide hands-on experience in analyzing different types of vibrations and their impact on mechanical systems.
2. To understand and investigate failure mechanisms in mechanical components through experimental analysis.
3. To design and implement basic mechatronic systems for mechanical applications.
4. To explore the principles of process control using PID controllers for various physical parameters (temperature, level, flow, etc.).

Course Outcomes: At the end of the course, students will be able to:

CO1	Analyze various types of vibrations and assess their effects on mechanical systems through experimental methods.
CO2	Investigate mechanical component failures using practical testing and failure analysis techniques.
CO3	Design and implement basic mechatronic systems for real-world mechanical engineering applications.
CO4	Apply principles of process control using PID controllers to regulate physical parameters like temperature, flow, and level.

Course Contents:	
1	Experiment on damped vibration
2	Torsional vibration analysis
3	Experiment based on failure analysis of mechanical component.
4	Design of mechatronic system for mechanical application
5	Demonstration of process control such as temp, level, flow, etc control using PID controller
6	2D element problem linear static analysis

Title of the Course Name: **Yoga and Meditation**	**L**	**T**	**P**	**Credits**
Course Code: P25MD108	1	--	--	AU
	ISE	MSE	ESE	Total
	--	**--**	**--**	**--**

Pre-Requisite: No formal pre-requisites.

Course Objectives: The course aims to:

1. To explore the philosophical and psychological foundations of Yoga and Meditation through Patanjali's Yoga Sutras.
2. To introduce and practice the Eight Limbs of Yoga (*Ashtanga Yoga*) for holistic self-regulation.
3. To train students in meditation, breathing, and ethical practices for enhancing clarity, focus, and emotional balance.
4. To help students integrate yogic wisdom and mindfulness into their academic and personal lives.

Course Outcomes: At the end of the course, students will be able to:

CO1	Comprehend the core teachings of Patanjali's Yoga Sutras.
CO2	Practice foundational yogic techniques such as asana, pranayama, and dhyana.
CO3	Apply principles of *Yama* and *Niyama* for improved discipline, ethics, and self-awareness.
CO4	Develop concentration and mindfulness for stress reduction and productivity.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Foundations of Yoga Philosophy** Origin and evolution of Yoga; Introduction to Patanjali and Yoga Sutras. Definition of Yoga – "Yogas Chitta Vritti Nirodha". The five Vrittis (mental fluctuations) and their control.	03
2	**Ethical and Personal Discipline (Yama & Niyama)** The five Yamas – Ahimsa, Satya, Asteya, Brahmacharya, Aparigraha. The five Niyamas – Shaucha, Santosha, Tapas, Svadhyaya, Ishwar Pranidhana. Relevance of Yama-Niyama in academic and professional life.	03
3	**Physical & Mental Purification (Asana, Pranayama, Pratyahara)** *Asana* – Role of posture; stability and comfort in the body Pranayama – Breath control techniques; calming the nervous system Pratyahara – Withdrawal of senses; mastering inner awareness	03
4	**Concentration, Meditation, and Liberation (Dharana, Dhyana, Samadhi)** Dharana – Developing concentration and focus Dhyana – The process and practice of meditation Samadhi – State of absorption; experiencing inner peace and unity	**03**

References:

1. The Yoga Sutras of Patanjali – Swami Satchidananda
2. Light *on the Yoga* Sutras *of* Patanjali – B.K.S. Iyengar
3. Four *Chapters* on Freedom – Swami Satyananda Saraswati
4. Raja Yoga – Swami Vivekananda

PG Program: Mechanical Design Engineering
Semester: II

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
PCC	P25MD201	Finite Element Method in Design	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD202	Integrated Product Development	3	1	-	4	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PCC	P25MD203	Design for Manufacturing and Assembly	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
PEC	P25MD204	Program Elective-II	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
OE	P25MD205	Open Elective-I	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
VEC	P25MD206	Technologies for Industrial Evolution	2	-	-	2	ISE-I	25		20
							ISE-II	25		
ELC	P25MD207	Mini Project	-	-	2	1	ISE-I	25		40
							ISE-II	25		
							ESE (POE)	50	20	
PCC	P25MD208	PG Lab- II	-	-	4	2	ISE	50	20	40
							ESE (POE)	50	20	
ELC	P25MD209	Internship/Field Training	-	-	-	-	Will be Evaluated in Sem-III	-	-	
	Total		**18**	**0**	**06**	**22**		**750**		
Total Contact Hours- 24							**Total Credits- 22**			

Title of the Course Name: **Finite Element Method in Design** Course Code: **P25MD201**	**L**	**T**	**P**	**Credits**
	3	1	--	4
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Theory of Structures and Strength of Materials

Course Objectives: The course aims to:

1. To recall the principles of elasticity, finite element formulations, and numerical methods relevant to structural mechanics problems.
2. To understand and interpret finite element techniques such as isoparametric formulation, plate bending, shell modeling, and dynamic analysis.
3. To apply appropriate FEM procedures to solve 1D, 2D, axisymmetric, plate, and shell structures under various loads and boundary conditions.
4. To evaluate the structural response and stability using finite element analysis techniques in both static and dynamic contexts for engineering components.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and summarize key concepts of elasticity, FEM formulation, numerical integration, structural modeling, dynamic analysis, and stability methods used in finite element analysis.
CO2	Interpret and formulate finite element models for beams, plates, axisymmetric solids, and shells, incorporating plane stress/strain, dynamic effects, and boundary conditions.
CO3	Apply FEM concepts such as isoparametric elements, numerical techniques, plate/shell modeling, and structural dynamics to analyze real-world structural systems.
CO4	Evaluate structural behavior and stability under static and dynamic conditions by integrating convergence checks, stress recovery, plate bending theories, and stability assessment methods.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Fundamentals of 1D Finite Element Formulation** Principles of linear elastic mechanics, virtual displacement, and minimum potential energy; introduction to Rayleigh-Ritz method; comparison between exact and approximate solutions; formulation and application of beam elements in 1D problems.	**06**
2	**Analysis of 2D Problems – Plane Stress and Plane Strain** Formulation of 2D finite element problems under plane stress and plane strain conditions; use of triangular elements such as Constant Strain Triangle (CST) and Linear Strain Triangle (LST); application of quadrilateral elements; incorporation of body forces, stress recovery, and boundary conditions.	**06**
3	**Isoparametric Elements and Numerical Integration Techniques** Development of Lagrange and Serendipity shape functions; isoparametric formulation for 2D problems; numerical integration using Gauss quadrature; modeling with isoparametric elements; convergence requirements, patch test, reduced integration, and treatment of nonconforming elements.	**06**
4	**Axisymmetric Solids and Plate Bending using Kirchhoff Theory** Governing equations and finite element formulation for axisymmetric solids; introduction to axisymmetric elements and their applications; mixed formulations; plate bending analysis using Kirchhoff plate theory; continuity conditions and boundary requirements for bending elements.	**06**
5	**Thick Plates, Shells, and Structural Assemblages** Discrete Kirchhoff elements for bending analysis; thick plate formulations and applications; modeling of shell structures as assemblage of flat plates; finite element modeling strategies for complex shell geometries and their structural responses.	**06**
6	**Dynamic Analysis and Elastic Stability in FEM** Formulation of finite element models for dynamic problems; derivation and use of consistent and lumped mass matrices; introduction to structural dynamics; elastic stability concepts in frames and plates; preliminary assessment of buckling behavior in FEM.	**06**

Text books

1. R. D. Cook, *"Concepts and Applications of Finite Element Analysis"*, John Wiley and Sons, 2nd edition, 1981.
2. C. S. Krishnamurti, *"Finite Element Method"*, Tata McGraw-Hill Publication, 1st edition, 2005.
3. T. R. Chandrupatla, *"Finite Elements in Engineering"*, PHI Publication, 1st edition, 2001.

References Books:

1. O. C. Zienkiewicz, R. L. Taylor, and J. Z. Zhu, *"The Finite Element Method: Its Basis and Fundamentals"*, Butterworth-Heinemann, 7th edition, 2013.
2. Klaus-Jürgen Bathe, *"Finite Element Procedures"*, Prentice Hall, 1st edition, 1996.
3. Robert D. Cook, David Malkus, Michael Plesha, and Robert Witt, *"Concepts and Applications of Finite Element Analysis"*, John Wiley and Sons, 4th edition, 2001.

Title of the Course Name: **Integrated Product Development** Course Code: **P25MD202**	**L**	**T**	**P**	**Credits**
	3	1	--	4
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Product Lifecycle Concepts, Project Management

Course Objectives: The course aims to:

1. To introduce a structured approach to new product design and development by aligning customer needs with business objectives.
2. To understand key stages of product development, including concept generation, evaluation, testing, and specification.
3. To explore product architecture, industrial design, and design for manufacturability principles.
4. To learn rapid prototyping, robust design practices, and project/economic management in the product development cycle.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall fundamental concepts of product development, customer need identification, specification setting, product architecture, prototyping, and project planning.
CO2	Interpret and analyze techniques for concept generation, industrial design, DFM, robust design, and economic tools used throughout the product development cycle.
CO3	Apply structured methods to design, test, prototype, and plan product development activities while ensuring usability, cost-effectiveness, and manufacturability.
CO4	Evaluate product development projects for performance, feasibility, economic return, and cross-functional integration using structured and robust design strategies.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Product Development Fundamentals and Customer Needs** Overview of successful product development characteristics, timelines, and cost factors; understanding development challenges; types of development processes and organizational structures; product planning stages; techniques for identifying and prioritizing customer needs.	**06**
2	**Specification Development and Concept Creation** Establishing target and final specifications; methods for systematic concept generation; concept screening and scoring; evaluating concepts through structured testing methodologies.	**06**
3	**Product Architecture and Industrial Design Management** Concept of product architecture and its implications; delayed differentiation, platform planning, and system-level design issues; importance of industrial design, managing the design process, and evaluating design aesthetics, usability, and branding.	**06**
4	**Design for Manufacture and Cost Estimation** Principles of Design for Manufacture (DFM); estimation and breakdown of manufacturing costs; methods for reducing component, assembly, and overhead costs; evaluating DFM decisions for cross-functional impact.	**06**
5	**Prototyping Strategies and Robust Design** Introduction to prototyping; planning, principles, and types of prototyping technologies; robust design concepts and process steps to improve reliability and performance under variation.	**06**
6	**Economic Analysis and Project Execution** Tools and elements of economic analysis in product development; project task breakdown and scheduling; strategies for planning, accelerating, and executing product development projects; postmortem evaluation for continuous improvement.	**06**

Texts Books:

1. Karl T. Ulrich and Steven D. Eppinger, *"Product Design and Development"*, McGraw-Hill, 6th edition, 2015.
2. Edward B. Magrab and Ronald G. Askin, *"Integrated Product and Process Design and Development: The Product Realization Process"*, CRC Press, 2nd edition, 2009.
3. Mohan M. Rao, *"Concurrent Engineering: Automation, Tools, and Techniques"*, Springer, 1st edition, 1996.

References Books:

1. Douglas D. Caldwell, *"Product Development: A Structured Approach to Consumer Product Development"*, CRC Press, 1st edition, 1998.
2. Benjamin S. Blanchard and Wolter J. Fabrycky, *"Systems Engineering and Analysis"*, Pearson, 5th edition, 2010.
3. Lucy C. Morse and Daniel L. Babcock, *"Managing Engineering and Technology"*, Pearson, 6th edition, 2016.

Title of the Course Name: **Design for Manufacturing and Assembly** Course Code: P25MD203	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Engineering Mechanics and Product Design

Course Objectives: The course aims to:

1. To impart knowledge of manufacturing-aware design methodologies that optimize cost, quality, and production feasibility.
2. To develop an understanding of material and process selection for various manufacturing techniques.
3. To equip students with the skills to analyze, modify, and enhance product designs considering manufacturing and assembly constraints.
4. To promote integration of design and manufacturing for rapid, automated, and economical production.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and describe the key concepts of design for manufacturing, casting, welding, material selection, and assembly automation.
CO2	Explain the interrelationships between manufacturing processes, design decisions, material selection, and process ranking for effective product development.
CO3	Apply design for manufacturing and assembly principles to real-world problems, including selection of materials and process optimization across various production techniques.
CO4	Evaluate product designs based on manufacturability, process constraints, automation potential, and economic performance using cross-functional DFM strategies.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**DESIGN FOR MANUFACTURING:** Reduce the cost of manufacturing process, understanding the process and constraints, standard components and process, consider the impact of DFM decisions and other factors.	**06**
2	**DESIGN CONSIDERATION IN METAL CASTING:** Mold and Gating System Design, Directional Solidification, and Troubleshooting.	**06**
3	**DESIGN FOR WELDING:** selection of materials for joining, welding defects, minimize the residual stresses etc. Design for forging and sheet metal and powder metal process.	**06**
4	**SELECTION OF MATERIALS:** choice of materials, organizing material and processes.	**06**
5	**Design Application** Application of Design for manufacture and assembly with selection of materials and ranking of processes like casting, injection moulding, sheet metal working, die casting, powder metal process, investment casting and hot forging,	**06**
6	Design for assembly and automation	**06**

Texts Books:

1. J. M. Coulson, R. K. Sinnott, and J. F. Richardson, *"Chemical Engineering, Volume 6: Design"*, Maxwell Macmillan International Edition, 1st edition, 1993.
2. Sabin Crocker, *"Piping Handbook"*, McGraw-Hill Publication, 5th edition, 1990.
3. G. K. Sahu, *"Handbook of Piping Design"*, New Age International, 1st edition, 1998.

References Books:

1. Mohinder L. Nayyar, *"Piping Handbook"*, McGraw-Hill Education, 7th edition, 2000.
2. Becht Charles, *"Process Piping: The Complete Guide to ASME B31.3"*, ASME Press, 3rd edition, 2012.
3. Kiran D. Patil, *"Piping Design Handbook"*, Gulf Professional Publishing, 1st edition, 2008.

Title of the Course Name: **Tribology in Design** Course Code: **P25MD204A**	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Machine Design, Fluid Mechanics

Course Objectives: The course aims to:

1. To provide a comprehensive understanding of surface interactions, friction, and wear mechanisms in tribological systems.
2. To introduce the principles and regimes of lubrication, including fluid film and advanced lubrication techniques.
3. To study the design, analysis, and performance of fluid film and rolling element bearings.
4. To familiarize students with tribological testing methods and international standards for surface and bearing evaluation.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and describe core concepts of tribology including friction, wear mechanisms, lubrication types, bearing designs, and measurement systems.
CO2	Interpret tribological behavior in fluid film bearings, rolling element systems, and surface-modified materials under mechanical loading and environmental conditions.
CO3	Apply theoretical and empirical models to design and analyze lubrication regimes, bearing life, surface coatings, and failure diagnostics for tribo-systems.
CO4	Evaluate tribological performance using design parameters, failure analysis, instrumentation techniques, and international standards in real engineering applications.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Surfaces, friction and wear:** Topography of Surfaces, Surface features, Surface interaction, Theory of Friction, Sliding and Rolling Friction, Friction properties of metallic and non -metallic materials, Friction in extreme conditions, Wear, types of wear, Mechanism of wear, wear resistance materials, Surface treatment, Surface modifications, Surface coatings.	**06**
2	**Lubrication theory:** Lubricants and their physical properties lubricants standards, Lubrication Regimes in Hydrodynamic lubrication, Reynolds Equation, Thermal, inertia and turbulent effects.	**06**
3	**Other types of lubrication:** Electro-hydrodynamic (EHD), Magneto hydrodynamic lubrication, Hydro static lubrication, Gas lubrication, Solid lubrication.	**06**
4	**Design of fluid film bearings:** Design and performance analysis of thrust and journal bearings, Full, Partial, Fixed and pivoted journal bearings design, Lubricant flow and delivery, Power loss, Heat and temperature of steady and dynamically loaded journal bearings, Special bearings, Hydrostatic Bearing design.	**06**
5	**Rolling element bearings:** Geometry and kinematics, Materials and manufacturing processes, contact stresses, Hertzian stress equation, Load divisions, Stresses and deflection, Axial loads and rotational effects, bearing life capacity and variable loads, ISO standards, Oil films and their effects, Rolling Bearings Failures.	**06**
6	**Tribo measurement and Instrumentation:** Surface Topography measurements, Electron microscope and friction and wear measurements, Laser method, Instrumentation, International standards, Bearings performance measurements, bearing vibration measurement	**06**

Texts Books:

1. Cameron A., "*Basic Lubrication Theory*", Ellis Horwood Ltd., UK, 1981
2. Halling J. (Editor) "*Principles of Tribology* ", Macmillian, 1984.
3. Williams J.A., "*Engineering Tribology*", Oxford Univ. Press, 1994.

References Books:

1. ASM International, *"ASM Handbook Volume 18: Friction, Lubrication, and Wear Technology"*, ASM International, 1st edition, 1992.
2. Michael J. Neale, David Dowson, and Clifford M. Taylor, *"The Tribology Handbook"*, Butterworth-Heinemann, 2nd edition, 2001.
3. R. K. Singal, *"Tribology in Mechanical Design"*, I K International Publishing House, 1st edition, 2010.

Title of the Course Name: **Theory of Elasticity and Plasticity** Course Code: **P25MD204B**	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Stress and Strain Concepts, **Advanced Mathematics**

Course Objectives: The course aims to:

1. To establish a fundamental understanding of stress and strain transformations in 2D and 3D elastic bodies.
2. To develop analytical skills to solve classical elasticity problems using different coordinate systems and geometries.
3. To introduce bending, torsion, and energy methods within the context of 3D elasticity.
4. To provide a foundational understanding of plasticity theory, including yield criteria, flow rules, and elastoplastic behavior.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and define fundamental principles of stress-strain transformation, 2D and 3D elasticity problems, plasticity theory, and energy theorems.
CO2	Solve classical elasticity problems in Cartesian, cylindrical, and spherical coordinate systems.
CO3	Apply elasticity theory, torsion models, plasticity rules, and stress functions to analyze prismatic bars, rods, beams, and structural members under axial, bending, and torsional loads.
CO4	Evaluate the structural behavior and safety of elastic and elastoplastic components using principles of superposition, uniqueness, shear center, limit analysis, and energy theorems.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Introduction**: Stress transformation and Strain transformation at a point in an elastic body, 3D Problems, Rigid body translation and rotation of an element in space. Generalized, Hook law, Separation of Elastic Strains and rigid body displacement for a general displacement field u, v, w. Principal Stress and Strains.	**06**
2	**Two dimensional problems in elasticity:** Plane Stress and Plane Strain Problems. Differential equations of equilibrium and compatibility equations. Boundary Conditions & Stress Functions. Problems in Rectangular coordinates, Polynomial solutions, Cantilever loaded at the end, simply supported load beam under uniformly distributed load, linear loading, Two dimensional problems in polar coordinated, stress distribution symmetrical about an axis, pure bending of curved bar, Displacement for symmetric loaded cases, Bending of curved bar by forces at end. Effect of circular hole in plate under in plane loading. Concentrated load at point of Straight boundary. Stresses in circular disk. Forces acting on end of wedge.	**06**
3	**Three dimensional problems in elasticity:** Differential equation of equilibrium in 3D, Condition of Compatibility, Determination of Displacement, Principal of superposition, Uniqueness theorem, Problems of Rods under axial stress, Bar under its own weight, Pure bending of Prismatic roads, Torsion of Prismatic bars of Elliptical, rectangular, triangular and other sections, Membrane Analogy-Torsion of narrow rectangular bars. Torsion of hollow shaft and thin tubes.	**06**
4	**Bending of prismatic bars as a problem of elasticity in 3D:** Bending of a cantilever, Stress function, Circular and rectangular sections, Non-symmetrical cross section. Shear Centre for different cross sections of bars, Calculation of deflections.	**06**
5	**Energy theorems:** Applications of complimentary energy theorems to the problems of elasticity	**06**
6	**Introduction to Plasticity:** Criteria of yielding, strain hardening, rules of plastic flow, different stress strains relations. Total Strain theory, theorems of limit analysis. Elastoplastic bending and torsion of bars.	**06**

Texts Books:

1. Wang, *"Applied Elasticity"*, McGraw-Hill Book Co., 1st edition,
2. S. P. Timoshenko, *"Theory of Elasticity"*, McGraw-Hill Book Co., 3rd edition, 1970.
3. J. Chakrabarti, *"Theory of Plasticity"*, McGraw-Hill Book Co., 1st edition,

References Books:

1. R. A. C. Slater, *"Engineering Plasticity: Theory and Applications to Metal Forming"*, Macmillan Press, 1st edition, 1977.
2. C. R. Calladine, *"Plasticity for Engineers: Theory and Applications"*, Horwood Publishing, 1st edition, 2000.
3. S. P. Timoshenko and J. N. Goodier, *"Theory of Elasticity"*, McGraw-Hill Book Co., 3rd edition, 1970.

Title of the Course Name: **Engineering computing**	**L**	**T**	**P**	**Credits**
Course Code: **P25MD204C**	3	--	--	3
	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Basic understanding of Calculus**,** Linear Algebra and Differential Equations

Course Objectives: The course aims to:

1. To develop proficiency in numerical techniques for data analysis, curve fitting, and interpolation.
2. To equip students with efficient numerical methods for solving linear systems and differential equations.
3. To introduce numerical approaches for boundary value and eigenvalue problems.
4. To develop skills in mathematical modeling of engineering systems using differential equations.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and describe fundamental numerical methods for interpolation, curve fitting, solving equations, ODEs, PDEs, and mathematical modeling.
CO2	Interpret and formulate numerical algorithms for solving algebraic systems, differential equations, eigenvalue problems, and model-based computations.
CO3	Apply numerical methods such as finite difference, spline interpolation, Runge-Kutta, and matrix-based approaches to solve engineering problems computationally.
CO4	Evaluate numerical solutions in terms of convergence, accuracy, efficiency, and applicability to engineering modeling using differential equations and iterative methods.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Data Analysis and Curve Fitting:** Errors in numerical calculations, Interpolation by central differences, sterling Bessel & Everett Formulae, Interpolation Formula for unequal Intervals, Spline Interpolation, Cubic Splines. Least square method for linear & non-linear functions, weighted least square methods.	**06**

2	**Solution of Linear System of Equations:** Gauss Elimination with Pivoting, LU Decomposition method, Iterative methods, Eigen vectors-Jacobi method, Jacob's method, Gauss Siedel method.	**06**
3	**Solution of Ordinary Differential Equation, Numerical Differentiation & Integration:** Differentiation by Finite Differences, Numerical Integration by Newton-Cotes formula & Gauss Quadrature. Picard's Method, Euler's & Modified Euler's Method, Runge-KuttaMethod (up to fourth order), Predictor-Corrector Methods, Milne Sompson, Adams Bashforth Moulten Methods.	**06**
4	**Boundary value and Eigen value problems:** Shooting method, finite difference method to solve boundary value problems, Polynomial method, power method to solve Eigen value problems.	**06**
5	**Solution of Partial differential equations:** Finite difference method, solution of Laplace & Parabolic equations.	**06**
6	**Mathematical Modeling:** Mathematical Modeling of Physical Problems, modeling Concept, Modeling of Linear Differential Equations of Second order.	**06**

Texts Books:

1. Dr. B. S. Grewal, *"Numerical Methods for Science & Engineering"*, Khanna Publications, 1st edition, Year not specified.
2. M. K. Jain, *"Numerical Methods for Scientific & Engineering Computation"*, New Age International Publication, 1st edition, Year not specified.
3. E. Balagurusamy, *"Numerical Methods"*, Tata McGraw Hill Publications, 1st edition,

References books:

1. Steven C. Chapra and Raymond P. Canale, *"Numerical Methods for Engineers"*, McGraw Hill Education, 7th edition, 2015.
2. David M. Smith, *"Engineering Computation with MATLAB"*, Pearson Education, 1st edition,
3. Steven C. Chapra, *"Applied Numerical Methods with MATLAB for Engineers and Scientists"*, McGraw Hill Education, 4th edition, 2017.

Title of the Course Name: Environment and Development	**L**	**T**	**P**	**Credits**
	3	--	--	3
Course Code: P25MD205A	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Basic knowledge of environmental science and sustainable practices

Course Objectives:

1. To understand the interrelationship between environment and development.
2. To assess the impact of development activities on ecosystems, biodiversity, and natural resources.
3. To analyze sustainable development concepts, environmental ethics, and green technologies.
4. To explore national and international environmental policies and enhance awareness on climate change and mitigation strategies.

Course Outcomes:

CO1	Recall and summarize the core concepts of environmental science, sustainable development, climate change, resource degradation, and ecological ethics.
CO2	Interpret the interrelationships between environment, development, governance policies, and technological strategies for sustainability.
CO3	Apply the principles of sustainable development, green technologies, and environmental ethics.
CO4	Evaluate contemporary environmental issues and global case studies to assess the effectiveness of policies, renewable technologies, and sustainable practices.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Introduction to Environment and Development** Definition and Scope, Need for Sustainable Development, Historical Background, Environmental Movements.	**6**
2	**Natural Resources and Environmental Degradation** Types of Natural Resources, Resource Depletion, Land Degradation, Pollution and Biodiversity Loss.	**6**
3	**Sustainable Development and Environmental Ethics** Principles of Sustainability, Environmental Ethics, Ecological Footprint, Green and Clean Technologies.	**6**
4	**Climate Change and Global Concerns** Climate Change Causes and Impacts, Global Warming, Carbon Cycle, Adaptation and Mitigation Strategies.	**6**
5	**Policy and Governance** Environmental Policies, Acts and Protocols (India & Global), Role of Government and NGOs, Environmental Impact Assessment (EIA).	**6**
6	**Contemporary Issues and Case Studies** Urbanization and Environment, Renewable Energy, Case Studies on Sustainable Practices in India and Abroad.	**6**

Text Books:

1. R. Rajagopalan, *"Environmental Studies: From Crisis to Cure"*, Oxford University Press, 3rd edition, 2016.
2. Erach Bharucha, *"Textbook of Environmental Studies"*, UGC Publication, 1st edition, 2005.
3. P. D. Sharma, *"Ecology and Environment"*, Rastogi Publications, 11th edition, 2021.

Reference Books:

1. W. P. Cunningham and M. A. Cunningham, *"Principles of Environmental Science"*, Tata McGraw-Hill, 7th edition, 2014.
2. D. B. Botkin and E. A. Keller, *"Environmental Science: Earth as a Living Planet"*, Wiley India, 8th edition, 2011.
3. J. D. Sachs, *"The Age of Sustainable Development"*, Columbia University Press, 1st edition, 2015.

Course Name: **Engineering Economics**	**L**	**T**	**P**	**Credits**
	3	--	--	3
Course Code: P25MD205B	ISE	MSE	ESE	Total
	20	**30**	**50**	**100**

Pre-Requisite: Management Information Systems (MIS)

Course Objectives: The course aims,	
1	To understand fundamental economic concepts and cost analysis in engineering.
2	To apply interest formulas and cash flow techniques to evaluate alternatives.
3	To analyse depreciation and asset replacement decisions.
4	To evaluate public vs private projects with cost-benefit considerations.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall and define key concepts in engineering economics such as cost elements, interest factors, cash flow models, depreciation techniques, and project financing.
CO2	Interpret and compare economic decision-making tools including present worth, future worth, annual equivalent, and rate of return across engineering applications.
CO3	Apply economic analysis techniques to evaluate material selection, make-or-buy decisions, equipment replacement, depreciation schedules, and project investments.
CO4	Evaluate engineering alternatives and public-private project outcomes using life-cycle costing, value engineering principles, and inflation-adjusted economic assessments.

Course Contents

Unit No.	Contents	Hours
1	**Introduction Engineering Economy:** Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering – Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis, P – V ratio, Elementary economic Analysis– Material selection for product, Design selection for a product, Process planning.	6
2	**Value Engineering:** Make or buy decision, Value engineering – Function, aims, Value engineering procedure.Interest formulae and their applications– Time value of money, Single payment compoundamount factor, Single payment present worth factor, Equal payment series sinking fundfactor,EqualpaymentseriespaymentPresentworthfactor– equalpaymentseriescapitalrecovery factor – Uniform gradient series annual equivalent factor, Effective interest rate,Examples in all the methods.	6
3	**Cash Flow:** Methods of comparison of alternatives – Present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, Cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, Cost dominated cash flow diagram), rate of return method, Examples in all methods.	6
4	**Replacement And Maintenance Analysis:** Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset– capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.	6
5	**Depreciation:** Depreciation – Introduction, Straight line method of depreciation, – Declining balance method of depreciation – Sum of the years digits method of depreciation, – Sinking fund method of depreciation/Annuity method of depreciation, service output method of depreciation – Evaluation of public alternatives – Introduction – Examples – Inflation adjusted decisions – Procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.	6
6	**Financing & Public vs Private Projects:** Financing sources, economic evaluation in public projects, social costs, and regulatory factors.	6

Text Books:

1. Panneer Selvam, R, "*Engineering Economics*", Prentice Hall of India Ltd, New Delhi,2001.
2. Suma Damodaran, " *Managerial economics*", Oxford university press2006
3. A Text book of Economic Theory: by stonier and hauge, pearson Publication.

Reference Books:

1. Sampat Mukherjee, *"Modern Economic Theory"*, New Age International Publisher, 1st edition.
2. DeGarmo, *"Engineering Economics"*, Prentice Hall, 1st edition.
3. Bo Sodersten, *"International Economics"*, Macmillan, 1st edition

Course Name: **Project Management**	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
Course Code: **P25MD205C**	**20**	**30**	**50**	**100**

Pre-Requisite: Knowledge of simple geometrical theories and their constructional procedure.

Course Objectives: The course aims,	
1	To impart basic concepts Project Management.
2	To impart and inculcate proper understanding of the Project Management.
3	To improve the visualization skill of Project Management.
4	To impart knowledge about standard principles of Project Management.

Course Outcomes: Students will be able to

CO1	Recall and summarize project management fundamentals, work breakdown structures, scheduling tools, resource allocation, and control strategies.
CO2	Interpret and explain the stages of project management, scheduling techniques, cost estimation, and contract and procurement processes.
CO3	Apply project planning, scheduling, resource optimization, and project execution techniques using tools like Gantt charts, CPM/PERT, and cost-time trade-offs.
CO4	Evaluate project success through monitoring, post-project evaluation, financial control, and risk analysis to improve future project outcomes.

Course Contents

Unit No.	Contents	Hours
1	**Introduction to Project management:** Definition and objectives of Project Management, Characteristics of projects, Stages of Project Management, Project Planning Process, Establishing Project organization. Work definition: Defining work content, Time Estimation Method, Project Cost Estimation and budgeting, Project Risk Management, Project scheduling and Planning Tools: Work Breakdown structure, LRC, Gantt charts, CPM/PERT Networks.	6
2	**Project Planning and Resource Optimization:** Developing Project Plan (Baseline), Project cash flow analysis, Project scheduling with resource constraints: Resource Leveling and Resource Allocation. Time Cost Trade off: Crashing Heuristic.	6
3	**Project Execution and Control Strategies:** Project Implementation: Project Monitoring and Control with PERT/Cost, Computers applications in Project Management, Contract Management, Project Procurement Management. Post-Project Analysis.	6
4	**Project Scheduling & Control:** Developing Project Plan (Baseline), Project cash flow analysis, Project scheduling with 28 resource constraints: Resource Leveling and Resource Allocation. Time Cost Trade off: Crashing Heuristic.	6
5	**Project Execution, Monitoring & Evaluation:** Project Implementation: Project Monitoring and Control with PERT/Cost, Computers applications in Project Management, Contract Management, Project Procurement Management. Post-Project Analysis.	6

Reference Books:

1. Shtub, A., Bard, J. F., & Globerson, S., *"Project Management: Engineering, Technology and Implementation"*, Prentice Hall India, 1st edition,
2. Lock, D., *"Project Management Handbook"*, Gower Publishing, 1st edition

Title of the Course Name: **Healthcare Engineering**	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
Course Code:**P25MD205D**	**20**	**30**	**50**	**100**

Pre-Requisite: Basics of Management, Market Research Fundamentals, Financial Accounting Basics.

Course Objectives: The course aims:

1. To understand how the healthcare system works and what challenges it faces.
2. To learn how to improve hospital services using planning and optimization methods.
3. To study how patient waiting lines and hospital processes can be modeled and improved.
4. To explore new technologies like AI, remote care, and digital tools in future healthcare.

Course Outcomes: Students will be able to	
CO1	Recall fundamental components of healthcare systems, including resource planning, queuing models, data flows, and innovations in digital health.
CO2	Interpret and formulate mathematical models for workforce optimization, facility layout, patient queuing, and healthcare delivery systems
CO3	Apply optimization, queuing theory, and simulation methods to enhance healthcare system efficiency, throughput, and patient experience.
CO4	Evaluate emerging healthcare technologies and simulation outcomes to improve clinical operations, policy design, and access to quality care.

Unit No.	**Unit title and Content**	**Hours**
1	**Introduction to Healthcare System** **Introduction:** Facets of a Healthcare System, Size of a Healthcare System, Health Insurance and Financing, Healthcare Services, Healthcare Ecosystem, Healthcare System Challenges, Access to Healthcare, Healthcare Systems Engineering,	**06**

	Understanding Delivery: Data and Processes: Types of Healthcare Data, National Datasets, Healthcare Delivery Process Data, Process Throughput	
2	**Healthcare Resource Workforce and Access to Care Optimization** **Workforce:** Optimization, Supply-Demand Matching, Assignment Models, Optimization : Facility Optimization, Developing Facility Layout to Minimize Travel Wastage, Considering Multiple Conflicting Objectives, Optimization using a Modeling Language	**06**
3	**Modeling Patient Queues** Kendall's Notation for Queuing Systems, Little's Law, Markovian Queuing Models: M/M/1, M/G/1 Queuing Model, Modeling Interconnected Services using Queuing Networks,	**06**
4	**Healthcare System Simulation** Building a Simulation Study Framework, Event Calendars in Discrete Event Simulation, Input Modeling in Simulation, Output Analysis in Simulation, Estimation in a Non-Terminating, Non-Stationary System: Emergency Department, Simulation of a Hospital Queuing Network	**06**
5	**Future of Healthcare** Shifting from Volume to Value, Evidence-Based Medicine, Personalized Medicine, Vision of the Future, Connected Medicine, Disease and Condition Management: Virtual Assistants, Remote Monitoring, Medication Adherence, Accessible Diagnostic Tests, Smart Implantable, Digital Health and Therapeutics, AI, Conversational AI, Making and rationalizing decisions: Drug discovery, 3-D printing, Personalized prosthetics, Bioprinting and tissue engineering, Pharmacology and devices, Education, Gene therapy, Virtual and Augmented Reality, Merged Reality, Pain Management, Physical Therapy, Nursing and Delivery of Medicine, Virtual Appointments and Classrooms, Blockchain, Patient Record Access., Applications of AI in Healthcare	**06**

Reference Books:

1. Sanjay Mehrotra, Kevin Bui, and Hari Balasubramanian, *"Healthcare Engineering"*, Springer, 1st edition, 2022.
2. Arjun Panesar, *"Machine Learning and AI for Healthcare"*, Apress, 1st edition, 2019.

Course Name: **Technologies for Industrial Evolution** **Course Code:** P25MD206	**L**	**T**	**P**	**Credits**
	2	--	--	2
	ISE	MSE	ESE	Total
	20	**--**	**--**	**50**

Pre-Requisite: Knowledge of Automation, IoT and Industrial Engineering

Course Objectives: The course aims:

1. To understand the key technologies & impact of technological evolution on modern industries.
2. To provide insight into the integration of AI, Big Data, and Cloud Computing in industrial operations.
3. To familiarize students with digital twin, predictive maintenance, and robotic process automation.
4. To enable students to analyze current trends and future directions in industrial digitization.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Recall the evolution, core technologies, digital tools, automation systems, predictive analytics, and future trends shaping Industry 4.0.
CO2	Interpret the role and integration of smart technologies such as IIoT, AI, cloud computing, and robotics in modern manufacturing ecosystems.
CO3	Apply digital transformation methods and smart manufacturing tools to solve real-world challenges in automation, condition monitoring, and fault diagnostics.
CO4	Evaluate the impact of Industry 4.0 initiatives using sustainability frameworks, case study insights, and advanced tools like digital twins and 5G networks.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Introduction to Industrial Evolution** Historical Industrial Revolutions, Key Drivers of Industry 4.0, Comparison of Industry 3.0 and 4.0, Global Trends and Indian Scenario.	**6**
2	**Core Technologies in Industry 4.0** IIoT, Smart Sensors, Embedded Systems, Cyber Physical Systems (CPS), Edge and Fog Computing.	**6**
3	**Digital Transformation Tools** Cloud Computing, Big Data Analytics, AI & Machine Learning for Industry, Blockchain in Supply Chain.	**6**
4	**Automation and Smart Manufacturing** Additive Manufacturing, Smart Factories, Industrial Robotics, Human-Machine Collaboration.	**6**
5	**Predictive Maintenance and Digital Twin** Condition Monitoring, Real-time Data Acquisition, Digital Twin Modeling, Fault Diagnosis.	**6**
6	**Future Trends and Case Studies** Green Manufacturing, Sustainable Technologies, 5G for Industry, Case Studies on Digital Transformation.	**6**

Text Books:

1. Alasdair Gilchrist, *"Industry 4.0: The Industrial Internet of Things"*, Apress, 1st edition, 2016.
2. Sabina Jeschke et al., *"Industrial Internet of Things: Cyber Manufacturing Systems"*, Springer, 1st edition, 2017
3. Brettel M., *"How Virtualization, Decentralization and Network Building Change the Manufacturing Landscape: An Industry 4.0 Perspective"*, Springer, 1st edition, 2014.

Reference Books:

1. Klaus Schwab, *"The Fourth Industrial Revolution"*, World Economic Forum, 1st edition, 2016.
2. Jay Lee, *"Smart Manufacturing"*, Springer, 1st edition, 2021.
3. Andrew Ng, *"Machine Learning Yearning"*, DeepLearning.ai, 1st edition, 2018.

Title of the Course Name: **Mini Project** Course Code: **P25MD207**	**L**	**T**	**P**	**Credits**
	--	--	2	1
	ISE	MSE	ESE	Total
	50	**--**	**50**	**50**

Pre-Requisite: Previously studied courses

Course Objectives: The course aims to:

1. To train students in identifying, analyzing, and solving real-world engineering or managerial problems.
2. To encourage students to take initiative in selecting research-oriented or industrially relevant topics.
3. To provide exposure to live problems through industrial visits, case studies, or field-based research.
4. To develop independent thinking, technical report writing, and effective presentation skills and group-based mini projects .

Course Outcomes: At the end of the course, students will be able to:

CO1	Identify and define an engineering or industrial problem of practical relevance or research interest.
CO2	Analyze the problem systematically and apply domain knowledge to propose viable solutions.
CO3	Document the project findings clearly in a structured report and defend the work through oral presentation.
CO4	Demonstrate initiative, self-learning, and professional responsibility in executing project tasks individually or collaboratively.

Sr.No.	Guidelines
1	**Activities involved:** 1. Mini project should be undertaken individually. 2. Topic should be relevant to mechanical design engineering with focus on problem solving, innovation, or application 3. A detailed proposal should be submitted with problem statement, objectives, methodology, and timeline 4. Regular progress reviews should be conducted (at least two internal

	reviews) 5. Emphasis should be placed on originality, practical relevance, and feasibility 6. Maintain a project logbook detailing weekly progress, issues faced, and resolutions 7. Final submission must include a well-structured report, simulation/implementation files, and presentation 8. Viva-voce will be conducted to assess individual contribution and understanding
2	Format for Report (Spiral Bound & Soft Copy) 1. Cover Page 2. Certificate (Guide + Head of Department) 3. Declaration 4. Acknowledgement 5. Abstract 6. Table of Contents 7. List of Figures/Tables (if applicable) 8. Chapters: o Introduction o Literature Review o Problem Statement o Objectives o System Design and Methodologies o Implementation and Testing o Results and Discussions o Conclusion and Future Work 9. References (IEEE format) 10. Appendix (if applicable)
3	Deliverables • **Mini Project Proposal** (hard copy & soft copy – before implementation begins) • **Weekly Progress Logbook** signed by the guide • **Final Project Report** in hard copy and PDF (as per the given format) • **Working Model/Simulation Output** (if applicable) • **Presentation Slides (PPT)** • **Final Viva & Demonstration** before PRC • **Source Code/Design Files** on CD/pen drive or shared via link

Title of the Course Name: **PG Lab-II**	**L**	**T**	**P**	**Credits**
Course Code: **P25MD208**	--	--	4	2
	ISE	MSE	ESE	Total
	50	**--**	**50**	**50**

Pre-Requisite: Previously studied courses

Course Objectives: The course aims to:

1. To develop hands-on proficiency in using CATIA for 2D sketching, 3D part modeling, and surface design.
2. To train students in assembling mechanical components using appropriate constraints in CATIA.
3. To introduce surface modeling techniques and advanced solid modeling features like Boolean operations and sweeps.
4. To simulate motion and analyze the kinematics of mechanical assemblies using CATIA DMU Kinematics

Course Outcomes: At the end of the course, students will be able to:

CO1	Create fully constrained 2D sketches and generate 3D part models using CATIA Part Design tools.
CO2	Perform surface modeling using B-Spline curves and advanced surface features in the Generative Shape Design workbench.
CO3	Assemble multiple components and apply suitable mechanical constraints using CATIA Assembly Design.
CO4	Simulate kinematic motion of mechanical linkages and mechanisms using CATIA DMU Kinematics.

Lab Contents:

1. Creating 2D Profiles and Applying Geometric Constraints in CATIA Sketcher
2. 3D Part Modeling using Pad, Pocket, Shaft, and Groove Features in CATIA Part Design
3. Surface Modeling of a B-Spline Curve-Based Component in CATIA Generative Shape Design.
4. Assembly Modeling and Constraint Application in CATIA Assembly Design Workbench
5. Simulation of a Mechanism using CATIA

Title of the Course Name: **Internship/Field Training**#	**L**	**T**	**P**	**Credits**
	--	--	4	2
Course Code: **P25MD209**	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Previously studied courses

Course Objectives: The course aims to:

1. To expose students to real-time industry operations, tools, and technologies relevant to their domain of study.
2. To develop an understanding of organizational structure, workflows, safety standards, and professional ethics in the workplace.
3. To apply theoretical knowledge acquired during the first year to practical industrial challenges and problem-solving.
4. To encourage self-learning, teamwork, communication, and project documentation skills through active industry engagement.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall the functional processes, safety norms, and professional expectations observed in a domain-specific industrial setting.
CO2	Understand and explain the industrial practices, technology integration, organizational hierarchy, and role-specific responsibilities.
CO3	Apply engineering concepts and problem-solving techniques to complete assigned tasks or mini-projects during the internship.
CO4	Evaluate professional practices, identify gaps between theory and application, and prepare structured reports demonstrating industrial learning.

Title of the Course Name: Internship/Training	L	T	P	Credits
	--	--	2	2
Course Code:P25MD209	ISE	MSE	ESE	Total
	50	**--**	**--**	**50**

Pre-Requisite:

- Completion of core PG coursework in Mechanical Design Engineering
- Basic technical skills
- Awareness of industrial tools, platforms, or technologies relevant to the chosen domain
- Readiness for professional work ethics and environment
- Resume and basic documentation (cover letter, academic transcripts)

Course Objectives: The course aims:

1. To bridge the gap between academic learning and industrial practices through exposure to real-world engineering environments.
2. To develop domain-specific technical competencies and hands-on skills via industrial participation.
3. To enhance students' understanding of project workflows, tools, standards, and collaborative teamwork in professional settings.
4. To strengthen interpersonal communication, reporting skills, and awareness of innovation and regulatory practices in industry.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Identify industry-relevant problems and apply classroom knowledge to practical situations.
CO2	Demonstrate technical proficiency and professional behavior through active participation in industrial tasks.
CO3	Analyze industrial systems, workflows, and project execution practices effectively.
CO4	Compile and present a structured internship report with observations, learning's, and contributions.

Sr. No.	Guidelines
1	Activities Involved 1. Identifying and applying to companies or R&D organizations 2. Completion of internship spanning 4 weeks 3. Hands-on work under assigned industry mentors 4. Weekly task updates and feedback sessions 5. Final presentation and submission of training report
2	**Requirements** • Internship should be in a core or allied domain: • Prior approval must be taken from the Internship/Training Coordinator • Maintain a **daily logbook** recording work done, observations, and reflections • Internship certificate must be obtained from the industry at the end of the training • Students are required to submit: a) Internship Completion Certificate b) Internship Report (format below) c) Logbook or Weekly Activity Sheet d) Presentation and Viva before Evaluation Panel.
3	Internship Report Format (Hardbound Copy) 1. **Cover Page** (Institute, Title, Student Name, Industry Name, Duration) 2. **Certificate from Institute** 3. **Certificate from Company** 4. **Acknowledgment** 5. **Table of Contents** 6. **Chapter 1: Introduction** – Overview of the organization and objectives 7. **Chapter 2: Training Activities** – Tasks performed, tools used, departments visited 8. **Chapter 3: Technical Learning** – Concepts, skills, technologies learned 9. **Chapter 4: Analysis and Outcomes** – Contributions made, learnings, challenges 10. **Chapter 5: Conclusion** – Summary and future scope 11. **References** (if applicable) 12. **Appendices** – Screenshots, tools used, code samples (if allowed)

PG Program: Mechanical Design Engineering
Semester: III

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
OE	P25MD301	Open Elective-II[$]	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
MDM	P25MD302	Multi-Disciplinary Minor[$]	3	-	-	3	ISE-I	10		40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
ELC	P25MD303	Dissertation Phase-I*	-	-	20	10	ISE-I	25		40
							ISE-II	25		
							ESE (POE)	50	20	
ELC	P25MD209	Internship/Field Training[#]	-	-	-	2	ISE	50	20	
Total			**6**	**-**	**20**	**18**	**350**			
Total Contact Hours- 26 Total Credits- 18										

$ It is mandatory to opt these courses certification from SWAYAM/NPTEL, MOOC platform.
* It is required to complete 30% work of Dissertation.
# It is required to do Four weeks domain specific industrial internship after completing first year of the program evaluated in Semester-III

Title of the Course Name: Labour Welfare and Industrial Relations **Course Code:**P25CM301A/ P25CS301A/ P25ET301A/ P25MD301A / P25MP301A	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Fundamentals of Human Resource Management, Basics of Organizational Behaviour, Indian Labour Laws (basic awareness preferred)

Course Objectives: The course aims:

1. Provide an in-depth understanding of labour welfare concepts and principles.
2. Study the evolution and framework of industrial relations in India.
3. Analyze the role of trade unions, collective bargaining, and dispute resolution mechanisms.
4. Evaluate labour policies, legislation, and welfare measures with real-world applications.

Course Outcomes: At the end of the course, students will be able to:

CO	**Course Outcomes**
CO1	Define and explain the concepts of labour welfare and industrial relations.
CO2	Analyze the role of trade unions, employee participation, and dispute resolution mechanisms.
CO3	Examine labour laws and welfare measures applicable in industrial settings.
CO4	Evaluate the effectiveness of industrial relations strategies in promoting harmony and productivity.

Course Content		
Unit No.	**Contents**	**Hrs**
1	**Introduction to Labour Welfare:** Concept of labour welfare and its importance, Principles and types of labour welfare, Role of the government and employers in labour welfare, Statutory and non-statutory welfare measures	**6**

2	**Industrial Relations Framework:** Evolution and scope of industrial relations, Objectives and importance of industrial relations, Approaches to industrial relations, Role of stakeholders (government, employers, employees)	**6**
3	**Trade Unions in India:** Trade unions: concept, structure, and functions, Growth of trade union movement in India, Trade union legislation, Role of trade unions in industrial relations, Challenges faced by trade unions	**6**
4	**Collective Bargaining and Employee Participation:** Concept and process of collective bargaining, Types and importance of collective bargaining, Workers' participation in management, Joint management councils, Works committees	**6**
5	**Industrial Disputes and Resolution Mechanisms:** Causes and effects of industrial disputes, Methods of dispute resolution (conciliation, arbitration, adjudication), Role of grievance redressal systems, Disciplinary procedures	**6**
6	**Labour Legislation and Contemporary Issues:** Overview of key labour laws (Factories Act, Trade Unions Act, Industrial Disputes Act), Recent changes in Indian labour codes, Case studies on labour welfare and industrial relations, Emerging trends and challenges	**6**

Text Books:

1. **Sinha, P.R.N., Sinha, I.B., and Shekhar, S.P.** – *Industrial Relations, Trade Unions, and Labour Legislation*, Pearson Education
2. **Mamoria, C.B. and Mamoria, S.** – *Dynamics of Industrial Relations*, Himalaya Publishing House

Reference Books:

1. **Monappa A., Nambudiri R. &Selvaraj, P.** – *Industrial Relations and Labour Laws*, 2nd Edition ,McGraw Hill
2. **Srivastava, S.C.** – *Industrial Relations and Labour Laws*, Vikas Publishing
3. **Indian Labour Codes & Government Publications** – Ministry of Labour and Employment

MOOC/NPTEL Platform:

1. **NPTEL: https://onlinecourses.nptel.ac.in/noc25_mg159/preview**

Title of the Course Name: Sustainable Technology	**L**	**T**	**P**	**Credits**
Course Code:P25CM301B/ P25CS301B/ P25ET301B/ P25MD301B/ P25MP301B	3	--	--	3
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Basic knowledge of science, environment, and technological applications, Awareness of current environmental challenges and sustainability needs

Course Objectives: The course aims:

1. To introduce the concepts and principles of sustainable development and technology.
2. To evaluate the impact of current technologies on environmental, social, and economic systems.
3. To explore clean and green technologies that promote sustainability.
4. To enable students to design or adopt sustainable solutions for real-world applications.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Explain the core principles of sustainability and sustainable development
CO2	Analyze various sustainable technologies in energy, water, and waste sectors
CO3	Evaluate lifecycle and environmental impact of a given technology
CO4	Propose sustainable technology solutions for specific local/global issues

Course Content		
Unit No.	**Contents**	**Hrs**
1	**Introduction to Sustainable Development and Technology:** Sustainability principles, triple bottom line, SDGs, environmental degradation, ecological footprint, carbon emissions, circular economy	**6**
2	**Sustainable Energy Technologies:** **Renewable energy sources, solar PV, wind, hydropower, biomass, green hydrogen, energy efficiency, smart grids**	**6**
3	**Sustainable Water and Sanitation Technologies:** Rainwater harvesting, water purification technologies, wastewater treatment, greywater recycling, low-flow devices, SDG 6 focus	**6**
4	**Sustainable Waste Management:** **Waste hierarchy (Reduce-Reuse-Recycle), e-waste, composting, biodegradable packaging, plastic alternatives, waste-to-energy**	**6**
5	**Green Building and Smart Infrastructure:** Energy-efficient building materials, passive solar design, green rating systems (LEED, GRIHA), smart cities, sustainable transportation	**6**
6	**Life Cycle Assessment and Sustainable Innovation:** LCA tools and methods, carbon footprint tools, eco-design, green product innovation, sustainable entrepreneurship, case studies	**6**

Text Books:

1. Sustainable Engineering: Concepts, Design and Case Studies – D. Allen, D. Shonnard
2. Sustainability Principles and Practice – Margaret Robertson

Reference Books:

1. Green Technologies and Environmental Sustainability – R. Raveendran
2. Reports from UNEP, NITI Aayog, MoEFCC

MOOC/NPTEL Platform:

1. **NPTEL:** Sustainable Engineering Concepts and Life Cycle by ByProf.Brajesh Kumar Dubey, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc25_ce117/preview

Title of the Course Name: Entrepreneurship Development **Course Code:**P25CM303C/ P25CS301C/ P25ET301C/ P25MD301C/ P25MP301C	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Basics of Management, Market Research Fundamentals, Financial Accounting Basics.

Course Objectives: The course aims:

1. To introduce the fundamental concepts and evolution of entrepreneurship, including the role of creativity and innovation.
2. To enable students to recognize business opportunities and develop viable business models using structured techniques.
3. To equip students with knowledge of business planning, financial feasibility, legal structures, and institutional support for startups.
4. To explore funding strategies, growth management, and emerging trends in entrepreneurship and intrapreneurship.

Course Outcomes: At the end of the course, students will be able:

CO	Course Outcomes
CO1	Explain the concepts, types, and evolution of entrepreneurship along with the importance of innovation.
CO2	Apply opportunity recognition and business modeling techniques like BMC and lean startup.
CO3	Analyze the feasibility of a business idea considering financial, legal, and institutional frameworks.
CO4	Evaluate different funding options and growth strategies, including emerging trends in entrepreneurship.

Course Content		
Unit No.	**Contents**	**Hrs**
1	**Fundamentals of Entrepreneurship** Definition, types and evolution of entrepreneurship, Entrepreneur vs intrapreneur, Importance of creativity and innovation in venture creation.	**6**
2	**Opportunity Recognition & Business Models** Idea generation techniques - brainstorming, TRIZ, SCAMPER, Market research and feasibility analysis, Business Model Canvas and lean startup methodology.	**6**
3	**Business Planning and Project Feasibility** Components of a business plan, Cost–benefit analysis - NPV, IRR, ROI, Financial planning, budgeting, cost structures.	**6**
4	**Legal & Institutional Framework** Business entity types - sole proprietorship, LLP, Pvt. Ltd, Registration processes, IPR fundamentals - patents, trademarks, Schemes and support - Start-up India, SIDBI, NABARD.	**6**
5	**Financing and Growth Management** Funding sources - bootstrapping, angel investors, VC, loans, Scaling strategies, growth stages, risk management, Role of incubation, accelerators, and mentorship.	**6**
6	**Emerging Entrepreneurship Trends** Social, rural, digital entrepreneurship, Corporate intrapreneurship dynamics, Technology-driven ventures and ecosystem trends.	**6**

Text Books:

1. Engineering Entrepreneurship: From Idea to Business Plan – Paul Swamidass, Cambridge University Press, 2015.
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, Crown Business, 2011.
3. Entrepreneurship Development, S. Anil Kumar, Scientific Publishers, 2019.

Reference Books:

1. Disciplined Entrepreneurship: 24 Steps to a Successful Startup, Bill Aulet, Wiley, 2013.
2. Opportunity Recognition in Entrepreneurial Teams, Maureen McKelvey, Per Davidsson, Leif Wennberg, Springer, 2021.
3. Effectuation: Elements of Entrepreneurial Expertise, Saras D. Sarasvathy, Edward Elgar, 2008, 2nd ed. 2021.

Title of the Course Name: Industrial Automation **Course Code:**P25CM301D/ P25CS301D/ P25ET301D/ P25MD301D/ P25MP301D	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Electrical Networks and Control, Digital Electronics Basics.

Course Objectives: The course aims:

1. To familiarize students with the hierarchical structure of industrial automation systems and various sensing technologies used in the industry.
2. To impart knowledge of process control systems and tuning techniques including PID controllers and advanced control methods.
3. To train students in PLC programming, sequential control, and industrial networking protocols for automation.
4. To introduce advanced automation technologies including IIoT, CNC, robotics, and cyber-secure smart manufacturing systems.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Explain the structure of industrial automation systems and describe the working principles of common industrial sensors and actuators.
CO2	Apply PID tuning techniques to control processes using feedback loops, cascade control, and feed-forward methods.
CO3	Develop ladder and structured text programs for automation using PLCs and integrate industrial communication protocols (e.g., Modbus, Profibus).
CO4	Analyze and evaluate the integration of advanced automation systems like SCADA, IIoT, and robotics for Industry 4.0 implementations.

Course Content		
Unit No.	**Contents**	**Hrs**
1	**Architecture and Sensing in Industrial Automation** Overview of Automation Systems - Architecture, CPS, levels of automation, discrete vs process systems, Industrial Sensors and Signal Conditioning - Temperature, pressure, displacement, flow, force sensors; calibration, error analysis and conditioning circuits.	**6**
2	**Process Control and PID Techniques** Fundamentals of Control Systems - Feedback loops, stability, controller types, PID Controllers - P/PI/PID tuning methods Ziegler–Nichols, feed-forward, cascade, predictive control.	**6**
3	**Sequence Control and PLC Programming** Components of a business plan, PLC Basics - Hardware architecture, scan cycle, I/O interfacing, Programming in Ladder and Structured Control - Relay logic, timers, counter blocks, structured design.	**6**
4	**Fieldbus Protocols, SCADA and DCS** Industrial Communication Networks -Modbus, Profibus, HART, Fieldbus, Ethernet/IP,SCADA/DCS Architecture and HMI - Data acquisition, historian logs, alarms, cybersecurity, OPC UA.	**6**
5	**Actuators and Drive Systems** Actuator Technologies - Hydraulic, pneumatic valves, electric drives, stepper and servo motors, Drive Systems and VFDs - Variable frequency drives, speed control, energy-efficient operation.	**6**
6	**Advanced Automation and Industry 4.0 Integration** CNC & Robotics Basics - Machine tool control loops, robotic manipulators, grippers, kinematics, IIoT, Analytics and Cybersecurity - Edge computing, data analytics, smart manufacturing and automation system security.	**6**

Text Books:

1. Industrial Automation: Hands-On, Frank Lamb, McGraw-Hill, 1st ed., 2013
2. Industrial Automation Solutions for PLC, SCADA, Drive and Field Instruments – Sanjay B. Katariya, Notion Press, 2020..

Reference Books:

1. Standard Handbook of Industrial Automation – Douglas M. Considine & Glenn D. Considine, Springer, 1st ed., 1987.
2. Instrumentation for Process Measurement and Control – Norman A. Anderson, Chilton Company, 3rd ed., Circa 1990.
3. Industrial Automation from Scratch, Olushola Akande, Packt Publishing, 2023.

Title of the Course Name: Introduction to Industry 4.0 and Industrial Internet of Things **Course Code:** P25MD302	**L**	**T**	**P**	**Credits**
	3	--	--	3
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Fundamentals of Sensors, Instrumentation, and Control Systems

Course Objectives: The course aims to:

1. To introduce the fundamental concepts of Industry 4.0, IoT, cyber-physical systems, and smart factories.
2. To understand the role of sensors, networking, data analytics, and cybersecurity in industrial IoT environments.
3. To apply IoT architectures, communication protocols, and AI/ML tools to industrial applications and case studies.
4. To evaluate real-world IIoT strategies, sustainability considerations, and future trends in smart manufacturing systems.

Course Outcomes: At the end of the course, students will be able to:

CO1	Recall the core concepts of Industry 4.0, IoT architectures, sensors, network protocols, cybersecurity, and industrial case studies.
CO2	Understand and interpret the functions of IoT layers, cloud-edge processing, big data tools, and smart systems integration in industrial setups.
CO3	Apply suitable IIoT architectures, networking models, and machine learning tools to solve problems in domains such as manufacturing, healthcare, and automation.
CO4	Evaluate IIoT solutions using real-time data handling, case study analysis, cost-benefit techniques, and strategy development for future-ready industrial systems.

Course Content		
Unit No.	**Unit title and Content**	**Hrs**
1	**Fundamentals of Industry 4.0 and IoT** Introduction to sensing and actuation, communication and networking fundamentals, overview of Industry 4.0, globalization and trends, lean to smart factories, connected business models, cyber-physical systems, collaborative platforms, and PLM.	**06**
2	**Advanced Technologies Enabling Industry 4.0** Next-generation sensors and devices, AR/VR applications in industry, basics of AI and ML, big data and predictive analytics, industrial internet systems, cybersecurity foundations, and industrial IoT overview.	**06**
3	**Architecture and Layers of IoT** IoT business models, reference architectures, sensing layer, edge devices, processing layer (edge vs cloud), communication layer protocols (MQTT, CoAP), network topologies, and challenges in industrial IoT networking.	**06**
4	**Data Analytics, Networking, and Security in IIoT** Big data storage and visualization, machine learning tools (R, Julia, Hadoop), software-defined networking (SDN), cloud computing, fog computing for real-time data handling, and cyber security practices in industrial systems.	**06**
5	**Application Domains and Industrial Case Studies** IoT in smart factories, assembly lines, food and beverage, healthcare, power plants, inventory and quality control, safety management, oil and pharma industries, UAVs in automation, Case Study I: Milk processing and packaging, Case Study II: Smart manufacturing systems.	**06**
6	**Strategy Development and Future Trends** Designing IoT strategies for smart manufacturing, integration with legacy systems, data-driven decision-making, scaling IoT solutions, cost-benefit analysis, sustainability and green IoT, upcoming trends in Industry 4.0 and digital transformation.	**06**

Text Books:

1. Alasdair Gilchrist, "*Industry 4.0: The Industrial Internet of Things"*, Apress, 1st Edition, 2016.
2. Rajkumar Buyya, Amir Vahid Dastjerdi, "*Internet of Things: Principles and Paradigms*, Elsevier", 1st Edition, 2016.
3. Uday Kamath, Krishna Choppella, Anand Deshpande, "*Industrial Digital Transformation: Accelerate digital transformation with business optimization, AI, and Industry 4.0"*, Packt Publishing, 2021.

References Books

1. Milan Milenkovic, "*Internet of Things: Concepts and System Design"*, Springer, 1st Edition, 2020.
2. William Stallings, "*Wireless Communications and Networks"*, Pearson, 2nd Edition, 2005.
3. Brett King ," *Augmented: Life in the Smart Lane"*, Marshall Cavendish, 1st Edition, 2016.

Title of the Course Name: **Dissertation Phase- I***	**L**	**T**	**P**	**Credits**
	--	--	20	10
Course Code: P25MD304	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

*Note –Minimum 30% work of Dissertation Phase- II should be completed.

Pre-Requisite:

- Understanding of core and elective subjects related to the chosen domain.
- Familiarity with research methodology, academic writing, and referencing.
- Knowledge of simulation tools, programming platforms, or hardware (as required by the topic).

Course Objectives: The course aims:

1. To identify a research problem relevant to Mechanical Design Engineering.
2. To conduct an in-depth literature survey and identify research gaps.
3. To formulate objectives, scope, and methodology of the proposed work.
4. To enhance research planning, time management, and technical writing skills.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Identify and define a research problem with appropriate scope and relevance.
CO2	Conduct a comprehensive literature survey and identify research gaps.
CO3	Formulate problem statements, objectives, and methodology.
CO4	Prepare and present a project proposal with justification and expected outcomes.
CO5	Demonstrate the ability to document and present research progress professionally

Sr.No.	Guidelines
1	Activities Involved 1. Selection of a relevant research topic in consultation with a guide. 2. Literature review using journals, conference papers, patents, and technical reports. 3. Identification of research gaps, problem statement formulation. 4. Planning of methodology, tools, datasets, and experimental setup (if applicable). 5. Partial implementation or simulation (as feasible). 6. Periodic presentations and documentation.
2	Format for Report (Spiral Bound & Soft Copy) 11. Cover Page 12. Certificate (Guide + Head of Department) 13. Declaration 14. Acknowledgement 15. Abstract 16. Table of Contents 17. List of Figures/Tables (if applicable) 18. Chapters: o Introduction o Literature Review o Problem Statement o Objectives o Proposed Methodology o Preliminary Work Done o Conclusion and Future Work 19. References 20. Appendix (if applicable)
3	Deliverables • Synopsis (approved by guide and PRC). • Interim progress report. • Final report of Dissertation Phase–I. • Presentation and viva before the department PRC.

PG Program: Mechanical Design Engineering
Semester: IV

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme			
			L	T	P	Cr	Components	Max	Min for Passing	
Project	P25MD401	Dissertation Phase-II*	-	-	40	20	ISE-I	50	40	
							ISE-II	50		
							ESE (POE)	100	40	80
Total			**-**	**-**	**40**	**20**	**200**			
Total Contact Hours- 40							**Total Credits- 20**			

* It is required to publish/present two papers out of which at least one paper should be in a SCI/ SCIE/ SCOPUS/ Web of Science/ Peer-Reviewed Journal before Thesis Submission.

Title of the Course Name: Dissertation Phase-II	**L**	**T**	**P**	**Credits**
Course Code:P25MD401	--	--	40	20
	ISE	MSE	ESE	Total
	100	**--**	**100**	**200**

Pre-Requisite:

- Completion of Dissertation Phase–I with approved synopsis and partial implementation.
- Working knowledge of design tools, simulation software, or experimental hardware platforms.
- Familiarity with academic writing, plagiarism policies, and peer-reviewed publishing process.

Course Objectives: The course aims:

1. To implement the proposed methodology from Dissertation Phase–I using suitable tools and techniques.
2. To conduct detailed experimentation, simulation, or design, and critically analyze the results obtained.
3. To interpret research outcomes in the context of existing literature and assess their academic or practical impact.
4. To compile, document, and present the complete dissertation work through a formal report, presentation, and publication.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Apply the selected research methodology and tools to execute the project effectively.
CO2	Analyze and interpret the results from experimentation or simulation to derive meaningful insights.
CO3	Demonstrate problem-solving, innovation, and research skills through validated outcomes and academic publications.
CO4	Prepare and present a complete dissertation report, defend the work confidently, and adhere to academic and ethical standards.

Sr.No.	Guidelines
1	Activities Involved 1. Full implementation of the system/methodology. 2. Conduct simulations, hardware experiments, or data analysis. 3. Compare results with existing methods or baseline systems. 4. Write and submit research papers to suitable conferences or journals. 5. Prepare the final dissertation report. 6. Final seminar and viva-voce before internal and external examiners.
2	**Mandatory Paper Publication Requirements** • Each student must publish **a minimum of two research papers** based on their dissertation work **before submission**. • The papers must be: o **At least one in a SCI/ SCIE/ SCOPUS/ Web of Science/ Peer-Reviewed Journal.** o **The second can be in a national/international conference with review and proceedings.** • Proof of **acceptance or publication** must be submitted along with the final dissertation. • Co-authorship with guide or peer students is acceptable, but the student must be the primary contributor.
	Report Format (Hardbound Copy) 1. Cover Page 2. Certificate (Guide, HoD, External Examiner) 3. Declaration 4. Acknowledgement 5. Abstract 6. Table of Contents 7. List of Figures and Tables 8. Chapters: o Introduction o Literature Review o Gap Identification o Problem Statement o Objectives o Methodology o Implementation o Results and Discussion o Conclusion and Future Scope 9. References

	10. Appendices (if applicable) 11. Copies of Published Papers (as Annexure)
3	Deliverables • **Hardbound final dissertation report** (in prescribed format). • **Soft copy of report and presentation** (PDF and PPT). • **Plagiarism report** (Turnitin/Urkund ≤ 10%). • **Proof of 2 paper publications** (acceptance letters/certificates/published copy). • **Source code, design files, datasets** (if applicable). • **Final presentation and viva sheet** signed by the PRC.
	Mandatory Paper Publication Requirements • Each student must publish **a minimum of two research papers** based on their dissertation work **before submission**. • The papers must be: o **At least one in a SCI/ SCIE/ SCOPUS/ Web of Science/ Peer-Reviewed Journal.** o **The second can be in a national/international conference with review and proceedings.** • Proof of **acceptance or publication** must be submitted along with the final dissertation. • Co-authorship with guide or peer students is acceptable, but the student must be the primary contributor.

Exit Courses after Semester– II - P.G. Diploma

Type of Course	Course Code	Course Name	Teaching Scheme				Evaluation Scheme		
			L	T	P	Cr	Components	Max	Min. for Passing
ELC	P25MD209	Internship/Field Training#	-		-	2	ISE	50	20
AEC	P25MD210	Employability Skill Development*	4	-	-	4	ISE	50	40
							ESE	50	
	Total		**04**	**00**	**00**	**6**		**200**	
Total Contact Hours- 04 Total Credits- 06									

*It is mandatory to opt this course certification from SWAYAM/NPTEL MOOC platform
Four weeks domain specific industrial internship after successfully completing first year of the program.

Title of the Course Name: Internship/Training	L	T	P	Credits
	--	--	2	2
Course Code:P25MD209	ISE	MSE	ESE	Total
	50	**--**	**--**	**50**

Pre-Requisite:

- Completion of core PG coursework in Mechanical Design Engineering
- Basic technical skills
- Awareness of industrial tools, platforms, or technologies relevant to the chosen domain
- Readiness for professional work ethics and environment
- Resume and basic documentation (cover letter, academic transcripts)

Course Objectives: The course aims:

1. To bridge the gap between academic learning and industrial practices through exposure to real-world engineering environments.
2. To develop domain-specific technical competencies and hands-on skills via industrial participation.
3. To enhance students' understanding of project workflows, tools, standards, and collaborative teamwork in professional settings.
4. To strengthen interpersonal communication, reporting skills, and awareness of innovation and regulatory practices in industry.

Course Outcomes: At the end of the course, students will be able to:

CO	Course Outcomes
CO1	Identify industry-relevant problems and apply classroom knowledge to practical situations.
CO2	Demonstrate technical proficiency and professional behavior through active participation in industrial tasks.
CO3	Analyze industrial systems, workflows, and project execution practices effectively.
CO4	Compile and present a structured internship report with observations, learning's, and contributions.

Sr. No.	Guidelines
1	Activities Involved 6. Identifying and applying to companies or R&D organizations 7. Completion of internship spanning 4 weeks 8. Hands-on work under assigned industry mentors 9. Weekly task updates and feedback sessions 10. Final presentation and submission of training report
2	**Requirements** • Internship should be in a core or allied domain: • Prior approval must be taken from the Internship/Training Coordinator • Maintain a **daily logbook** recording work done, observations, and reflections • Internship certificate must be obtained from the industry at the end of the training • Students are required to submit: a) Internship Completion Certificate b) Internship Report (format below) c) Logbook or Weekly Activity Sheet d) Presentation and Viva before Evaluation Panel.
3	Internship Report Format (Hardbound Copy) 13. **Cover Page** (Institute, Title, Student Name, Industry Name, Duration) 14. **Certificate from Institute** 15. **Certificate from Company** 16. **Acknowledgment** 17. **Table of Contents** 18. **Chapter 1: Introduction** – Overview of the organization and objectives 19. **Chapter 2: Training Activities** – Tasks performed, tools used, departments visited 20. **Chapter 3: Technical Learning** – Concepts, skills, technologies learned 21. **Chapter 4: Analysis and Outcomes** – Contributions made, learnings, challenges 22. **Chapter 5: Conclusion** – Summary and future scope 23. **References** (if applicable) 24. **Appendices** – Screenshots, tools used, code samples (if allowed)

Title of the Course Name: Employability Skill Development **Course Code:**P25MD210	**L**	**T**	**P**	**Credits**
	4	--	--	4
	ISE	MSE	ESE	Total
	50	**--**	**50**	**100**

Pre-Requisite: Basic English communication

Course Objectives: The course aims:

1. To develop effective communication, teamwork, and interpersonal skills
2. To enhance professional readiness through resume building and interview practice
3. To build leadership qualities and critical thinking for workplace adaptability
4. To inculcate ethics, etiquette, and time management in professional settings

Course Outcomes: At the end of the course, students will be able:

CO	Course Outcomes
CO1	Demonstrate effective communication and interpersonal skills
CO2	Apply leadership and teamwork principles in professional settings
CO3	Prepare resumes and participate effectively in interviews and group discussions
CO4	Practice workplace etiquette, time management, and ethical behavior

Course Content		
Unit No.	**Contents**	**Hrs**
1	**Communication Skills** Verbal and non-verbal communication, active listening, barriers to communication, clarity and coherence, email and business communication, public speaking, presentation skills	**6**
2	**Personality Development and Interpersonal Skills** Positive attitude, self-confidence, grooming and body language, self-awareness, empathy, emotional intelligence, teamwork and collaboration, conflict resolution	**6**
3	**Resume and Cover Letter Writing** Types of resumes, components of an effective resume, tailoring resumes to job roles, cover letter writing, common errors in resumes, creating a LinkedIn profile	**6**
4	**Interview Preparation and Group Discussion** Types of interviews, interview etiquette, commonly asked questions, STAR technique, mock interviews, types of group discussions, do's and don'ts in GD, communication in a group setting	**6**
5	**Professional Skills and Workplace Etiquette** Workplace behavior, ethics and integrity, corporate etiquette, professionalism, time management, goal setting, stress management, adaptability	**6**
6	**Career Planning and Employability Readiness** Career planning techniques, self-assessment and SWOT analysis, decision-making skills, building confidence, job search strategies, facing challenges in the workplace	**6**

Text Books:

1. Barun K. Mitra , Personality Development and Soft Skills, Oxford University Press
2. Andrews, Sudhir , How to Succeed at Interviews, Tata McGraw Hill

Reference Books:

1. **Dr. K. Alex** – *Soft Skills: Know Yourself & Know the World*, S. Chand
2. **Wallace & Masters** – *Personal Development for Life and Work*, Cengage Learning
3. **Dale Carnegie** – *How to Win Friends and Influence People*, Simon & Schuster
4. NSDC / NASSCOM soft skills modules, National Skill Development Corporation resources.

MOOC/NPTEL Platform:

1. **Developing Soft Skills and Personality** by Prof. T Ravichandran (IIT Kanpur)]
   Link: https://nptel.ac.in/courses/109/104/109104115