CURRICULUM SCHEME

(NEP COMPLIANT)

FOR

I-VIII SEMESTER

B.TECH. MECANICAL ENGINEERING

W.E.F.

BATCH 2025-2029 & Onwards

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT
& RESEARCH, NAGPUR.
(An Autonomous Institute, Affiliated to RTMNU, Nagpur)
DEPARTMENT OF MECHANICAL ENGINEERING
(NBA Accredited)
Vision: Emerge as an excellent centre for Mechanical Engineering education.

CURRICULUM SCHEME OF FIRST YEAR ENGINEERING MECHANICAL ENGINEERING

SEMESTER-I [NEP-COMPLIANT]

Scheme of Teaching & Examination of Bachelor of Technology, I Semester B.Tech. (Mechanical Engineering)

Sr. No.	Course Code	Course Title	Hours Per Week			Credits	Maximum Marks			ESE
			L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs)
1	N-BSC101T	Successive Differentiation and Differential Equation	3	1	0	4	40	60	100	3
2	N-BSC103T	Chemistry for Engineering	2	0	0	2	20	30	50	2
3	N-BSC103P	Engineering Chemistry Lab	0	0	2	1	50	-	50	-
4	N-ESC101T	Electrical Engineering	2	1	0	3	40	60	100	3
5	N-ESC101P	Electrical Engineering Lab	0	0	2	1	50	-	50	-
6	N-VSCME101P	Workshop Practices	0	0	4	2	50	-	50	-
7	N-ESC102T	Programming for Problem Solving	3	0	0	3	40	60	100	3
8	N-ESC102P	Programming for Problem Solving Lab	0	0	4	2	50	-	50	-
9	N-AEC101T	Communicative English	1	0	0	1	20	30	50	2
10	N-AEC101P	Communicative English Lab	0	0	2	1	50	-	50	-
11	N-CC102	Liberal Learning Course - 2	1	0	2	2	50	-	50	-
		TOTAL	**12**	**2**	**16**	**22**	**460**	**240**	**700**	

Revision	BoS Meeting	Date	W. E. F.
01	10th	29/03/2025	2025-26

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CURRICULUM SCHEME OF FIRST YEAR ENGINEERING MECHANICAL ENGINEERING

SEMESTER-II [NEP-COMPLIANT]

Scheme of Teaching & Examination of Bachelor of Technology, II Semester B.Tech. (Mechanical Engineering)

Sr. No.	Course Code	Course Title	Hours Per Week			Credits	Maximum Marks			ESE
			L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs)
1	N-BSC104T	Integral Calculus and Linear Algebra	3	1	0	4	40	60	100	3
2	N-BSC102T	Applied Physics	2	0	0	2	20	30	50	2
3	N-BSC102P	Applied Physics Lab	0	0	2	1	50	-	50	-
4	N-ESC103T	Engineering Graphics and Design	1	0	0	1	40	60	100	4
5	N-ESC103P	Engineering Graphics and Design Lab	0	0	4	2	50	-	50	-
6	N-VSCME102P	Computer Aided Drafting	0	0	4	2	50	-	50	-
7	N-IKS101T	Indian Knowledge System	2	0	0	2	50	-	50	-
8	N-PCCME101T	Basics of Mechanical Engineering	2	0	0	2	20	30	50	2
9	N-PCCME101P	Basics of Mechanical Engineering Lab	0	0	2	1	50	-	50	-
10	N-CC101	Liberal Learning Course - 1	1	0	2	2	50	-	50	-
		TOTAL	**11**	**1**	**14**	**19**	**420**	**180**	**600**	

Revision	BoS Meeting	Date	W. E. F.
01	10th	29/03/2025	2025-26

Course Code	Course Title	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continuous Evaluation	End Sem. Exam	Total
N-PCCME101P	Basics of Mechanical Engineering Lab	0	0	2	1	50	-	50

Course Objective
1. To have insight knowledge of selection of materials for various application in mechanical engineering.
2. Hands-on use of different measuring tools/ devices to measure various physical quantities.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	**Analyze: Illustrate** the crystal structure, crystal imperfection, and **analyze** the microstructure of a given Specimen using microscopes.
CO2	**Analyze: Select** appropriate measuring device for the measurement of various physical & Mechanical quantities.
CO3	**Apply: Apply** the basic principle of thermodynamics and fluid mechanics in real life application.
CO4	**Apply: Determine** the coefficient of friction, reaction forces at support, resultant force & centre of gravity of the structure/ mechanism and evaluate the mechanical advantage, velocity ratio & efficiency for simple machine.

List of Experiments	
Pre-Lab	Familiarization with Basics of Mechanical Engineering Lab. • Introduction to all machine setup available in lab • Hands-on practice on microscope, Tachometer, pressure measuring devices, temperature measuring devices, flow measuring devices, simple lifting machines.
1.	Illustrate crystal structures and crystal imperfections using ball models.
2.	Demonstrate the use of Optical Microscope to analyse the microstructure of the given Specimen.
3.	Microstructural examination of ferrous metals and non-ferrous metals.
4.	Basics of Scanning Electron Microscopy. (***Virtual lab platform***)
5.	Identify and demonstrate the use of different gauges, vernier caliper & micrometer to measure the geometric parameters of the given work piece.
6.	Identify and demonstrate the use of different measuring devices for the measurement of Pressure, temperature, speed, flow, and force in mechanical system.

7.	Verification of Bernoulli's theorem.
8.	Determination of forces in the members of Jib crane and verification of Lami's theorem
9.	Determination of C.G. of Planar Figures.
10.	Verification of triangle law of forces.
11.	Determination of mechanical advantage, velocity ratio, and efficiency for simple machines.
12.	Determination of the coefficient of friction and the angle of repose using an inclined plane setup between two different surfaces.
13.	Determination of reactions at the supports of a simply supported beam and verification of the law of moments
Post -Lab	Open ended experiments

Note- Minimum 8 experiments need to be performed.

Reference Books Recommended
1. Mechanical Measurement and Instrumentations by R K Rajput, 4th edition , 2022 ,S.K. Kataria & Sons publication
2. Experimental Techniques in Materials and Mechanics by C.Suryanarayana, 3rd edition, 2019, CRC Press publication.
3. Experiments in Fluid Mechanics by Sarbjit Singh, 1st edition, 2018, PHI Publication.
4. Experiments in Material Science and Engineering by Tariq A Khraishi and Marwan S, 2nd edition, 2019, Cognella, Inc publication.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-VSCME102P	Computer Aided Drafting	0	0	4	2	50	-	50	-

Course Objective
To develop drafting skill in computer aided design.

Course Outcomes	
After successful completion of the course, the students will able to:	
CO1	**Understand:** Explain various commands used in computer aided design.
CO2	**Apply:** Develop 2-Dimensional geometrics of mechanical components.
CO3	**Apply:** Develop 3-Dimensional geometrics of mechanical components.
CO4	**Create:** Construct and draft various machine components.

SYLLABUS

Module – I : Introduction to AutoCAD

The user interface of AutoCAD such as panels, ribbon, model space, etc.,

Draw commands: Concepts of drawing a toolbar, line command, polyline command, circle command, arc command, text, and rectangle command.

Modify command: Erase commands, selection of multiple objects, move and copy command, the distance method, the two point's method, trim and extend.

Text command layers blocks: The concept of creating, renaming, and removing layers, specifying the default properties, sort, filter and group layers names, dimension objects, layers visibility

Module – II : 2D Fundamentals

AutoCAD workspace and user interface, organizing drawing objects in layers, using basic drawing editing and viewing tools, preparing a layout to be plotted.

Geometric construction: Construction on commands, point commands, ray commands, xline commands.

Orthographic projection: Concept of invisible line, representation of curved surface, object as a single piece, object as an assembly, selection of view, type of drawing principle of multi-view, box command, centre line method.

Module III: Isometric drawing

Theory of isometric projection, isometric view and isometric drawing, non-isometric lines, methods to generate isometric drawing, draw isometric in AutoCAD, rounded surface in isometric drawing, isometric drafting for mechanical components.

Revision	BoS Meeting	Date	W. E. F.
01	10th	29/03/2025	2025-26

Module IV: Applications for Mechanical Engineering

Drawing management/file types, design processes and methods, sketching CAD Mechanical AutoCAD, orthographic projection/multi-view drawings, pictorials, geometric constructions, dimensioning and tolerances.

Reference Books Recommended

1. Engineering Graphics with AutoCAD by D. M. Kulkari, A. P. Rastogi, A. K. Sarkar, 3rd Edition, 2010, PHI Publication.
2. Engineering graphics with introduction to AutoCAD by A.R. Bapat, 2nd Edition, 2013, Allied Publisher Private Limited.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continuous Evaluation	End Sem. Exam	Total
N-VSCME101P	Workshop Practices	-	-	4	2	50	-	50

Course Objective	
1	To aware the students about basic manufacturing processes used in industries.
2	To aware the students with new technologies used in manufacturing industries.
3	To demonstrate the students with basic tools and components used in automobile Mechanical manufacturing, computer assembly and troubleshooting.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	**Apply**: Select appropriate mechanical tools/equipment commonly employed in Industry/Automobile and work effectively.
CO2	**Create:** Create jobs in fitting/ carpentry/welding/smithy/plumbing/with acceptable Dimensions as per the given drawing following prevailing safety practices.

Syllabus

MODULE-I:
Fitting shop: - Hands-on training of various tools and equipment to shape, cut, join, and assemble material.

MODULE-II:
Carpentry: - Hand-on training in carpentry techniques, and woodworking tools for cutting, shaping, and fasting of wood components.

MODULE-III:
Welding shop: - Hands-on training in various welding types, safety procedures, and welding equipment used for joining of plates by lap welding/butt welding using electric arc welding.

MODULE-IV:
Smithy: - Hands-on training in basic smithy techniques such as forging, heat treating, hammering, and shaping metal.

MODULE-V:
Plumbing: - Hands-on training on plumbing operations like pipe fitting, soldering, installing fixtures, and troubleshooting common plumbing issues

MODULE-VI:
Automobile Workshop: - Hands-on training on assembly and maintenance of two-wheeler components, its function, and troubleshooting.

Revision	BoS Meeting	Date	W. E. F.
01	10th	29/03/2025	2025-26

Sr. No.	List of Practical
Pre-Lab Session	1. Familiarization with measuring equipment. 2. Familiarization with machines and cutting tools.
1	To make a V-Fit from the given mild steel pieces.
2	To make a Square fit from the given mild steel pieces.
3	To Perform Carpentry operations by creating the specified job.
4	To Perform the electric arc welding process by creating a specified job.
5	To Perform the smithy operation by creating a specified job.
6	To perform various plumbing operations by creating a specified job.
7	To Perform the maintenance operation on two wheeler vehicle.
8	To Perform the assembly and disassembly operation on the 4-stroke (Single Cylinder) petrol engine.
Post -Lab	Open Ended Experiment

Reference Books Recommended
1. Workshop Technology (Volume II), S. K. Hajra Choudhury, 15th Edition, Reprint 2021., Media Promoters & Publishers
2. Workshop Technology (Vol. I), V. S. Raghuwanshi, Reprint Edition, 2020,Dhanpat Rai & Sons,.
3. Manufacturing Science, Ghosh & Mallik, East West Press, 2nd Edition, 2010.
4. Manufacturing Technology (Metal Cutting & Machine Tools) Vol. II, P. N. Rao, 4th Edition, 2017.McGraw Hill,

Revision	BoS Meeting	Date	W. E. F.
01	10th	29/03/2025	2025–26

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem.	Total	Duration (Hrs.)
N-ESC103P	Engineering Graphics and Design Lab	0	0	4	2	50	-	50	-

Sr. No.	Course Objective
1	This course is aimed to create awareness and emphasize on the need of Engineering Graphics in all the engineering branches.
2	To develop skills in three-dimensional visualization of any engineering component.
3	This course offers insight knowledge of theories and practical applications related to projections and concepts of engineering drawing using CAD application software.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	**Apply:** Identify and draw different types of curves.
CO2	**Apply:** Apply the concepts of orthographic projection to draw problems on lines, planes, and solids.
CO3	**Apply**: Develop an ability to predict orthographic and isometric projections and to determine section and development of solids
CO4	**Apply**: Apply the knowledge of drafting software to draw problems on projection of lines, orthographic and Isometric views.

Sr No	List of Experiments
Pre-Lab Session	Familiarization with Drawing Instruments
1.	General applications of different lines, Dimensioning & lettering
2.	Engineering Curves (Minimum four curves)
3.	Projection of Lines (Minimum four problems)
4.	Projection of Planes (Minimum four problems)
5.	Projections of solids (Minimum four problems)
6.	Section of solid and development of lateral surfaces. (Minimum four problems)
7.	Orthographic Views (To draw orthographic views from given pictorial view, minimum four problems.)
8.	Isometric Views/Projection (Two problems, each on Isometric views & Isometric projections.)

9.	Projection of 2-D and 3-D objects using drafting software.
Post - Lab	Open Ended Experiment

Reference Books Recommended
1. Elementary Engineering Drawing - N.D. Bhatt, 54th Edition, 2023, Charotar Publishing house, Anand, India.
2. Engineering Drawing - D. A. Johle, 1st Edition, 2017, Tata McGraw-Hill Publishing Co.Ltd.
3. Engineering Graphics with an introduction to AUTOCAD - A. R. Bapat, 6th reprint Edition, 2012, Allied Publishers, New Delhi.
4. Engineering Graphics with AutoCAD - D. M. Kulkarni, A. P. Rastogi, A. K. Sarkar, Revised Edition, 2010, PHI Publication.

CURRICULUM SCHEME
FOR
B.TECH. MECHANICAL ENGINEERING
2nd YEAR
SEMESTER-III
[NEP-COMPLIANT]

Scheme of Teaching & Examination of Bachelor of Technology, III Semester B.Tech. (Mechanical Engineering)

Sr. No.	Course Code	Course Title	Hours per week			Credits	Maximum Marks			ESE
			L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
1	N-PCCME301T	Mathematics for Mechanical Engineering	3	1	0	4	40	60	100	3
2	N-PCCME302T	Kinematics of Machines	3	0	0	3	40	60	100	3
3	N-PCCME303T	Fluid Mechanics	3	0	0	3	40	60	100	3
4	N-PCCME303P	Fluid Mechanics Lab	0	0	2	1	50	-	50	-
5	N-PCCME304T	Material Science and Metallurgy	2	0	0	2	20	30	50	2
6	N-PCCME304P	Material Science and Metallurgy Lab	0	0	2	1	50	-	50	-
7	N-MDM	Multidisciplinary Minor Course-1	3	0	0	3	40	60	100	3
8	N-OEC	Open Elective Course-I	3	0	0	3	40	60	100	3
9	N-VECME301T	Universal Human Values	2	0	0	2	50	-	50	-
10	N-CEPME301	Community Engagement Project (CEP)	0	0	4	2	50	-	50	-
	OR									
	N-FPME301	Field Project (FP)								
11	N-MCME301	Indian Constitution	2	0	0	-	50	-	50	-
Total			**21**	**1**	**8**	**24**	**470**	**330**	**800**	**-**

Revision	BoS Meeting	Date	wef. Academic Year
1	10th	29/03/2025	2026-27

CURRICULUM SCHEME
FOR
B.TECH. MECHANICAL ENGINEERING
2nd YEAR
SEMESTER-IV
[NEP-COMPLIANT]

Scheme of Teaching & Examination of Bachelor of Technology, IV Semester B.Tech. (Mechanical Engineering)

Sr. No.	Course Code	Course Title	Hours per week			Credits	Maximum Marks			ESE
			L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
1	N-PCCME401T	Engineering Thermodynamics	3	0	0	3	40	60	100	3
2	N-PCCME402T	Mechanics of Deformable Solids	3	0	0	3	40	60	100	3
3	N-PCCME402P	Mechanics of Deformable Solids Lab	0	0	2	1	50	-	50	-
4	N-PCCME403T	Manufacturing Processes	2	0	0	2	20	30	50	2
5	N-PCCME403P	Manufacturing Processes Lab	0	0	2	1	50	-	50	-
6	N-MDM	Multidisciplinary Minor Course-2	3	0	0	3	40	60	100	3
7	N-OEC	Open Elective Course- 2	3	0	0	3	40	60	100	3
8	N-SECME401P	Python for Mechanical Engineers	0	0	2	1	50	-	50	-
9	N-SECME402P	Integration of IoT in Mechanical Systems	0	0	2	1	50	-	50	-
10	N-AECME401T	Business Communications	2	0	0	2	20	30	50	2
11	N-HSSMME401T	Entrepreneurship Development	2	0	0	2	50	-	50	-
12	N-VECME401T	Environmental Studies	2	0	0	2	50	-	50	-
Total			**20**	**0**	**08**	**24**	**500**	**300**	**800**	-

Revision	BoS Meeting	Date	wef. Academic Year
1	10th	29/03/2025	2026-27

CURRICULUM SCHEME
FOR
B.TECH. MECHANICAL ENGINEERING
3rd YEAR
SEMESTER-V
[NEP-COMPLIANT]

Scheme of Teaching & Examination of Bachelor of Technology, V Semester B.Tech. (Mechanical Engineering)

Sr. No.	Course Code	Course Title	Hours per week			Credits	Maximum Marks			ESE
			L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
1	N-PCCME501T	Design of Machine Elements	3	0	0	3	40	60	100	3
2	N-PCCME502T	Heat Transfer	3	0	0	3	40	60	100	3
3	N-PCCME502P	Heat Transfer Lab	0	0	2	1	50	-	50	-
4	N-PCCME503T	Manufacturing Technology	2	0	0	2	20	30	50	2
5	N-PCCME503P	Manufacturing Technology Lab	0	0	2	1	50	-	50	-
6	N-PCCME504T	Measurements & Metrology	2	0	0	2	20	30	50	2
7	N-PCCME504P	Measurements & Metrology Lab	0	0	2	1	50	-	50	-
8	N-PCCME505P	Machine Drawing and Solid Modelling Lab	0	0	2	1	50	-	50	-
9	N-PEC	Program Elective- 1	3	0	0	3	40	60	100	3
10	N-MDM	Multidisciplinary Minor Course-3	3	0	0	3	40	60	100	3
11	N-OEC	Open Elective Course- 3	2	0	0	2	20	30	50	2
Total			**18**	**0**	**8**	**22**	**420**	**330**	**750**	-

Program Elective - 1		
Sr. No.	**Course Code**	**Course Title**
1	N-PECME501T	Hydraulic Machines
2	N-PECME502T	Optimization Techniques
3	N-PECME503T	Control Systems Engineering

Revision	BoS Meeting	Date	wef. Academic Year
1	10th	29/03/2025	2027-28

CURRICULUM SCHEME
FOR
B.TECH. MECHANICAL ENGINEERING
3rd YEAR
SEMESTER-VI
[NEP-COMPLIANT]

Scheme of Teaching & Examination of Bachelor of Technology, VI Semester B.Tech. (Mechanical Engineering)

Sr. No.	Course Code	Course Title	Hours per week			Credits	Maximum Marks			ESE
			L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
1	N-PCCME601T	Computer Aided Design	3	0	0	3	40	60	100	3
2	N-PCCME601P	Computer Aided Design Lab	0	0	2	1	50	-	50	-
3	N-PCCME602T	Energy Conversion-I	3	0	0	3	40	60	100	3
4	N-PCCME603T	Dynamics of Machines	3	0	0	3	40	60	100	3
5	N-PCCME603P	Dynamics of Machines Lab	0	0	2	1	50	-	50	-
6	N-PEC	Program Elective- 2	3	0	0	3	40	60	100	3
7	N-PEC	Program Elective- 3	3	0	0	3	40	60	100	3
8	N-MDM	Multidisciplinary Minor Course- 4	3	0	0	3	40	60	100	3
9	N-SECME601P	Simulation Methods in Mechanical Engineering	0	0	2	1	50	-	50	-
10	N-SECME602P	CNC Machine Programming and Operations	0	0	2	1	50	-	50	-
Total			**18**	**0**	**8**	**22**	**440**	**360**	**800**	**-**

Program Elective - 2		
Sr. No.	**Course Code**	**Course Title**
1	N-PECME601T	Internal Combustion Engines
2	N-PECME602T	Industrial Engineering
3	N-PECME603T	Hydraulic and Pneumatic Systems

Program Elective - 3		
Sr. No.	**Course Code**	**Course Title**
1	N-PECME604T	Refrigeration & Air Conditioning
2	N-PECME605T	Automobile Engineering
3	N-PECME606T	Environmental Engineering

Revision	BoS Meeting	Date	wef. Academic Year
1	10th	29/03/2025	2027-28

CURRICULUM SCHEME
FOR
B.TECH. MECHANICAL ENGINEERING
4th YEAR
SEMESTER-VII
[NEP-COMPLIANT]

Scheme of Teaching & Examination of Bachelor of Technology, VII Semester B.Tech. (Mechanical Engineering)										
Sr. No.	Course Code	Course Title	Hours per week			Credits	Maximum Marks			ESE
			L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
1	N-PCCME701T	Energy Conversion-II	3	0	0	3	40	60	100	3
2	N-PCCME701P	Energy Conversion-II Lab	0	0	2	1	50	-	50	-
3	N-PCCME702T	Design of Mechanical Drives	3	0	0	3	40	60	100	3
4	N-PEC	Program Elective- 4	3	0	0	3	40	60	100	3
5	N-PEC	Program Elective- 5	3	0	0	3	40	60	100	3
6	N-MDM	Multidisciplinary Minor Course- 5	2	0	0	2	20	30	50	2
7	N-PROJME701	Project- I	0	0	8	4	75	75	150	-
Total			**14**	**0**	**10**	**19**	**305**	**345**	**650**	**-**

Program Elective - 4		
Sr. No.	Course Code	Course Title
1	N-PECME701T	Power Plant Engineering
2	N-PECME702T	Statistics and Quality Control
3	N-PECME703T	Product Design and Development

Program Elective - 5		
Sr. No.	Course Code	Course Title
1	N-PECME704T	Finite Element Analysis
2	N-PECME705T	Additive Manufacturing
3	N-PECME706T	Solar Energy Utilization

Revision	BoS Meeting	Date	wef. Academic Year
1	10th	29/03/2025	2028-29

CURRICULUM SCHEME
FOR
B.TECH. MECHANICAL ENGINEERING
4th YEAR
SEMESTER-VIII
[NEP-COMPLIANT]

Scheme of Teaching & Examination of Bachelor of Technology, VIII Semester B.Tech. (Mechanical Engineering)										
Sr. No.	Course Code	Course Title	Hours per week			Credits	Maximum Marks			ESE
			L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
1	N-PEC	Program Elective- 6	3	0	0	3	40	60	100	3
2	N-RMME801T	Research Methodology	3	0	0	3	40	60	100	3
3	N- PROJME801	Project-II	0	0	12	6	100	100	200	-
Total			**6**	**0**	**12**	**12**	**180**	**220**	**400**	**-**
OR										
1	N-ELCME801	Internship/On-Job Training (OJT)	One Semester			12	100	100	200	-

Program Elective - 6		
Sr. No.	Course Code	Course Title
1	N-PECME801T	Renewable Energy Systems
2	N-PECME802T	Industrial Management
3	N-PECME803T	Automation in Manufacturing

Revision	BoS Meeting	Date	wef. Academic Year
1	10th	29/03/2025	2028-29

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME501T	Design of Machine Elements	3	0	0	3	40	60	100	3

Course Objective

Equip students with the fundamental knowledge of machine design in order to understand the various steps involved in designing machine components using standard data and practice.

Course Outcomes

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

CO1	**Understand:** Explain the phases of the design process, design methods, and summarize the roles of aesthetic and ergonomic considerations in machine design.
CO2	**Apply:** Select appropriate materials for different types of joints and apply design principles to determine stresses under static loading conditions.
CO3	**Analyze:** Examine the efficiency and performance of threaded joints and power screws by analyzing design and torque parameters.
CO4	**Evaluate:** Determine the design parameters for pressure vessels and their components as per the application.
CO5	**Analyze:** Examine the design parameters of springs and levers under various loading conditions and classify their functionality based on performance criteria.
CO6	**Evaluate:** Select design parameters and determine the shaft diameter by applying design principles and ASME codes in power transmission systems.

SYLLABUS

Unit-I: Design Process

Introduction to mechanical engineering design, phases of design process, design methods and considerations, use of standards, codes in design, selection of preferred sizes and series, design factor and factor of safety, design tool and resources, design engineers professional responsibilities, aesthetic and ergonomic considerations in design, material properties and their uses in design, stress concentration.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Unit-II: Design under static loading
Introduction to pin joints, design of cotter joints, design of knuckle joint, terminology of riveted joints and its types, modes of failure of riveted joints and its remedies, design of boiler joint(longitudinal joint and circumferential joint), design of lozenge joint, strength of transverse and parallel fillet weld, axially loaded unsymmetrical welded joint, eccentrically loaded welded joint.

Unit-III: Threaded Joints and Power Transmission Screws
Threaded Joints: Types of screw fastening, bolt of uniform strength, terminology of screw threads, designation of Indian Standard thread, eccentrically loaded bolted joints, torque requirement for bolt tightening, design of turn buckle.
Power Screw: Forms of thread profiles, terminology of power screw, torque requirement for lifting and lowering load, self- locking and overhauling screws, efficiency of screw, collar friction torque. Design of power transmission screws, design of screw jack.

Unit-IV: Cylinders and Pressure Vessels
Introduction to pressure vessels, thin and thick cylinders, application of thick and thin cylinders in industries, stresses induced in pressure vessel, application of Lame's, Clavarino's and Bernie's equations. Design of cylinders, design of nut, bolt, gaskets and cover plates for pressure vessels.

Unit-V: Springs and Levers
Springs: Function of springs, types of springs and their applications, spring material, Wahl's correction factor, deflection of springs, surging, design of helical compression & tension springs under static and variable loads, design of leaf spring, nipping in leaf springs.
Levers: Types of levers and applications, design of hand and foot lever, lever loaded safety valve for boilers, bell crank lever in air craft control system.

Unit-VI: Transmission shafts
Introduction to shaft, types of shafts, standard sizes of shafts, shaft design on strength basis, shaft design on torsional rigidity basis, American Society of Mechanical Engineers (ASME) code for shaft design, forces on shafts in drivers, static and fatigue criteria for shaft design, design of shaft for power transmission, effect of keyways on shafts, design of key under shear and crushing failures.

Textbooks Recommended

1. Design of Machine Elements, V. B. Bhandari, 5th Edition, 2020, Tata McGraw Hill.
2. Machine Design, U.C. Jindal, 2nd Edition, 2024, Pearson.
3. Design of Machine Elements, B.D. Shiwalkar, Reprint, 2018, Dennet and Co.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Reference Books Recommended
1. Machine Design: An Integrated Approach, Robert L. Norton, 6th Edition, 2019, Prentice Hall.
2.Analysis and Design of Machine Elements, Wei Jiang, 1st Edition, 2019, John Wiley & Sons Singapore Pvt. Ltd.
3.Shigley's Mechanical Engineering Design, Richard G. Budynas and J. Keith Nisbett, 11th Edition, 2019, McGraw Hill.

Revision	BoS Meeting	Date	W. E. F.
-	10th	24/03/2025	2025-26

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DEPARTMENT OF MECHANICAL ENGINEERING

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME502T	Heat Transfer	3	0	0	3	40	60	100	3

Course Objective

The objective of this course is to provide students with a comprehensive understanding of the fundamental principles and applications of heat transfer, focusing on conduction, convection, and radiation. The course aims to equip students with analytical skills to solve real-world engineering problems related to heat transfer.

Course Outcomes

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

CO1	**Apply:** Solve one-dimensional steady-state heat conduction problems for plane walls, cylinders, and spheres.
CO2	**Evaluate:** Evaluate the performance of fins by determining their efficiency and effectiveness under specified thermal conditions
CO3	**Analyze:** Analyze the impact of flow regime (laminar or turbulent) on forced convection heat transfer during external and internal flow situations
CO4	**Analyze:** Analyze the impact of laminar and turbulent regimes on natural convection heat transfer for specified geometries.
CO5	**Analyze:** Analyze radiation exchange between surfaces, including black and gray surfaces, using shape factors, and develop shape factor relations for simple geometries.
CO6	**Evaluate:** Evaluate the performance of heat exchangers using the LMTD and Effectiveness-NTU approach for specified flow configurations.

SYLLABUS

Unit-I: Conduction-I

Introduction: Modes of Heat Transfer, Basic Laws of Heat Transfer and Conservation of Energy requirements. Derivation of general Heat conduction equation in Cartesian, Cylindrical and Spherical Co-ordinates, Thermal conductivity, and Thermal diffusivity. One dimensional steady state conduction equation for the plane wall, Cylinder and Sphere, Thermal resistance of composite structures, Contact resistance, and overall heat transfer coefficient.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Unit-II: Conduction-II
Conduction with uniform internal heat generation: within plane wall, solid Cylinder and solid sphere, Extended Surfaces with uniform cross section area, temperature distribution and their heat transfer rate, Fin efficiency and effectiveness.

Unit-III: Forced Convection
Physical signification of related non-dimensional parameters, Newton's law of cooling, Concept of velocity and thermal boundary layer, Local and average heat transfer coefficient, Using Empirical co-relation (from heat transfer data book) for heat transfer during external and internal flow in laminar and turbulent regime for UHF and UWT condition, for determination of heat transfer coefficient.

Unit-IV: Free Convection
Natural Convection: Grashoff number, Rayleigh number, Hydrodynamic and Thermal Boundary Layer. Using Empirical co-relation (from heat transfer data book) for heat transfer during external flow in laminar and turbulent regime for UHF and UWT condition (over plates & cylinders in Horizonal and vertical position, and over sphere). Heat transfer with phase change (Theory only): Pool boiling phenomenon, curve and regimes of pool boiling, Film and drop wise condensation, Film wise condensation on vertical surface (plate & cylinder), horizontal tube & bank of tubes, effect of superheated and non-condensable gasses on condensation heat transfer.

Unit-V: Radiation
Radiation Basic Radiation Concepts: Fundamentals, Basic ideas, spectrum, basic definitions, radiative properties of opaque surfaces, Spectral and directional variations, emissive power, radiosity, intensity of radiation and solid angle, Band Emission. Black Body Radiation Laws: Planck's law, Stefan Boltzmann law, Wien's Displacement law, Kirchhoff's law, Lambert cosine law, Radiation Energy Exchange: Concept of black and gray bodies, Radiation exchange between black surfaces, Radiation exchange between gray surfaces Shape Factor Concepts– Definition, relations, and its properties. Radiation network for radiative exchange. Radiation between parallel plates, concentric Cylinders, and concentric spheres & simple enclosures

Unit-VI: Heat Exchangers
Heat Exchanger: Classification of heat exchangers, overall heat transfer coefficient, fouling factor, temperature distribution Heat Exchanger Analysis for parallel & Counter flow heat exchangers using LMTD Approach and Effectiveness - NTU approach.

Textbooks Recommended

1. Incropera's Principles of Heat and Mass Transfer, Frank P. Incropera and David P. Dewitt, 2nd Edition, 2018, Wiley Publication.
2. Heat & Mass Transfer, R.K. Rajput, 10th Edition, 2018, Laxmi Publication.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

3. Heat and Mass Transfer: Fundamentals and Applications, Yunus A. Cengel and Afshin J. Ghajar, 6th Edition, 2020, McGraw Hill.

Reference Books Recommended

1. Heat Transfer, J Holman, Souvik Bhattacharyya, 10th Edition, 2017, McGraw Hill.
2. Heat and Mass Transfer, P K. Nag, 3rd Edition, 2011, McGraw Hill.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME502P	Heat Transfer Lab	0	0	2	1	25	25	50	-

Course Objective
The course enables the students to gain knowledge of various modes of heat transfer through various experimental setups.

Course Outcomes	
After successful completion of the course, the students will be able to:	
CO1	**Evaluate:** Determine and measure the conduction phenomenon in different material.
CO2	**Evaluate:** Estimate surface heat transfer coefficient the natural and forced convection.
CO3	**Evaluate:** Estimate radiation heat transfer coefficient using Stefan Boltzman law.
CO4	**Evaluate:** Performance analysis of heat exchanger to estimate its effectiveness.

Sr. No	Aim of Practical
Pre-lab session	1. Familiarization with heat transfer lab. 2. Plotting of graph through Excel software/online tools.
1	Determination of total thermal resistance, thermal conductivity, and plot temperature gradient along composite wall structure.
2	Determination of thermal conductivity of insulating powder.
3	Determination of thermal conductivity of lagging material.
4	Determination of thermal conductivity and plotting the temperature distribution along the length of metal bar.
5	Determination of surface heat transfer coefficient for a vertical tube losing heat by natural convection.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

6	Determine the average surface heat transfer coefficient for pipe losing heat by forced convection and compare the effect of air flows rates on average heat transfer coefficient.
7	Determine convective heat transfer coefficient for Pin-Fin in natural and forced convection.
8	Determination of emissivity of a Test Plate.
9	An experimental investigation of the Radiation Stefan Boltzman Constant.
10	Determination of the effectiveness of a parallel & counter flow heat exchanger.
11	Performance analysis of Heat Exchanger using twisted tape insert for enhancement of heat transfer rate.
12	Experimental investigation of Newton's law of cooling of different material and different liquids. (Virtual Lab)
Post lab session	Open-Ended Practical

Note: *Minimum eight experiments to be performed based on the above list.*

Suggested References

1. Fundamental of Heat & Mass Transfer, Kothandaraman C.P., 4th edition 2020, New Age Techno Press.
2. Heat and Mass Transfer: Fundamentals & Applications, Yunus A. Çengel and Afshin J. Ghajar, 6th Edition 2020, McGraw Hill Education.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

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(An Autonomous Institute. Affiliated to RTMNU. Nagpur)

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME503T	Manufacturing Technology	2	0	0	2	20	30	50	2

Course Objective

The course enables the students to understand the tooling needed for conventional & non-conventional machining processes and quality control techniques in the manufacturing process.

Course Outcomes

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

CO1	**Apply:** Select and explain conventional machining processes to manufacture components as per application.
CO2	**Analyze:** Examine and explain machining processes for finishing components as per specification.
CO3	**Apply:** Select and explain non-conventional machining processes for material removal operations.
CO4	**Analyze:** Explain and analyze the various systems of automation in manufacturing processes and various aspects of Computer Aided Manufacturing & Computer Integrated Manufacturing.

SYLLABUS

UNIT I: Conventional Machining Processes

Lathe: Introduction to lathe, construction, types, work holding devices, operating conditions, operations on lathe, turrets, capstan, and automats. Drilling: Operating conditions, material removal rate, boring, reaming, tapping, Shaping, Planning, and Slotting: Introduction, types, operating conditions, machining time, material removal rate. Milling: Introduction, types, milling process, operating conditions, material removal rate, types of milling operations. Indexing.

Unit-II: Grinding and Super Finishing Processes

Grinding: Operations, grinding wheel, specifications & selection, cylindrical & centerless grinding operation, surface grinding, tool & cutter grinding, time estimation for grinding operations.

Super Finishing Process: Honing, lapping, polishing, buffing, metal spraying, galvanizing, and electroplating.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Unit-III: Non- Conventional Machining Processes
Introduction, need, and classification. abrasive jet machining (AJM), water jet machining (WJM), abrasive water jet machining (AWJM), ultrasonic machining (USM), electrical discharge machining (EDM), electrochemical machining (ECM), electrochemical discharge machining (ECDM), laser beam machining (LBM), electron beam machining (EBM), plasma arc machining (PAM), process parameters application and limitations.

Unit-IV: Automation and Manufacturing Technologies
Introduction to automation, numerical control, industrial robots, Computer aided manufacturing, computer aided process planning, group technology, Cellular manufacturing, flexible manufacturing systems, holonic manufacturing.

Textbooks Recommended

1. Manufacturing Technology (Volume II), P. N. Rao, 4th Edition, 2018, Tata McGraw Hill.
2. Traditional Machining Technology, Helmi A. Youssef and Hassan El-Hofy, 2nd Edition, 2020, CRC Press.

Reference Books Recommended

1. Fundamentals of Modern Manufacturing Materials, Processes, and Systems, Mikell P. Groover, 6th Edition, 2020,John Wiley & Sons, Inc.
2. Manufacturing Engineering & Technology, Kalpakjian, 8th Edition, 2020, Pearson.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

(An Autonomous Institute, Affiliated to RTMNU, Nagpur)

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME503P	Manufacturing Technology Lab	0	0	2	1	25	25	50	-

Course Objective
The course enables the students to gain hands-on knowledge of material removal processes and tools used.

Course Outcomes	
After successful completion of the course, the students will be able to:	
CO1	**Evaluate:** Identify and examine various cutting tools and cutting forces.
CO2	**Evaluate:** Demonstrate lathe, CNC, shaper, milling, drilling, and boring machines.
CO3	**Evaluate:** Prepare jobs on lathe, shaper, milling, drilling, and boring machines.
CO4	**Analyze:** Examine the non-conventional machining using virtual lab.

Sr. No.	List of Experiments
Pre-Lab Session	Familiarization with machines and cutting tools.
1	Identify and examine single-point and multiple-point cutting tools.
2	Analyze various forces acting on single-point cutting tools using analytical and graphical methods.
3	Prepare a job of thread cutting and taper turning on lathe machine.
4	Prepare a job of drilling, boring, and taping on drilling machine.
5	Prepare a Job of gear cutting on milling machine.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

6	Prepare a job of straight cutting on shaper machine.
7	Demonstration of computer numerical control (CNC) machine.
8	Demonstration of Capstan lathe machine.
9	Study of Electrochemical machining process. (Virtual Lab)
10	Generating machining toolpath for complex 3D Shapes for CNC machine (Virtual Lab)
Post-Lab Session	Open-Ended Experiment.

Note: *Minimum eight experiments to be performed based on the above list*

Suggested References

1. A course in Workshop Technology (Volume II), B. S. Raghuwanshi, 1st Edition, 2019, Dhanpatrai and company.
2. Manufacturing Technology (Volume II), P. N. Rao, 4th Edition, 2011, Tata McGraw Hill.
3. Engineering metrology and measurements, N.V. Raghavendra and L. Krishnamurthy, 1st Edition, 2013, Oxford University Press.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

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DEPARTMENT OF MECHANICAL ENGINEERING

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME504T	Measurements & Metrology	2	0	0	2	20	30	50	2

Course Objective

To provide students with fundamental knowledge and skills in measurement techniques and metrology for engineering applications.

Course Outcomes

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

CO1	**Understand:** Describe the principles of measurement systems, identify different types of errors, and explain how limits, fits, and tolerances are applied to ensure precision in engineering.
CO2	**Evaluate:** Explain linear and angular measuring instruments, assess methods for straightness and roundness measurement, and recommend suitable instruments for specific applications.
CO3	**Evaluate:** Explain surface roughness measurement techniques, identify instruments for thread and gear tooth measurement, and evaluate the use of optical projectors, autocollimators, and coordinate measuring machines (CMMs) in industrial inspection.
CO4	**Apply:** Explain temperature, pressure, and speed measurement methods, including non-contact techniques, robotics, AI, and metrology in quality management systems, and recommend suitable methods for specific applications.

SYLLABUS

Unit-I: Fundamentals of Measurement and Metrology

Importance, need, and applications of measurements in engineering. Static and dynamic characteristics, primary and secondary standards. Process of calibration. Errors in Measurement: Systematic errors, random errors, environmental factors, and techniques to reduce errors. Limits, Fits, and Tolerances, applications in engineering assemblies.

Unit-II: Linear and Angular Measurements

Linear Measurement: Vernier calipers, micrometers, dial gauges, and height gauges. Mechanical Comparators and their applications. Slip Gauges. Angular Measurements: Sine bars, sine centers, angle gauges, and bevel protractors. Straightness, Flatness, and Roundness measurement.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Unit-III: Surface and Form Metrology
Introduction to roughness parameters and methods to measure the surface roughness. Instruments for surface measurement, thread measurement, and gear tooth measurement. Working and applications of Optical profile projectors and Autocollimator. Coordinate Measuring Machines (CMM) and applications in industrial inspection. Basics of machine vision for quality inspection and feature measurement.

Unit-IV: Advanced Measurement Techniques
Methods of Temperature, pressure, and speed measurement; Non-contact measurement techniques, types of sensors and their selection criteria. Introduction of robotics and AI in industrial inspection and metrology. Role of metrology in Six Sigma, Total Quality Management (TQM), and statistical process control (SPC).

Textbooks Recommended	
1.	Engineering Metrology by R.K. Jain, Special Edition 2022, Khanna Publications
2.	Mechanical Measurements and Instrumentation by R.K. Rajput, 2021, S. Chand Publications
3.	Metrology and Measurement by Anand K. Bewoor and Vinay A. Kulkarni, 2nd Edition, 2020, McGraw Hill Education
4.	Metrology and Quality Control by M. Mahajan, 2022, Dhanpat Rai Publications
5.	Engineering Metrology & Mechanical Measurements by R. Venkat Reddy, 2021, I.K. International Publishing House

Reference Books Recommended	
1.	Mechanical Measurements by T.G. Beckwith, R.D. Marangoni, and J.H. Lienhard, 6th Edition, 2022, Pearson Education
2.	Introduction to Metrology: Practice and Science of Measurement by David Lepek, 2023, Springer
3.	Engineering Metrology & Mechanical Measurements by R. Venkat Reddy, 2021, I.K. International Publishing House

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025–26

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

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DEPARTMENT OF MECHANICAL ENGINEERING

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME504P	Measurements & Metrology Lab	0	0	2	1	25	25	50	-

Course Objective
To provide students with practical skills in measurement techniques and metrology for engineering applications.

Course-Outcomes	
After successful completion of the course, the students will be able to:	
CO1	**Evaluate:** Measure the linear and angular dimensions using instruments such as Vernier calipers, micrometers, Bevel protractor and sine bars.
CO2	**Evaluate:** Measure the gear tooth profiles, screw threads, and flatness using instruments like profile projectors, optical flats, and gear tooth micrometers.
CO3	**Evaluate:** Measure physical, mechanical quantities such as temperature, force, torque, pressure, speed, power etc. using various sensors and instruments.
CO4	**Evaluate:** Evaluate and calibrate various sensors and instruments to ensure precision in measurements.

Sr. No	Aim of Practical
Pre-Lab Session	Familiarization with Lab and Measuring equipment.
1	Measure and Compare the Linear dimensions by using Vernier Caliper & Micrometer
2	Evaluate and Calibrate the Vernier Caliper & Micrometer using slip gauges.
3	Measure the linear displacement using a Linear variable differential transformer (LVDT).
4	Measure the angle by using a Combination Set, Bevel Protractor and Sine bar.
5	Measure the angular displacement using a variable capacitive transducer.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

6	Evaluate the flatness of standard surface by using optical flat and monochromatic light source.
7	Measure the gear tooth profile using gear tooth Vernier /Gear tooth micrometer.
8	Measure the screw thread by using Profile projector.
9	Measure the speed of the rotating disc by using a stroboscope.
10	Evaluate and Calibrate the pressure gauge by the Dead Weight Pressure Gauge.
11	Measure the force using strain gauge set-up.
12	Measure the temperature of water by using Resistance Temperature Devices/ Thermocouple/ Thermistor/ IC sensor kit.
Post-Lab Session	Open-Ended Experiment.

Note: *Minimum eight experiments to be performed based on the above list.*

Suggested References:

1. Engineering Metrology by R.K. Jain, Special Edition 2022, Khanna Publications
2. Mechanical Measurements and Instrumentation by R.K. Rajput, 2021, S. Chand Publications
3. Metrology and Measurement by Anand K. Bewoor and Vinay A. Kulkarni, 2nd Edition, 2020, McGraw Hill Education
4. Metrology and Quality Control by M. Mahajan, 2022, Dhanpat Rai Publications
5. Engineering Metrology & Mechanical Measurements by R. Venkat Reddy, 2021, I.K. International Publishing House

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	202 5-26

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DEPARTMENT OF MECHANICAL ENGINEERING

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME505P	Machine Drawing and Solid Modelling Lab	0	0	2	1	25	25	50	-

Course Objective
To equip students with the skills to create assembly and detailed drawing of mechanical components as per given limits, fits and tolerances.

Course Outcomes	
After successful completion of the course, the students will be able to:	
CO1	**Understand:** Explain different conventions used in machine drawing.
CO2	**Apply:** Apply fundamentals of projections and draw sectional orthographic views for mechanical components and intersection of solids.
CO3	**Apply:** Predict and draw detailed drawing, assembly drawing and production drawing of given machine components.
CO4	**Create:** Develop 2D drawing and 3D models of mechanical components in CAD software.

Sr. No	Aim of Practical
Pre-Lab Session	Familiarization with Lab.
1	Draw the Conventional representation of Machine Components and Machining Symbols: Conventional representation of Machining Symbols, Welding Symbols, and Surface Finish Symbols.
2	Draw standard machine elements: Threads, Bolts, Nuts, Washers, Rivets, Welds, Keys & Keyways, Couplings.
3	Draw sectional views of machine components: Orthographic Projections, Sectional Views of machine component.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

4	Draw intersection of solids. (Prism with prism, cylinder with cylinder, prism with cylinder, cylinder with cone).
5	Draw assembly of mechanical joints and mechanisms. (Manual drafting).
6	Create assembly of a machine component using CAD software.
7	Create detailed drawing of machine component using CAD software (Couplings, joints, screw jack).
8	Draw component and assembly for a given machine part.
9	Draw production drawing of a given machine component (Manual drafting).
10	Develop 3-D model of machine component using CAD software.
Post-Lab Session	Open-Ended Experiment.

Note: *Minimum eight experiments to be performed based on the above list*

Textbooks Recommended
1. Machine Drawing, N.D.Bhatt, V.M. Panchal, 51th Edition, 2022, Charotar Publishing House.
2. Machine Drawing, K. L. Narayana, P.Kannaiah, K.Venkata Reddy, 6th Edition, 2019, New Age International (P) Limited Publishers.
3. Machine Drawing, R.K.Dhawan, Revised Edition, 2015, S.Chand Publication.
4. Fundamentals of Engineering Drawing, Warren J. Luzadder, Jon M. Duff, 11th Edition, 2015, Prentice Hall

Reference Books Recommended
1. Machine Drawing, R.K. Dhawan, Revised Edition, 2018, S. Chand Publications.
2. Machine Drawing, P. S. Gill, 7th Edition, 2018, S. K. Kataria & Sons.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PECME501T	Hydraulic Machines	3	0	0	3	40	60	100	3

Course Objective

The course enables the students to gain knowledge of working principles of fluid machineries, its design aspects and performance characteristics.

Course Outcomes

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

CO1	**Apply:** Apply the impulse-momentum principle to analyze the dynamic action of a jet on fixed and moving plates, and velocity triangles.
CO2	**Evaluate:** Explain the construction, working principles, velocity diagrams and determine the performance parameter, and design aspects of impulse water turbines.
CO3	**Evaluate:** Explain the construction, working principles, velocity diagrams and determine the performance parameter, and design aspects of reaction water turbines.
CO4	**Analyze:** Examine the performance parameters of roto-dynamic pumps.
CO5	**Analyze:** Analyze the performance parameters of Positive Displacement Pumps.
CO6	**Understand:** Classify and explain the working principles and applications of various miscellaneous hydraulic machines.

SYLLABUS

Unit-I: Impact of jet

Impulse momentum principle and its applications, dynamic action of jet on fixed and moving plates, curved vanes, series of plates and vanes, velocity triangles and their analysis, Introduction to hydroelectric power plant.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Unit –II: Impulse Water Turbines
Classification of hydraulic turbines construction, principle of working, velocity diagrams and analysis, design aspects, performance parameters, performance characteristics, specific speed, selection of turbines, multi-jet Pelton wheel.

Unit –III: Reaction Water Turbines
Classifications, Francis, Propeller, Kaplan Turbines, construction features, velocity diagrams and analysis, degree of reaction, performance characteristics.
Draft tubes: types and analysis, causes and remedies for cavitation phenomenon, governing of turbines, similitude and dimensional analysis of hydraulic turbines

Unit –V: Centrifugal Pumps
Classification of rotodynamic pumps, components of centrifugal pump, types of heads, velocity triangles and their analysis, effect of outlet blade angle, cavitation, NPSH, Thoma's cavitation factor, priming of pumps, installation, specific speed, performance characteristics of centrifugal pump, series and parallel operation of pumps.

Unit –V: Positive Displacement Pumps
Basic Principle, classification, reciprocating pump working, discharge, work done and power required to drive single-acting reciprocating pump and double-acting reciprocating pump, coefficient of discharge, slip, percentage slip and negative slip of reciprocating pump, indicator diagram, effect of acceleration and friction head on indicator diagram, cavitation, air vessel, separation.

Unit –VI: Miscellaneous Hydraulic Machines
Hydraulic accumulator, hydraulic intensifier, hydraulic press, hydraulic crane, hydraulic lift, hydraulic ram, hydraulic coupling, air lift pump, jet pump.

Textbooks Recommended

1. Hydraulic and Fluid Mechanics, Dr. P.N. Modi and Dr. S.M. Seth, 22nd Edition, 2019, Rajsons Publication.
2. Fluid Mechanics & Hydraulic Machines, R.K. Rajput, 6th Edition, 2016, S. Chand Publication.
3. Fluid Mechanics & Hydraulic Machines, Dr. R.K. Bansal, 10th Edition, 2018, Laxmi Publication.

Reference Books Recommended

1. Fluid Mechanics: Fundamentals and Applications, Yunus A. Cengel and John M. Cimbala, 3rd Edition, 2014, McGraw Hill Publication.
2. Fluid Mechanics, Frank M. White, 9th Edition, 2022, McGraw-Hill Publication.
3. Fluid Mechanics and Fluid Machines, S.K. Som, 3rd Edition, 2017, McGraw-Hill Publication.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

(An Autonomous Institute. Affiliated to RTMNU, Nagpur)

DEPARTMENT OF MECHANICAL ENGINEERING

(NBA Accredited)

Vision: Emerge as an excellent centre for Mechanical Engineering education.

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PECME502T	Optimization Techniques	3	0	0	3	40	60	100	3

Course Objective

To enable students with strong foundation for understanding the fundamental principles and laws of optimization techniques to understand linear programming, transportation and assignment model, inventory control, and project management.

Course Outcomes

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

CO1	**Apply:** Formulate real-world problems as Linear Programming Problems and solve using graphical, simplex methods.
CO2	**Evaluate:** Evaluate real world Assignment and Transportation Models for feasible solution
CO3	**Apply:** Apply inventory control models and sequencing algorithms to optimize inventory management and job scheduling in real-world scenarios.
CO4	**Evaluate:** Determine project schedules using PERT and CPM techniques, construct network diagrams, and evaluate cost-time trade-offs through network crashing methods.
CO5	**Evaluate:** Make decisions related to replacement of equipment.
CO6	**Apply:** Apply queuing theory to solve problems involving single-server systems and use Monte Carlo simulation to model real-world scenarios in waiting lines, inventory, and networks.

SYLLABUS

Unit-I: Linear Programming Problem

Introduction to Operations Research: Evolution, definitions, scope, objectives, phases, models and limitation of Operations Research. **Linear Programming Problem:** Formulation of LPP for various scenarios in business and industry, optimal solution to linear programming problem by graphical method and simplex method, big-M method. Introduction of Primal and Dual Problems, Sensitivity analysis.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Unit-II: Transportation and Assignment Model

Transportation Model: Formulation of transportation model, initial basic feasible solution using different methods (North-West corner, Least Cost, Vogel's Approximation Method), optimization by Modified Distribution method (MODI). Special cases: Unbalanced problems, profit maximization problems, degeneracy in transportation. **Assignment Model:** Formulation of task assignment problem and solution by Hungarian method. Variation in problem such as prohibited assignment, infinite cost, maximization problem. Travelling Salesman Problem by branch and bound method

Unit –III: Inventory Control and Sequencing Model

Inventory Control: Inventory classification, types of cost associated with inventory, inventory models with deterministic demands (single Product): model (a) demand rate uniform and replenishment rate infinite, model (b) demand rate uniform and production rate finite. Inventory models with price breaks, ABC analysis. **Sequencing Model:** Basic assumptions, Johnson's algorithm, sequencing n jobs on single machine using priority rules, sequencing using Johnson's rule—n jobs on 2 machines, n jobs on 3 machines, n jobs on m machines.

Unit-IV: Project Management

Basics of project management, Phases of project management, construction of network diagrams, Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM). Crashing of network for finding minimum cost solution and/or minimum time solution.

Unit-V: Replacement models

Replacement of items that deteriorate with time: No changes in the value of money, changes in the value of money. Replacement of Items that fail completely: Individual replacement and group replacement policies.

Unit –VI: Queuing Theory and Simulation

Queuing Theory: Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Single server queuing model (M/M/1:∞/∞/FCFS) : Poisson arrivals and Exponential service times. **Simulation:** Basic concepts, advantages and disadvantages, random number generation, Monte Carlo Simulation applied to waiting line situations, inventory and networks

Textbooks Recommended

1. Operations Research Theory and Applications, JK Sharma, 6th Edition, 2017, Trinity Press.
2. Operations Research, PK Gupta, DS Hira, 7th Edition, 2018, S. Chand Publication.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Reference Books Recommended
1. Introduction to Operations Research, Frederick S. Hillier and Gerald J. Lieberman, 11th Edition, 2021, McGraw Hill Education.
2. Operations Research: An Introduction by Hamdy A. Taha, 10th Edition, 2019, Pearson Publication.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

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		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PECME503T	Control Systems Engineering	3	0	0	3	40	60	100	3

Course Objective

Establish an understanding of fundamental concepts of the mathematical modeling, transfer function, stability analysis in time and frequency domain.

Course Outcomes

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

CO1	**Apply:** Understand and apply the fundamentals of control system representation and develop mathematical models of the mechanical systems.
CO2	**Apply:** Develop mathematical models of the electrical, electronic and electromechanical systems.
CO3	**Apply:** Make use of reduction technique and signal flow graph to develop transfer function system representation.
CO4	**Analyze:** Analyze steady state and time domain response.
CO5	**Create:** Construct root loci graph to estimate stability of the systems.
CO6	**Create:** Construct bode plot, polar plot to analyze the frequency response of the systems.

SYLLABUS

UNIT-I: Modeling of Physical Systems 1

Basic Elements of Control System- Open loop and closed loop systems, Feedback and feed forward systems, Classification of control systems, Servomechanisms, Laplace transform, Transfer function & its determination for physical systems.

Modeling of mechanical translational and rotational systems.

UNIT-II: Modeling of Physical Systems 2

Control system components- Operational amplifier, Servo potentiometers, Servomotors, Tachogenerator, Stepper motor, Synchros, Transfer function blocks of D.C. motor position control system.

Modeling of Electrical, Electronic and Electromechanical Systems.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

UNIT-III: Transfer Function System Representation
Block diagram representation- Reduction technique for single and multiple input/output.
Signal flow graph- Transfer function simplification using Masons Gain Formula.
Conversion of block diagram into signal flow Graph, Conversion of algebraic equation into block diagram and signal flow graph.

UNIT-IV: Time Domain Analysis
Step, Ramp, Impulse, Parabolic and Periodic signals, Types of errors, Steady state errors and Error constants, Time domain specifications, Transient response.
Mode of Controls, Basic control actions and industrial controllers, Introduction to P, PI and PID controllers their characteristics, Force control and adaptive control, representation and applications, Pneumatic, hydraulic and electric controllers.

UNIT-V: Stability Analysis
Concept and types of stability, Routh-Hurwitz Criterion and its application for determination of stability, limitations.
Simple transfer functions transient response from root locus, Necessary condition for stability, Root locus concept, Construction of Root loci.

UNIT-VI: Frequency Domain analysis
Introduction to frequency response, Determination of Gain Margin, Phase Margin and their Stability from Bode and Polar plots, Inverse Bode Plot, Transportation lag.

Text Books Recommended

1. Modern Control Engineering, Katsuhiko Ogata, 5th Edition, 2015, Pearson Publication.
2. Control Systems: Theory and Applications, Smarajit Ghosh, 2nd Edition, 2012, Pearson Publication.
3. Feedback Control System, R. A. Barapatre, 11th Edition, 2008, Tech-Max Publication.

Reference Books Recommended

1. Control System Engineering, I. J. Nagrath and M.Gopal, 6th Edition, 2021, New Age International Publishers.
2. Control System Engineering, Norman S. Nise, 5th Edition, 2018, Wiley Publication.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-MDMME501T	Electronic Controls	3	0	0	3	40	60	100	3

Course Objective
To provide thorough comprehension of electronic control systems from a mechanical perspective to design, and implement these systems in various engineering applications.

Course Outcomes	
After successful completion of the course, the students will be able to:	
CO1	**Understand:** Explain control system components and their applications.
CO2	**Analyze**: Analyze the characteristics and performance of different sensors and signal conditioning circuits for mechanical systems.
CO3	**Apply:** Apply the knowledge of actuators and drive systems to select suitable actuators for designed mechanical applications.
CO4	**Evaluate:** Evaluate the controller hardware for control system design and Explain the design challenges and considerations in industrial applications.
CO5	**Understand:** Explain the microcontroller applications in digital electronics.
CO6	**Apply**: Apply the knowledge of advanced technologies in electronic control.

SYLLABUS

Unit-I: Fundamentals of Electronic Control Systems
Introduction to control systems in mechanical engineering, Essential components: sensors, actuators, controllers, Open-loop and closed-loop control systems, System dynamics and feedback mechanisms, Linear and non-linear control systems.

Unit-II: Sensors and Signal Conditioning
Overview of sensor types: temperature, pressure, position, velocity, Sensor characteristics and selection criteria, Signal conditioning techniques: filtering, amplification, linearization, Electrical noise and interference in sensor outputs, Data acquisition systems, Calibration and maintenance of sensors.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Unit-III: Actuators and Electromechanical Systems
Types of actuators: electric motors, hydraulics, pneumatics, Drive mechanisms and transmission systems, Electrical drives: stepper and servo motors, Control of hydraulic and pneumatic actuators, Safety considerations in actuator systems.

Unit-IV: Control Systems Design and Analysis
Control system design methodologies, Controller hardware: selection and application, System identification and adaptive control, Design challenges and considerations in industrial applications.

Unit-V: Digital Electronics and Microcontroller Applications
Fundamentals of digital electronics, Microcontroller and types, Interfacing microcontrollers with sensors and actuators, Introduction to IoT-enabled control systems and Power electronics in control applications.

Unit-VI: Advances in control system
Basics of PID control, MEMS, and smart sensors, Wireless sensor networks and their applications, Sustainable and green technologies in control systems, Real-world applications.

Textbooks Recommended

1. Control Systems Engineering, I.J. Nagrath and M. Gopal, 6th Edition, New Age International Publishers 2021.
2. Automatic Control Systems, B. C. Kuo and FaridGolnaraghi, 9th Edition, Wiley India 2014.
3. Modern Control Engineering, Katsuhiko Ogata, 5th Edition, Prentice Hall India 2009.

Reference Books Recommended

1. Digital Signal Processing, S. Salivahanan, A. Vallavaraj, and C. Gnanapriya, 10th Edition, Tata McGraw Hill Education 2019.
2. Fundamentals of Electric Drives, G.K. Dubey, 2nd edition 2001, Narosa Publishing House.
3. Microcontrollers: Theory and Applications, Ajay V Deshmukh, Tata McGraw Hill Education 2017.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

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		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-OECME501T	Smart Manufacturing Systems	2	0	0	2	20	30	50	2

Course Objective

The course enables the students to gain knowledge of the basic and advance field in manufacturing.

Course Outcomes

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

CO1	**Understand:** Explain and classify basic conventional and non-conventional manufacturing processes.
CO2	**Understand:** Classify and explain various rapid prototyping processes.
CO3	**Analyze:** Explain and Analyze the various systems of automation in manufacturing processes and various aspects of Computer Aided Manufacturing & Computer Integrated Manufacturing.
CO4	**Understand:** Explain the basic principles and framework of Industry 4.0

SYLLABUS

Unit-I: Introduction to Manufacturing Processes

Introduction to manufacturing processes, classification of manufacturing processes, Forming Processes: casting, forging, rolling, extrusion, drawing and sheet metal forming. Machining Processes: Conventional machining and non-conventional machining processes, selection of manufacturing processes.

Unit-II: Rapid Prototyping Processes and Operations

Introduction to rapid prototyping, types of processes for rapid prototyping, subtractive processes, additive processes, virtual prototyping, self-replicating machines, direct manufacturing, rapid tooling.

Unit-III: Automation and Manufacturing Technologies

Introduction to automation, numerical control, industrial robots, Computer aided manufacturing, computer aided process planning, group technology, Cellular manufacturing, flexible manufacturing systems, holonic

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

manufacturing.
Unit-IV: Industry 4.0 Evolution of manufacturing industry, components of industry 4.0: industrial internet of things (IIoT), big data, cloud computing, additive manufacturing, advanced robotics, augmented and virtual reality, mass customization.

Textbooks Recommended
1. Manufacturing Technology (Volume I and II), P. N. Rao, 4th Edition, 2018, Tata McGraw Hill.
2. Manufacturing Engineering & Technology, Kalpakjian, 7th Edition, 2018, Pearson.

Reference Books Recommended
1. Fundamentals of Modern Manufacturing Materials, Processes, and Systems, Mikell P. Groover, 6th Edition, 2020, John Wiley & Sons, Inc.
2. Industry 4.0-The Industrial Internet of Things, Alasdair Gilchrist, 1st Edition, 2016, Springer Science Business Media, New York.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME601T	Computer Aided Design	3	0	0	3	40	60	100	3

Course Objective

The course enables the students to understand the insights of the computer aided design process to develop, modify and optimize the machine components.

Course Outcomes

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

CO1	**Understand:** Explain the concepts of computer graphics and CAD standards in the design process.
CO2	**Evaluate:** Determine the transformation matrix for translation, scaling, rotation, reflection and shear in two dimensional and three-dimensional geometries.
CO3	**Apply:** Apply the concept of geometrical modelling to develop geometrical entities.
CO4	**Evaluate:** Determine the stress, strain and displacement for one dimensional element using finite element method.
CO5	**Evaluate:** Determine the stress, strain and displacement for truss and two-dimensional elements using finite element method.
CO6	**Create:** Design the machine element using optimum design techniques by considering different optimizing parameters.

SYLLABUS

Unit-I: Overview of Computer Graphics and Product Cycle

Role of computers in the design process, difference between conventional and computer aided design, algorithm for the generation of basic geometric entities like line, circle, ellipse by using parametric & nonparametric equations.

CAD standards: Graphical Kernel System, standards for exchange images, Open Graphics Library, Data exchange standards. Communication standards.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Unit-II: Geometrical Transformations
Concept of windowing & clipping, window and viewport, line clipping and polygon clipping. Two-Dimensional Transformation: Translation, Scaling, Rotation, Reflection and Shear transformation, concept of homogeneous representation and concatenation, inverse transformation. Three-Dimensional Transformation: Translation, Scaling, Rotation, Reflection.

Unit-III: Techniques for Geometric Modelling
Parametric representation of geometry, Bezier curves, cubic spline curves, B-Spline curves, constructive solid geometry, feature based design, wire frame modelling, solid modelling and surface modelling of basic entities like box, cone, and cylinder, B- representation technique using set theory.

Unit-IV: One Dimensional Finite Element Method
Fundamental concept of finite element method, plain stress and strain, finite element modelling, potential energy approach, Galerkin Approach, coordinate and shape function, assembly of global stiffness matrix and load vector, properties of stiffness matrix, quadratic shape function.

Unit-V: Truss and Two-Dimensional Finite Element Method
Stiffness matrix for plane truss element, stress calculations, two-dimensional stress analysis using constant strain triangles, treatment of boundary conditions, shape functions for CST element. Formulation of stiffness matrices for truss and CST elements.

Unit-VI: Optimization in Engineering Design
Objectives of optimum design, adequate and optimum design, Johnson's Method of optimum design, primary design equation, subsidiary design equations and limit equations, optimum design with normal and redundant specifications of various machine elements.

Textbooks Recommended

1. CAD/CAM Theory and Practice, Zeid Ibrahim, 2nd Edition, 2009, McGraw Hill Education.
2. Introduction to Finite Elements in Engineering, T. R. Chandrupatla and A.D. Belegundu, 4th Edition, 2011, Prentice Hall India Learning Private Limited.
3. Computer Aided Design and Manufacturing. Bi, Zhuming, and Xiaoqin Wang. , 2020 . John Wiley & Sons.

Reference Books Recommended

1. Operational Methods in Computer-Aided Design. Leondes, Cornelius T. , 2019.,Computer-Aided Design, Engineering, and Manufacturing: Systems Techniques and Applications, CRC Press.
2. Computer Graphics, C version, Donald Hearn and M. Pauline Baker, 2nd Edition, 2002, Pearson.
3. Optimization for Engineering Design - Algorithms and Examples, Kalyanmoy Deb, 2nd Edition, 2013, PHI Learning.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME601P	Computer Aided Design Lab	0	0	2	1	25	25	50	-

Course Objective
The course enables students to develop the skill to create and analyze components using CAD software.

Course Outcomes	
After successful completion of the course, the students will be able to:	
CO1	**Create:** Develop 2D and 3D models of mechanical engineering components using CAD software tools.
CO2	**Create:** Formulate and solve one dimensional and two-dimensional machine components using finite element analysis software.
CO3	**Create:** Develop a program to generate graphical entities.

Sr.No.	List of Experiments
Pre-Lab Session	1. Familiarization with Computer Aided Design lab. 1. Understanding the framework of CAD tools and their application.
01	To generate 2D geometric modeling of an engineering object, demonstrating the use of Boolean operations like ADD, SUBTRACT, PAN, ZOOM and ROTATE commands in the CAD package.
02	To generate 3D geometric modeling of an engineering object, demonstrating EXTRUDE, REVOLVE and LOFT commands in the CAD package.
03	To generate CAD models of two simple and complex engineering solid models, illustrating the geometric and design properties using any CAD software.
04	To design and prepare the Assembly model of a complex engineering mechanism in 3D CAD package from the detailed drawing.
05	To design and perform Static Structural Analysis of 1D bar element by standard FE package and compare the analysis with results of analytical method.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

06	To design and perform Static Structural Analysis of 1D Truss element by standard FE package and compare the analysis with results of analytical method.
07	To design and perform Static Structural Analysis of 2D CST element by standard FE package and compare the analysis with results of analytical method.
08	To write programs to generate Bezier Curve in MATLAB.
09	To write a program for generation of entities like Line, Circle, and Ellipse using Bresenham's Algorithm in MATLAB.
10	To write programs for 2D and 3D Transformations in MATLAB.
Post Lab Session	Open-Ended Experiment.

Note: *A Minimum of eight experiments to be performed based on the above list.*

Suggested References:

1. Computer Graphics, C version, Donald Hearn and M. Pauline Baker, 2nd Edition, 2002, Pearson.
2. Computer Aided Design and Manufacturing. Bi, Zhuming, and Xiaoqin Wang. , 2020 . John Wiley & Sons.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME602T	Energy Conversion- I	3	0	0	3	40	60	100	3

Course Objective

The objective of this course is to provide students with a comprehensive understanding of the fundamental principles and practical applications of energy conversion systems in thermal power plants.

Course Outcomes

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

CO1	**Analyze:** Classify steam generators into different categories, compare fire tube and water tube boilers, and analyze their working principles, advantages, and applications.
CO2	**Evaluate:** Evaluate the performance of steam generators by determining evaporation capacity, equivalent evaporation, boiler efficiency, and preparing a heat balance sheet.
CO3	**Evaluate:** Evaluate the conditions for maximum discharge, determine the critical pressure ratio, and assess the effects of friction on nozzle performance.
CO4	**Apply:** Classify different types of steam turbines based on construction and working principles and apply this knowledge to identify suitable turbines for specific industrial or power plant applications.
CO5	**Evaluate:** Evaluate turbine performance by interpreting velocity diagrams and evaluating the work output, thrust, and power for both impulse and reaction turbines.
CO6	**Evaluate:** Evaluate and compare the performance of various types of steam condensers in terms of heat exchange efficiency, water consumption, and overall system performance for specific power plant applications

SYLLABUS

Unit-I: Introduction to Steam Power plant

Introduction to the layout of thermal power plants, Coal handling system, ash handling systems. Classification of steam generators (i.e. Boilers), comparison of fire tube & water tube boilers, high-pressure boilers, boiler mountings, and accessories.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Gchaudhari
Jitendra Chaudhari

Unit-II: Steam Generator and Chimney

Draught and its classification, calculations for chimney height, chimney diameter & efficiency. Condition for maximum discharge. Principle of steam generation, the necessity of water treatment, Performance of steam generators: Evaporation capacity, equivalent evaporation, boiler efficiency, and preparation of heat balance sheet of the boiler.

Unit-III: Steam Nozzles

Steam nozzles: Adiabatic expansion in nozzles, maximum discharge, critical pressure ratio and effects of friction, calculation of throat, exit areas and exit velocity of the nozzle, supersaturated flow, Wilson Line.

Unit-IV: Steam Turbine

Classification of Steam turbine, Advantages of steam turbine over Steam engines, Methods of Reducing Wheel or Rotor Speed, Impulse and Reaction Turbine, Turbine efficiencies, Governing and Control.

Unit-V: Compounding of Steam Turbine

Compounding of steam turbines, Energy losses in steam turbines, flow of steam through turbine blades, reheat factors, velocity diagrams, graphical and analytical methods, work done, thrust and power, dimensions and proportioning of the blades, , condition for maximum efficiencies, reheat and regenerative cycles.

Unit-VI: Steam Condenser and Cooling Towers

Steam condensers: Classification of condensers, quality and quantity of cooling water required, calculations for the surface condenser, Dalton's law of partial pressure, sources of air leakages and air removal, air ejectors.

Cooling towers: Natural draught and forced draught cooling towers, cooling ponds.

Textbooks Recommended

1. Thermal Engineering (Engineering Thermodynamics and Energy Conversation techniques), P.L Ballaney, 25th Edition 2018, Khanna Publication.
2. Thermal Engineering, R.K Rajput, 8th Edition 2017, Laxmi Publication.

Reference Books Recommended

1. Engineering Thermodynamics, P.K. Nag, 6th Edition 2017, McGraw Hill Publication.
2. Thermodynamics: An Engineering Approach, Yunus A Cengel, Michael A Boles, 9th Edition 2018, McGraw Hill Publication.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME603T	Dynamics of Machines	3	0	0	3	40	60	100	3

Course Objective

To equip students with the fundamental knowledge of dynamics in order to understand the forces, torque and energy involved in different machine parts and to make them conversant with the dynamics of vibrating system.

Course Outcomes

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

CO1	**Apply:** Apply the fundamentals of force analysis to calculate the various parameters of planer mechanism, jump-off speed in cams.
CO2	**Analyze:** Analyze the stabilization of sea vehicles, aircrafts, and automobile vehicles in order to examine the gyroscopic effect.
CO3	**Evaluate:** Construct, solve and interpret the outcome of balancing masses for rotating and reciprocating mass systems.
CO4	**Apply:** Demonstrate the dynamics of mechanism for control of flywheel and governor, and to calculate their energy fluctuation, effort and power.
CO5	**Evaluate:** Classify types of vibratory motions and determine the natural frequencies for the vibrating system.
CO6	**Evaluate:** Compare free torsional vibrations and determine the natural frequencies for the rotor systems under dynamic conditions.

SYLLABUS

Unit-I: Force Analysis

Role of force analysis in linkage design, concept of superposition of forces, static analysis of two and three force members, concept of centre of percussion, application of equivalent linkages, mass moment of inertia for linkage elements, D'Alembert's principle and inertial forces, dynamic analysis of linkages (graphical approach), force analysis on engine components (piston, connecting rod, bearing), cam dynamics and jump- off speed phenomenon in cams

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Unit-II: Gyroscopic Couple and Precessional Motion

Fundamentals of gyroscopic motion, directions of spin vector, precession vector and torque vector. Gyroscopic couple of a plane disc, gyro-couple and gyro-reaction couple, analogy with motion of particle in a circular path, analysis of the forces on bearings due to the forced precessing of rotating disc mounted on shafts, gyroscopic effects on an aero plane, gyroscopic stabilization of sea vessels (ships) during steering, pitching and rolling. Stability analysis of an automobile while negotiating a curve (four wheel drive vehicle and two wheel vehicle).

Unit-III: Balancing

Introduction to static and dynamic balancing , difference between active and passive balancing, balancing of several masses revolving in the same plane (analytical approach), balancing of several masses revolving in different planes (graphical approach), primary and secondary unbalanced forces of reciprocating masses, partial balancing of unbalanced primary force in a reciprocating engine, partial balancing of locomotives, variation of tractive force, swaying couple, hammer blow, balancing of multi-cylinder In-line engines, balancing of radial engines and V- engines. Field balancing of rotors.

Unit-IV: Mechanisms for Control: Flywheel and Governors

Flywheel: Purpose of flywheel, working principle of flywheel, turning moment diagram (TMD) for a single cylinder double acting steam engine, four stroke cycle internal combustion engine and multi-cylinder engine, fluctuation of energy, determination of maximum fluctuation of energy, coefficient of fluctuation of speed, size of flywheel, dimensions of flywheel rim, application of flywheel in punching press.

Governors: Necessity of governor, classification of governors, terminology used in governor, difference between flywheel and governor. Characteristics of centrifugal governor, quality of governor (controlling force, stability and isochronism, sensitiveness, hunting), power and effort of governor, governor effort and power.

Unit-V: Single degree of freedom (DOF) systems

Terms used in vibratory system analysis, basic features of vibrating system, types of vibrations, determination of natural frequency of free longitudinal vibrations by Equilibrium method, Energy method and Rayleigh's method, damped free vibrations, damping coefficient, damping ratio, and logarithmic decrement.

Forced vibrations, forced-damped vibrations, magnification factor, vibration isolation and transmissibility. Determination of natural frequency of free transverse vibration due to point loads, whirling of shafts.

Unit-VI: System with two degrees of freedom

Difference between single and two DOF system, normal modes and natural frequency of torsional vibratory system, determination of natural frequencies of two rotors and three rotors system. Concept of torsionally equivalent shafts, geared system and dynamic vibration absorber.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Textbooks Recommended
1. Theory of Machine, S. S. Rattan, 5th Edition, 2019, McGraw Hill Education (India) Private Limited.
2. Vibration and Noise for Engineers, Pujara .K, 8th Edition, 2018, Dhanpat Rai and Co. Private Limited.
3. Mechanical Vibrations, Singiresu S. Rao, 6th Edition, 2018, Nem Chand & Brothers Publication.

Reference Books Recommended
1. Theory of Mechanisms and Machines, Amitabha Ghosh and Ashok Kumar Mallik, 10th Edition, 2020, Affiliated East-West Press.
2. Mechanism and Machine Theory, J. S. Rao & Dukkipatti, 6th Edition, 2019, New Age International (P) Ltd, Publishers.
3. Mechanical Vibrations: Modeling and Measurement, Tony L. Schmitz and K. Scott Smith, 2nd Edition, 2020, Springer.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PCCME603P	Dynamics of Machines Lab	0	0	2	1	25	25	50	-

Course Objective
To develop an understanding of the concepts of dynamics of machines, performance characteristics of mechanism control devices and to make students conversant with mechanical vibratory systems.

Course Outcomes	
After successful completion of the course, the students will be able to:	
CO1	**Analyze:** Inspect the effects of gyroscopic torque on motorized gyroscope and examine the balancing condition of rotating masses in a balancing machine set up.
CO2	**Apply:** Identify jump-off phenomenon in cam system and calculate the mass moment of inertia of disc using bifilar-trifilar suspension system.
CO3	**Evaluate:** Evaluate the performance characteristics of governors and flywheel for given specifications.
CO4	**Evaluate:** Analyze the modes of vibrations and measure natural frequencies of given mechanical system.

Sr. No.	List of Experiments
Pre-Lab	1. Familiarization with dynamics of machines lab. 2. Hands on practice on digital tachometer, dimmer stat, mechanical governors and exposure to universal vibration system. 3. Plotting of graphs through Excel software / online tools.
1	Determine the performance characteristics of gyroscope, gyroscopic torque and verify the gyroscopic rules of plane disc by checking percentage of error.
2	Determine the balancing mass for the disturbing mass in the same plane and balancing of disturbing masses in different planes.
3	Performance of wheel balancing of four-wheeler vehicle by visiting any automobile workshop or

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	202 5-26

	service center.
4	Determine the jump off speed of a typical cam follower system, its spring tension and to plot the displacement diagram of a circular arc cam.
5	Determine the radius of gyration of a disc using bi-filar and tri-filar suspension and to calculate the moment of inertia of the disc.
6	Calculate the controlling force of governor at given speed, sensitiveness at given limits of lift, effort, power and to plot the characteristic curves of controlling force versus radius of rotation.
7	Calculate experimentally, the natural frequency of the free torsional vibration of single rotor & two rotor system and compare it with theoretical value.
8	Calculate the logarithmic decrement of damped torsional vibrations of single rotor system, compute the damping factor and plot the graph between logarithmic decrement versus depth of immersion.
9	Determine the natural frequency and time period of oscillation theoretically and actually of a free un- damped vibrating system and also to compute the spring stiffness.
10	Determine the whirling speed of shafts with various diameters experimentally and compare it with theoretical values and observe various modes of vibration.
11	Determine the natural frequency of cantilever beam under excitation.
12	To observe the Frequency Response Function (FRF) of a cantilever beam and determine natural frequencies under a vibration shaker experimental setup. (Virtual Lab)
13	Impact test on cantilever Modal analysis in order to judge and evaluate natural frequencies of a cantilever beam. (Virtual Lab).
Post-Lab	Open Ended Experiment.

Note: *A minimum of eight experiments to be performed based on the above list with minimum one experiment on virtual lab.*

Suggested References:

1. Kinematics and Dynamics of Machines: Modeling and Design with MATLAB®, Simulink®, and Simscape™ Multibody™, 1st Edition, 2025, Springer.
2. Mechanical Vibrations, R Venkatachalam, 2nd Edition, 2020, PHI Learning Private Limited.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

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DEPARTMENT OF MECHANICAL ENGINEERING

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PECME601T	Internal Combustion Engines	3	0	0	3	40	60	100	3

Course Objective

To develop a comprehensive understanding of Internal Combustion Engines, their construction and working principles, fuel types and supply systems, ignition systems and combustion processes, engine losses, lubrication and cooling, engine performance for various applications and understanding emissions control and emerging technologies.

Course Outcomes

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

CO1	**Understand:** Classify I.C. Engines, explain construction & working of I.C. Engines and relate engine performance parameters.
CO2	**Evaluate**: Compare automotive fuels and explain the fuel supply system required for petrol and diesel engines.
CO3	**Analyze:** Inspect ignition systems in I.C. Engines and Examine combustion process for S.I. and C.I. Engines.
CO4	**Analyze:** Inspect engine losses and analyze role of engine lubrication and cooling.
CO5	**Evaluate**: Evaluate the performance of I.C. Engine and judge the suitability of I.C. Engine for different application.
CO6	**Understand**: Summarize the various types of emissions from I.C. Engines and their controlling measures and understand new technologies used in IC Engine.

SYLLABUS

Unit-I: Introduction to Internal Combustion Engines:

Classification of heat engines, I.C. Engine components and nomenclature, classification of I.C. Engines, application of I.C. Engines.

Working principle of I.C. Engines- four stroke spark ignition engine; four stroke compressed ignition engine; two stroke engine; comparison of S.I. and C.I. engines, comparison of two stroke and four stroke engines, valve timing diagrams of S.I. and C.I. engines.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Relating first law of thermodynamics to I.C. Engines, I.C. Engine performance parameters, design and performance data for I.C. Engines.

Unit-II: Automotive Fuels and Fuel Supply Systems:

Automotive fuels: Air-fuel ratio requirement in I.C. Engines, stoichiometric ratio, rating of I.C. Engine fuels, merits and demerits of I.C. Engine fuels, alternative fuels and their properties (Ethanol, Methanol, Hydrogen, Natural Gas, CNG, LPG, Bio gas and Bio-diesel).

Fuel supply system:

Carburetion, Air-fuel ratio requirements at different loads, calculation of air-fuel ratio, principle of carburetion, types of carburetors.

Mechanical injection system: Functional requirements, classification of injection system, fuel fed pump, injection pump, injection pump governors and nozzle.

Electronic injection system: Multipoint Fuel Injection System (MPFI), Port Injection (PI), Throttle Body Injection System (TBI), Electronic Control System (ECU).

Unit-III: Ignition Systems and Combustion in I.C. Engines:

Ignition systems: Requirements of ignition system, Battery ignition system, Magneto ignition system, Modern ignition system (TCI and CDI), Ignition timing and engine parameters.

Combustion in S.I. Engines: Stages of combustion, flame front propagation, phenomenon of knock in S.I. Engine, combustion chambers for S.I. Engines.

Combustion in C.I. Engines: Stages of combustion, phenomenon of knock in C.I. Engine, combustion chambers for S.I. Engines.

Supercharging and turbo charging in I.C. Engines.

Unit-IV: Engine Friction, Lubrication and Cooling:

Engine friction: Losses in engines- direct, pumping, blowby and frictional losses; mechanical friction, efficiency and factors affecting mechanical friction.

Engine lubrication: Function of lubrication, mechanism of lubrication, lubrication of engine components, lubrication systems- mist, wet sump, dry sump and crankcase ventilation, properties, additives and SAE rating of lubricants.

Engine cooling: Parameters affecting engine heat transfer, need of cooling system, types of cooling system- liquid cooled and air cooled systems.

Unit-V: Engine Testing and Performance Parameters:

Engine testing: Need of testing of I. C. Engines, measurement of friction power, indicated & brake power, measurement of speed, fuel & air consumption.

Performance parameters: Calculation of engine power- indicated and brake power, indicated and brake mean effective pressure; calculation of engine efficiencies- air standard efficiency; indicated & brake thermal efficiency, mechanical efficiency, relative efficiency, volumetric efficiency; heat balance in I.C. Engines, factors influencing the performance of I.C. Engines, performance analysis of single and multi-cylinder I. C. Engines.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Unit-VI: Emissions of I.C. Engine and Modern Technologies in I.C. Engines:
Emissions of I.C. Engine: Atmospheric pollution from automotive engines, causes of gasoline emission and its control, Emission control methods- thermal converters and catalytic converters, particulate traps, Exhaust- Gas Recirculation (EGR), Positive Crankcase Ventilation (PCV), Evaporation emission control system, Euro Norms and Bharat stage Norms.
Modern Technologies in I.C. Engines: Homogeneous Charge Compression Ignition (HCCI) engine, Premixed Charge Compression Ignition (PCCI) engine, Gasoline Direct Injection Compression Ignition (GDCI) engine, Reactivity Controlled Compression Ignition (RCCI) engine, Variable Compression Ratio (VCR) engines, variable valve timing technology, fuel cell, hybrid engine, stratified charge engines.

Text Books Recommended
1. Internal Combustion Engines, V. Ganesan, 4th Edition, 2017, Tata McGraw Hill.
2. A course in Internal Combustion Engine, V. M. Domkundwar, 4th Edition, 2018, Dhanpat Rai & Co.

Reference Books Recommended
1. Internal Combustion Engine Fundamentals, John B. Heywood, 2nd Edition, 2018, McGraw-Hill Education.
2. Internal Combustion Engines, M. L. Mathur, R. P. Sharma, 2nd Edition, 2018, Dhanat Rai Publication.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PECME602T	Industrial Engineering	3	0	0	3	40	60	100	3

Course Objective

The course develops an understanding of design, improvement and installation of integrated system in industry.

Course Outcomes

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

CO1	**Understand:** Explain productivity concept, factors, and methods to measure and improve
CO2	**Apply:** Apply the concept of method study as a means of developing more effective methods.
CO3	**Apply:** Make use of the techniques of time study to establish the time for a qualified worker to carry out a specified job.
CO4	**Apply:** Examine the concept of ergonomics for work place design.
CO5	**Evaluate:** Compare various forecasting techniques and co-relate it to the concept of sales forecasting of industry
CO6	**Analyze:** Classify various types of maintenance and the factor governing successful maintenance system.

SYLLABUS

Unit-I: Productivity
Introduction and concept of productivity, types of productivity, factors affecting productivity. Tools and techniques to improve productivity, measurement of productivity.

Unit-II: Work Study
Introduction and definition of work study, basic procedure, human factor in the application of work study, concept of method study, objectives of method study and procedure of methods study.

Unit – III : Work Measurement
Objective of work measurement, work measurement techniques and uses of time study, steps in time study, factors affecting the rate of working, concept of allowance and calculation of standard time..

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Unit-IV: Ergonomics
Introduction and objective of human engineering, man machine system, display design, design of controls, Effect of environment on performance of worker and work place design.

Unit-V: Forecasting
Need for forecasting, classification of forecasting methods like judgmental technique, time series analysis, least square method, moving average method, exponential smoothing method.

Unit-VI: Maintenance
Objectives, types of maintenance, preventive, predictive, break down maintenance. Reliability and maintainability analysis. Failure data analysis, reliability, mean time between failure (MTBF), mean time to repair (MTTR), bath tub curve.

Textbooks Recommended

1. Industrial Engineering & Production Management, Martand Telsang, 3rd Edition 2018, S. Chand publication.
2. Motion & Time Study: Improving Productivity, Marvin E, Mundel & David L, 6th Edition 2013, Pearson Education

Reference Books Recommended

1. Industrial Engineering Handbook, Kjell B. Zandin, 7th Edition 2018, McGraw Hill.
2. Introduction to work study, International Labour office, 3rd Edition 2015, Geneva.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PECME603T	Hydraulic and Pneumatic Systems	3	0	0	3	40	60	100	3

Course Objective

This course equips students with basic understanding of hydraulic and pneumatic systems.

Course Outcomes

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

CO1	**Analyze** and apply the principles of fluid power to evaluate the selection, performance, and operation of hydraulic systems and pumps for industrial applications.
CO2	**Evaluate** the design, operation, and applications of hydraulic actuators, control components, and accessories in fluid power systems.
CO3	**Design** and evaluate hydraulic circuits and systems, including accumulators, intensifiers, and industrial applications, to address complex fluid power requirements.
CO4	**Analyze** the properties of air, control components, and circuit design methods to evaluate and optimize pneumatic and electro-pneumatic systems for industrial automation.
CO5	**Evaluate** and apply maintenance practices to address issues like oxidation, corrosion, contamination, and fluid-related problems in hydraulic and pneumatic systems.
CO6	**Design** hydraulic and pneumatic systems for industrial applications, troubleshoot issues, and optimize solutions for automation, power packs, and CNC tool handling

SYLLABUS

Unit I: Fluid Power Principles and Hydraulic Pumps

Introduction to Fluid power, Advantages and Applications, Fluid power systems, Types of fluids, Properties of fluids and selection, Basics of Hydraulics, Pascal's Law, Principles of flow, Friction loss, Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory, Pump Classification, Construction,

Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary, Fixed and Variable displacement pumps, Problems.
Unit II: Hydraulic Actuators and Control Components Hydraulic Actuators: Cylinders, Types and construction, Application, Hydraulic cushioning, Hydraulic motors, Control Components: Direction Control, Flow control and pressure control valves, Types, Construction and Operation, Servo and Proportional valves, Applications, Accessories: Reservoirs, Pressure Switches, Applications, Fluid Power ANSI Symbols, Problems.
Unit III: Hydraulic Circuits and Systems Accumulators, Intensifiers, Industrial hydraulic circuits, Regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.
Unit IV: Pneumatic and Electro Pneumatic Systems Properties of air , Perfect Gas Laws, Compressor, Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit, Cascade method, Electro Pneumatic System, Elements, Ladder diagram, Problems, Introduction to fluidics and pneumatic logic circuits.
Unit V: Maintenance of Hydraulic and Pneumatic Systems Introduction to types of maintenance - Oxidation and corrosion of hydraulic fluids - maintaining and deposing of fluids - wear of moving parts due to solid particle contamination of the fluid. Problems caused by gases in hydraulic fluids.
Unit VI: Trouble Shooting and Applications Installation, Selection, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools, Low cost automation, Hydraulic and Pneumatic power packs.

Textbooks Recommended
1. Fluid Power with Applications, Anthony Esposito 7th Edition, 2024 ,Pearson India Education, NewDelhi.
2. Industrial Hydraulics, John J. Pippenger, 3rd Edition , 1979 ,Tata McGraw Hill.
3. Pneumatic Systems, S. R. Mujumdar, Tata McGraw Hill.
4. Hydraulics and Pneumatics, Andrew Parr, 9th Edition, 2005, Jaico Publishing house.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Reference Books Recommended
1. Oil Hydraulic Systems, S.R. Majumdar, 2nd Edition,2002, Tata McGraw Hill.
2. Pneumatic Systems, S.R. Majumdar, 1st Edition, 2002, Tata McGraw Hill.
3. Pneumatics: Concepts, Design and Applications, Jagadeesha T, 1st Edition, Universities Press India, 2015.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

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DEPARTMENT OF MECHANICAL ENGINEERING

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PECME604T	Refrigeration and Air-Conditioning	3	0	0	3	40	60	100	3

Course Objective
The objective of this course is to provide students with a comprehensive understanding of refrigeration and air conditioning systems, including cycle analysis, heat load calculations, air distribution design, and environmental impacts of refrigerants.

Course Outcomes	
After successful completion of the course, the students will be able to:	
CO1	**Analyze:** Analyze the vapor compression refrigeration (VCR) system using P-h and T-s charts, considering the effects of subcooling, superheating, and variations in operating pressures on system performance.
CO2	**Evaluate:** Analyze and evaluate the performance of multistage VCR systems, multiple compressor systems, and multiple evaporator systems, considering factors such as system efficiency and capacity.
CO3	**Analyze:** Analyze the working principles and performance of aircraft refrigeration systems and other non-conventional refrigeration systems, including Bell-Coleman, bootstrap, Vortex tube, steam jet and thermoelectric refrigeration systems, pulse tube refrigeration and regenerative systems, to determine their suitability for specific applications.
CO4	**Evaluate:** Evaluate human comfort conditions using effective temperature scales, comfort charts, and psychrometric properties to recommend optimal air-conditioning parameters for residential, commercial, and industrial applications.
CO5	**Evaluate:** Evaluate the significance of sensible heat factor (RSHF, GSHF, and ESHF) in designing air conditioning systems for varying load conditions and indoor requirements.
CO6	**Evaluate:** Evaluate different duct design methods, such as equal friction method, static regain method, and velocity reduction method, for optimal air distribution in HVAC systems.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

SYLLABUS

Unit-I: Refrigeration

Applications of refrigeration reversed Carnot cycle, unit of refrigeration, coefficient of performance. Vapour compression refrigeration system (VCR): Introduction, VCR cycle and its analysis on P-h/T-s chart, effect of sub cooling, superheating, condenser pressure, evaporator pressure, pressure drops on the performance of the VCR system. Vapour absorption refrigeration system: Introduction, principle, ammonia-water & lithium bromide -water & three-fluid systems, performance. Refrigerants: Classifications, refrigerant properties, nomenclature of refrigerants, alternate refrigerants, global warming potential & ozone depletion potential,
Montreal & Kyoto protocol.

Unit-II: Multistage Vapour Compression Refrigeration Systems

Need of multistage VCR Systems, Multiple compressor system, multiple evaporator systems, Refrigeration equipment's: Compressors, evaporators, condenser, and expansion device & control, defrosting methods & charging of refrigeration systems.

Unit-III: Other Refrigeration systems

Aircraft refrigeration system: Introduction, bell-Coleman cycle, bootstrap and regenerative systems. Unconventional Refrigeration system: Vortex tube, steam jet and thermoelectric refrigeration systems, pulse tube refrigeration & Cryogenics.

Unit-IV: Psychrometric Properties and Human Comfort

Psychrometry: Introduction, psychrometric properties and processes, psychometric chart, by-pass factor of coils, air washer, evaporative cooling, adiabatic saturation, sensible heat factor. Human comfort: Thermodynamics of human body, factors affecting human comfort, effective temperature, comfort chart.

Unit-V: Air Conditioning Systems and Load Estimation

Air conditioning system: Summer air conditioning system, winter air conditioning system, year-round air conditioning system, central air conditioning system, all-air and all-water air conditioning system, evaporative air-cooling system, RSHF, GSHF, ESHF. Heat Load Calculations: Data collection for load calculation, various components of heat load, heat load estimate, cooling load calculations.

Unit-VI: Air Transmission & Distribution

Principle of air distribution, types of grills & diffusers & their selection criteria, air alteration, types of air filters, distribution of air through ducts, duct types & materials, pressure losses in ducts, equivalent diameter of circular duct for a rectangular duct, duct design methods, duct friction chart, duct arrangement systems. Air conditioning controls.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Textbooks Recommended
1. Refrigeration and Air Conditioning, Arora and Domkundwar, 18th Edition 2018, Dhanapat Rai and Sons Publishing Company.
2. Refrigeration and Air Conditioning, S.N. Sapali, 2nd Edition 2014, PHI.

Reference Books Recommended
1. Refrigeration & Air conditioning, C P Arora, 4th Edition 2021, McGraw Hill.
2. A Textbook of Refrigeration and Air Conditioning, RS Khurmi and J K Gupta, 4th Edition 2020, VISION IAS.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PECME605T	Automobile Engineering	3	0	0	3	40	60	100	3

Course Objective

This course is designed to understand the basic concepts of automobile, its components and working of various transmission systems, brakes, steering systems and suspension systems used in automobile.

Course Outcomes

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

CO1	**Understand:** Classify different types of chassis, engines and explain various types of Lubrication system & Cooling System.
CO2	**Understand:** Explain the construction and working principles of various types of clutches and gearbox.
CO3	**Analyze:** Classify and analyze various transmission system and brakes used in automobile.
CO4	**Analyze:** Analyze different types of steering and suspension systems used in automobile.
CO5	**Analyze:** Compare different types of tyres and analyze various factors affecting tyre life.
CO6	**Understand:** Explain various safety considerations and modern development in automobiles.

SYLLABUS

Unit I: Introduction to Automobile Engineering.

Introduction, classification of automobiles, chassis and body, frames, frameless construction. Different systems in an automobile. Automobile engines, different parts and auxiliary systems, engine terminology, four-stroke and two-stroke operation, multi-cylinder engines. Engine lubrication, points of lubrication, types of lubrication systems, properties of lubricants. Engine cooling, types of cooling systems.

Unit II: Clutches and Gear box

Clutches: Clutch operation and classification of clutches, single plate, multiplate, centrifugal and cone clutches, clutch construction, and lining.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Gear box: Function and necessity of manual transmission, types of gear box, sliding-mesh, constant-mesh and synchromesh gear box, gear shift mechanism, automatic transmission.

Unit III: Transmission system and Brakes

Transmission system: Propeller shafts, universal joints, four wheels drive arrangement, Differential.

Brakes: Need of braking systems, classification of brakes, hydraulic braking, pneumatic braking, master cylinder, disc brakes, drum brakes, requirements of brake fluid.

Unit IV: Steering systems and Suspension systems

Steering systems: Need of steering system, Principle of steering & steering geometry, turning radius, centre point, power steering principle.

Suspension systems: Suspension system, functions of suspension, component parts, coil springs, leaf springs, air springs, shock absorbers, conventional and independent suspension systems.

UNIT V: Wheels and Tyres

Classification of wheels, pressed wheels and cast wheels, wheel assembly and parts, wheel rim, tyres, tyres with tubes and tubeless tyres, advantages, construction of a tyre, plies, radial plies, tyre-treads and tyre specifications, factors affecting tyre life, precautions regarding wheel balancing.

UNIT VI: Automobile safety and Recent advances in automobiles

Safety in automobile: Safety considerations, state of the art safety systems, safety sensors, latest approach to automotive safety, requirements of automobile body, and materials for body work.

Recent advances in automobiles: ABS, electronic power steering, emission measurement and control techniques, use of machine learning and data analytics for automotive applications, hybrid and electric vehicle.

Textbooks Recommended

1. Automobile Engineering – Volume I and Volume II, Dr. Kirpal Singh, 14th Edition 2021, Standard Publishers Distributor.
2. Automobile Engineering, R.B. Gupta,13th Edition, 2019, Satya Prakashan New Delhi.

Reference Books Recommended

1. Automotive Engineering Powertrain- Chassis System and Vehicle Body, David A. Crolla, 8th Edition, 2021, Butterworth-Heinemann Ltd.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles- Fundamentals, Theory, and Design, Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, 6th Edition, 2022, CRC Press.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-PECME606T	Environmental Engineering	3	0	0	3	40	60	100	3

Course Objective

To develop an understanding of environmental challenges, analyze pollution sources, and evaluate control measures while applying sustainable practices and complying with environmental regulations.

Course Outcomes

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

CO1	**Understand:** Explain the impact of socio-economic structures and occupational exposures on the environment and the scope of environmental engineering.
CO2	**Apply:** Implement air pollution control measures using appropriate methods and equipment to reduce pollutant levels.
CO3	**Apply:** Utilize water pollution control techniques to mitigate adverse effects on health, ecosystems, and compliance with standards.
CO4	**Analyze:** Examine the effects of solid and liquid waste pollution on soil and determine suitable disposal methods
CO5	**Analyze:** Investigate the types and impacts of industrial noise pollution and propose strategies for its control
CO6	**Evaluate:** Assess environmental laws and management systems for their effectiveness in addressing pollution control and sustainability.

SYLLABUS

Unit-I: Introduction

Man and Environment: Overview (socio-economic structure & occupational exposures) – Scope of Environmental Engineering – pollution problems due to urbanization & industrialization

Unit-II: Air Pollution

Causes of air pollution, Analysis of Air Pollutants, Air Pollution Control Measures & Equipment, Methods &Approach of Air Pollution Control

Unit – III : Water & Environment

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Water Sources , Different Sources Of Water Pollution, Water Pollution & Its Control, Adverse effects on: Human Health & Environment, Animal life, Plant life , Indian Standards for Water Pollution Control
Unit-IV: Soil & Environment SOIL Polluting Agencies & Effect of Solution, Liquid & Solid Wastes, Toxic: Inorganic & Organic Pollutants, Solid Waste Disposal, Dumping Domestic & Industrial Solid Wastes: Advantages & Disadvantages
Unit-V: Noise & Environment Noise Pollution: Intensity, Duration – Types of Industrial Noise – Ill effects of Noise – Noise Measuring & Control – Permissible Noise Limits
Unit-VI: Environmental Legislations, Authorities & Systems Air & Water Pollution Control Acts & Rules (Salient Features only) – Functions of State / Central Pollution Control Boards – Environmental Management System: ISO 14 000 (Salient Features only)

Textbooks Recommended
1. Environmental Engineering by S.K. Garg, 31st Edition, Khanna Publishers
2. Environmental Pollution Control Engineering by C.S. Rao, 2nd Edition, 2018, New Age International Publishers
3. Environmental Engineering and Management by Suresh K. Dhameja, 3rd Edition, 2018 S.K. Kataria & Sons

Reference Books Recommended
1. Environmental Engineering: A Design Approach by V. Subramanian, 2nd Edition,2020, Tata McGraw-Hill Education.
2. Introduction to Environmental Engineering by Mackenzie L. Davis, 5th Edition, 2017 McGraw-Hill Education.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

(An Autonomous Institute. Affiliated to RTMNU, Nagpur)

DEPARTMENT OF MECHANICAL ENGINEERING

(NBA Accredited)

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Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-MDMME601T	Sustainable Development and Engineering	3	0	0	3	40	60	100	3

Course Objective

This course enables students to understand the principles and significance of sustainability in engineering, analyze the environmental challenges and evaluate their impact on sustainable development goals.

Course Outcomes

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

CO1	**Understand:** To familiarize the students to the area of sustainability and concepts of sustainability engineering
CO2	**Understand:** the relevance and the concept of sustainability and the global initiatives in this direction
CO3	**Understand:** Explain the different types of environmental pollution problems and their sustainable solutions
CO4	**Analyze:** analyze the impact of environmental regulations and standards on sustainable development
CO5	**Analyze:** analyze the concepts related to conventional and non-conventional energy
CO6	**Analyze:** analyze the broad perspective of sustainable practices by utilizing engineering knowledge and principles

SYLLABUS

Unit-I: Introduction to Sustainability

Need of Sustainability, technology and Sustainable Development-Natural resources and their pollution, Carbon credits, Zero waste concepts. Life Cycle Analysis, Environmental Impact Assessment studies, Sustainable habitat, Green buildings, green materials, Energy, Conventional and renewable sources, Sustainable urbanization, Industrial Ecology.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Unit-II: Development Goal Evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM).
Unit-III: Environmental Pollution Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.
Unit-IV: Environmental management standards ISO 14001:2015 framework and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.
Unit-V: Resources and its utilization Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.
Unit-VI: Sustainability practices Sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanization, Sustainable cities, Sustainable transport.

Textbooks Recommended
1. Introduction to Sustainability for Engineers, Toolseeram Ramjeawon, 1st Edition, 2020, CRC Press.
2. Sustainability Engineering: Concepts, Design and Case studies, 1st Edition, 2015, Prentice Hall.
3. System Analysis for sustainable Engineering: Theory and applications, Ni bin Chang, 1st Edition 2010, McGraw Hill Publications,

Reference Books Recommended
1. Engineering for Sustainable development: Delivery a sustainable development goals, 1st Edition, 2021, UNESCO, International Centre for Engineering Education, France.
2. Introduction to Sustainable Engineering, Rag. R.L. and Ramesh Lakshmi Dinachandran, 2nd Edition, 2016, PHI Learning Pvt. Ltd.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-SECME601P	Simulation Methods in Mechanical Engineering	0	0	2	1	25	25	50	-

Course Objective

The objective of the course is to gain proficiency and competency of various simulation software's used in Mechanical industries for better understanding of the engineering phenomenon.

Course Outcomes

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

CO1	**Apply:** Apply basic engineering knowledge to choose simulation methodologies and model the workflow.
CO2	**Apply:** Construct the meshing for physical models and apply engineering knowledge to utilize various solver settings in simulation software's.
CO3	**Evaluate:** Evaluate the performance of basic mechanical engineering systems using structural, thermal and fluid dynamics analysis.
CO4	**Create:** Create a complete solution of actual industrial systems including validation, verification and reporting.

SYLLABUS

Module I: Introduction to simulations in Mechanical Engineering

Definition and scope of simulation in engineering. Importance in design, testing, and optimization. Types of simulation: Structural, thermal, fluid dynamics, and multi-physics. Mathematical Foundations: Governing equations of mechanics (Newtonian, Navier-Stokes, heat conduction). Linear and nonlinear systems. Introduction to numerical methods: Finite Element Method (FEM), Finite Volume Method (FVM), and Finite Difference Method (FDM). Simulation Workflow: Problem definition. Preprocessing: Geometry creation, material properties, boundary conditions, and meshing. Solution and post-processing.

Module II: Preprocessing for simulations

Simulation Tools Overview: Overview of common tools like ANSYS, SolidWorks Simulation, and MATLAB/Simulink. Mesh Generation: Importance of meshing in simulation. Types of mesh: Structured,

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

unstructured, and hybrid. Mesh refinement and optimization techniques. Boundary Conditions Types of boundary conditions Solver Settings: Convergence criteria and solver settings. Importance of time-step selection in transient simulations. Computational cost optimization.
Module III: Simulations of basic Mechanical Engineering systems Structural Analysis: Stress and strain analysis in mechanical components. Thermal Analysis: steady-state and transient heat transfer simulations. Fluid Dynamics Simulation: Basics of Computational Fluid Dynamics (CFD), Simulation of internal and external flows.
Module IV: Simulations and reporting of actual industrial systems Thermal management in electronics cooling/Aerodynamics of automotive designs/Energy efficiency analysis in industrial systems. Validation and Verification: Techniques for model verification and validation. Comparison with experimental data. Project Work and Reporting: Developing a comprehensive simulation project, Documentation, visualization, and presentation of results.

**Minimum eight experiments (excluding Pre-Lab and Post Lab sessions) to be performed based on above modules.*

Textbooks Recommended
1. An Introduction to Computational Fluid Dynamics, The Finite Volume Method ,H. K. Versteeg and W. Malalasekera, 2nd ed. Harlow, UK: Pearson Education, 2007.
2. Computational Fluid Dynamics: The Basics with Applications, J. D. Anderson, McGraw- Hill.

Reference Books Recommended
1. Introduction to the Finite Element Method , J. N. Reddy, 4th Edition , 2018,McGraw-Hill Education
2. Applied Numerical Methods with MATLAB for Engineers and Scientists, 4th Edition , 2018, McGraw-Hill Education.
3. Engineering Analysis with ANSYS Workbench 2021, Theory, Applications, Case Studies , H.-H. Lee, SDC Publications, 2021.
4. Engineering Design and Visualization with Simulation Tools. J. Wickert, 2012, Clifton Park, NY, USA: Cengage Learning.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			ESE
		L	T	P		Continuous Evaluation	End Sem. Exam	Total	Duration (Hrs.)
N-SECME602P	CNC Machine Programming and Operations	0	0	2	1	25	25	50	-

Course Objective
The course enables students to develop skills in CNC machine programming, operation, and execution.

Course Outcomes	
After successful completion of the course, the students will be able to:	
CO1	**Create:** Create CNC part programs for basic and complex geometries using G and M codes.
CO2	**Apply:** Operate CNC machines (lathe and milling) for component manufacturing.
CO3	**Analyze:** Analyze machining operations to optimize process parameters and ensure quality.

Sr. No.	List of Experiments
Pre-Lab Session	Familiarization with CNC machining lab.
01	Create and simulate a simple CNC part program for turning operations, including facing and OD turning.
02	Create and execute a CNC part program for step turning, grooving, and threading on a CNC lathe.
03	Create and simulate a CNC milling program for pocketing and contouring operations.
04	Create and execute a CNC milling program for drilling and slot milling.
05	Perform tool length offset and work offset settings on CNC machines.
06	Perform machining of a component using canned cycles (drilling, boring) on CNC milling.
07	Analyze surface finish and dimensional accuracy of machined parts using metrology tools.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

08	Create and simulate a CNC program using CAD/CAM software for complex geometries.
09	Perform machine tool condition monitoring and maintenance practices.
Post Lab Session	Open-Ended Experiment

Note: *A Minimum of eight experiments to be performed based on the above list.*

Suggested References:

1. Computer Aided Design and Manufacturing, Khushdeep Goyal. 2022, S.K. Kataria & Sons.
2. Basics of CNC programming. Negi, Pawan, Mangey Ram, and Om Prakash Yadav. 2022., River Publishers.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26

Course Code	Course Title	Hours / Week			Credits	Maximum Marks	
		L	T	P		Continuous Evaluation	Total
NX-ME201	Additive Manufacturing	3	0	0	3	100	100

Course Objective

The course enables students to understand the principles and applications of additive manufacturing processes, equipping them with knowledge of design, planning, and material-specific techniques used in advanced manufacturing industries.

Course Outcomes

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

CO1	**Understand:** Understand and explain the principles, evolution, and classifications of additive manufacturing.
CO2	**Apply:** Apply computer-aided process planning and demonstrate the use of CAD tools in AM workflows.
CO3	**Analyze:** Analyze liquid-based AM techniques, their working principles, and industrial applications.
CO4	**Evaluate:** Evaluate sheet-based additive manufacturing techniques and their applicability for different materials and use cases.
CO5	**Create:** Create component designs suitable for wire additive manufacturing processes, focusing on real-world applications.
CO6	**Evaluate:** Assess powder-based additive manufacturing methods and propose solutions for process optimization.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2024-25

SYLLABUS

Unit-I: Introduction to Additive Manufacturing (AM)
Historical development of additive manufacturing and its distinction from traditional manufacturing methods, Principles of AM and overview of process flow (design to final product), Classification of AM processes as per ASTM standards, Applications of AM in aerospace, automotive, healthcare, and consumer goods industries, Benefits and limitations of AM.

Unit-II: Computer-Aided Process Planning for Additive Manufacturing
Fundamentals of computer-aided process planning (CAPP) and its role in AM, Slicing algorithms, layer thickness selection, and support structure generation, CAD tools and software for additive manufacturing: Pre-processing and optimization tools, Challenges in process planning, such as overhang structures and heat management, Case studies: Optimizing AM workflows for industrial applications.

Unit-III: Liquid Additive Manufacturing
Overview of liquid-based AM processes: Stereolithography (SLA) and Material Jetting, Working principles of liquid resin curing (photopolymerization), Materials: Photopolymers, liquid silicones, and hybrid resins, Process characteristics: Accuracy, surface finish, and mechanical properties of parts, Applications in rapid prototyping, dental implants, and bio-printing.

Unit-IV: Sheet Additive Manufacturing
Fundamentals of sheet lamination processes, Techniques: Laminated Object Manufacturing (LOM) and ultrasonic additive manufacturing, Materials used: Paper, polymers, metals, and composites, Advantages: Cost-effectiveness and rapid production of large parts, Limitations: Material compatibility and resolution, Case studies: Industrial use of sheet-based AM in packaging and tooling.

Unit-V: Wire Additive Manufacturing
Principles of wire arc additive manufacturing (WAAM), Equipment and setup: Wire feeders, arc sources, and substrate materials, Materials: Steel, aluminum, titanium, and their alloys, Characteristics of WAAM: High deposition rate, mechanical properties, and limitations, Applications: Aerospace, automotive, and large structural components, Hands-on approach: Designing components for WAAM.

Unit-VI: Powder Additive Manufacturing
Powder-based AM processes: Powder Bed Fusion (PBF), Binder Jetting, Directed Energy Deposition (DED), Material requirements: Particle size, shape, and flowability, Process parameters: Laser power, scanning speed, and layer thickness, Challenges: Powder handling, waste reduction, and part defects, Applications: Aerospace turbine blades, medical implants, and high-performance tooling, Advanced topics: Multi-material printing and recycling in powder-based AM.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2024-25

Textbooks Recommended
1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Ian Gibson, David Rosen, and Brent Stucker, Springer, New York, NY, 2015.
2. 3D printing and additive manufacturing technologies, Kumar, L. Jyothish, Pulak M. Pandey, and David Ian Wimpenny, eds. Singapore: Springer, 2019.

Reference Books Recommended
1. Rapid prototyping: laser-based and other technologies, Venuvinod, Patri K., and Weiyin Ma. Springer Science & Business Media, 2013.
2. Fundamentals of stereolithography, Jacobs, Paul F. In 1992 International Solid Freeform Fabrication Symposium. 1992.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2024-25

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT & RESEARCH, NAGPUR.

(An Autonomous Institute, Affiliated to RTMNU, Nagpur)

DEPARTMENT OF MECHANICAL ENGINEERING

(NBA Accredited)

Vision: Emerge as an excellent centre for Mechanical Engineering education.

B. TECH. MECHANICAL ENGINEERING

MULTIDISCIPLINARY MINOR COURSES [MDM]

Sr. No.	Multidisciplinary Minor Courses [MDM] Options
1	Multidisciplinary Minor in Engineering
2	Multidisciplinary Minor in Business Analytics
3	Multidisciplinary Minor in Economics & Finance

LIST OF COURSES- MULTIDISCIPLINARY MINOR IN ENGINEERING

Sr. No	Category	Course Code	Semester	Course Title
1	Multidisciplinary Minor-1	N-MDMME301T	Third	Introduction to Algorithms & Data Structures
2	Multidisciplinary Minor-2	N-MDMME401T	Fourth	Database Management Systems
3	Multidisciplinary Minor-3	N-MDMME501T	Fifth	Electronic Controls
4	Multidisciplinary Minor-4	N-MDMME601T	Sixth	Sustainable Development and Engineering
5	Multidisciplinary Minor-5	N-MDMME701T	Seventh	Data Analysis and Visualization

LIST OF COURSES- MULTIDISCIPLINARY MINOR IN BUSINESS ANALYTICS

Sr. No.	Category	Course Code	Semester	Course Title
1	Multidisciplinary Minor-1	N-MDMBA301T	Third	Introduction to Business Analytics
2	Multidisciplinary Minor-2	N-MDMBA401T	Fourth	Data Analysis and Visualization
3	Multidisciplinary Minor-3	N-MDMBA501T	Fifth	Statistical Methods for Business
4	Multidisciplinary Minor-4	N-MDMBA601T	Sixth	Data Warehousing and Mining
5	Multidisciplinary Minor-5	N-MDMBA701T	Seventh	Business Intelligence

LIST OF COURSES- MULTIDISCIPLINARY MINOR IN ECONOMICS & FINANCE

Sr. No.	Category	Course Code	Semester	Course Title
1	Multidisciplinary Minor-1	N-MDMEF301T	Third	Business Economics
2	Multidisciplinary Minor-2	N-MDMEF401T	Fourth	Fundamentals of Accounting
3	Multidisciplinary Minor-3	N-MDMEF501T	Fifth	Business Finance
4	Multidisciplinary Minor-4	N-MDMEF601T	Sixth	Financial Market & Services
5	Multidisciplinary Minor-5	N-MDMEF701T	Seventh	Investment Analysis & Portfolio Management

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B. TECH. MECHANICAL ENGINEERING
OPEN ELECTIVES

OPEN ELECTIVE-I

SN	Semester	Offering Programme	Course Code	Course Name
1	III	Computer Science and Engineering (Data Science)	N-OECCD301T	Ethics & Data Privacy
2	III	Computer Science and Engineering (Artificial Intelligence and Machine Learning)	N-OECCM301T	CRM Technologies
3	III	Computer Science and Engineering	N-OECCS301T	Digital Marketing
4	III	Electrical Engineering	N-OECEE301T	Solar Photovoltaic Systems
5	III	Electronics and Telecommunication Engineering	N-OECET301T	Digital Circuit Design

OPEN ELECTIVE-II

SN	Semester	Offering Programme	Course Code	Course Name
1	IV	Computer Science and Engineering (Data Science)	N-OECCD401T	Game Development Using Python
2	IV	Computer Science and Engineering (Artificial Intelligence and Machine Learning)	N-OECCM401T	Basics of Human Computer Interaction
3	IV	Computer Science and Engineering	N-OECCS401T	JavaScript Programming
4	IV	Electrical Engineering	N-OECEE401T	Electric Vehicles
5	IV	Electronics and Telecommunication Engineering	N-OECET401T	Wireless Sensor Networks

OPEN ELECTIVE-III

SN	Semester	Offering Programme	Course Code	Course Name
1	V	Computer Science and Engineering (Data Science)	N-OECCD501T	Web Development Using Python
2	V	Computer Science and Engineering (Artificial Intelligence and Machine Learning)	N-OECCM501T	Open-Source Tools for Project Development
3	V	Computer Science and Engineering	N-OECCS501T	Mobile Application Development
4	V	Electrical Engineering	N-OECEE501T	Electrical Energy Conservation & Audit
5	V	Electronics and Telecommunication Engineering	N-OECET501T	Data Communication

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NEP - LIST OF OPEN ELECTIVE

COURSES OFFERED BY THE MECHANICAL ENGINEERING DEPARTMENT TO OTHER PROGRAMMES

Sr. No.	Category	Course Code	Semester	Course Title
1	Open Elective-1	N-OECME301T	Third	Energy Systems and Technologies
2	Open Elective-2	N-OECME401T	Fourth	Operations Research
3	Open Elective-3	N-OECME501T	Fifth	Smart Manufacturing Systems

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B. TECH. MECHANICAL ENGINEERING

EXIT SCHEME

Levels	Exit After	Qualification Title	Programme Credit requirements	Additional Mandatory Exit Credit requirements offered during summer vacation			
4.5	1st Year Programme [2nd Semester]	One Year UG Certificate in Major Discipline	All Credits of I and II Semester	**Total Credits: 08**			
				Sr. No.	**Course Code**	**Course Name**	**Credits**
				1	NX-ME101	Machine Shop Practices	3
				2	NX-ME102	Welding and Fabrication	3
				3	NX-ME103	Internship/ Apprenticeship of 4 weeks	2
5	2nd Year Programme [4th Semester]	Two Years UG Diploma in Major Discipline	All Credits of I,II, III and IV Semester	**Total Credits: 08**			
				Sr. No.	**Course Code**	**Course Name**	**Credits**
				1	NX-ME201	Additive Manufacturing	3
				2	NX-ME202	Mini Project	3
				3	NX-ME203	Internship/ Apprenticeship of 4 weeks	2
5.5	3rd Year Programme [6th Semester]	Three Years B.Voc. in Major Discipline	All Credits of I,II, III,IV,V and VI Semester	**Total Credits: 08**			
				Sr. No.	**Course Code**	**Course Name**	**Credits**
				1	NX-ME301	Introduction to Robotics	3
				2	NX-ME302	Mini Project	3
				3	NX-ME303	Internship/ Apprenticeship of 4 weeks	2

B. TECH. MECHANICAL ENGINEERING

PROPOSED ASSESSMENT AND EVALUATION OF PRACTICAL COURSES

Course	Evaluation	Weightage
Practical Course	Continuous Evaluation	100%

A student shall be evaluated for his / her academic performance in a practical course on the basis of 100% continuous evaluation.

Continuous Evaluation [50 Marks]:

The Continuous evaluation shall be carried out comprehensively on the basis of assessment of his/ her performance in each conducted practical, journal completion, assessment Experiential Learning viz. Laboratory Assignment/ Mini Project and a Practical Examination as shown in below table.

Assessment Tools	Marks
*Day to Day Performance	**15**
Experiential Learning	**10**
Practical Examination	**25**
Total	**50**

** The rubrics of distribution of marks shall be as per the guidelines of Office of Dean Academics*

Day to Day Performance:

The students shall be evaluated regularly on the basis of performance in each laboratory practical/ experimentation conducted during practical hours including viva voce and journal evaluation. It shall include the following assessment parameters-

Regular Lab Performance- *It shall aid in evaluation of student's* ***punctuality, preparedness, execution and consistency*** *in lab work completion as well as adherence to the course coordinator guidelines.*

Lab Records/Reports- *It shall evaluate* ***completeness, correctness*** *of the lab work as well as assess* ***quality and timely submission*** *of lab activities.*

Viva-Voce during Lab – *It shall* ***test the understanding*** *of practical/ experiment performed by the student and his/ her ability to explain.*

Experiential Learning:

This assessment tool shall encourage student for ***independent learning*** *and* ***enhance his/ her creativity****. Laboratory Assignments/ Mini Projects etc. shall be undertaken it. The activities/ tasks can be simulation driven, software driven, through online platforms, virtual labs, mini models, hardware prototype etc. using modern tools. The flexibility is provided to the course co-ordinator to decide the mode in which this exercise shall be conducted. The following three modes are listed below:*

MODE-1

The activities of ***Experiential Learning*** *may be split into three tasks categories progressing from elementary to advanced level as per below table:*

Task No.	Difficulty Level	Marks
1	*Elementary*	**10**
2	*Intermediate*	
3	*Complex*	

MODE-2

Two tasks under ***Experiential Learning*** *shall be performed by student; the distribution of marks shall be as under:*

Experiential Learning	Marks
Task-1	**5**
Task -2	**5**

MODE-3

One task under ***Experiential Learning*** *shall be performed by student; the distribution of mark shall be as under:*

Experiential Learning	Marks
Task	**10**

The course-coordinator with approval from Chairman BoS shall select any of the above mode for implementation.

The list of student allocation and the details of Experiential Learning viz. laboratory assignment/ mini-project etc. in the form of ***assignment sheet/ problem statement*** *with adequate information including* ***task details, assessment rubrics, date of submission*** *etc.* ***shall be provided to the students at the beginning of the practical session****. The tasks of experiential learning and its*

assessment criteria/ rubrics shall be finalized ***in consultation with the Industry/ Academic Experts*** *of the field wherever possible and approved by the Chairman BoS.*

Practical Examination:

For practical courses, at the end of semester, a practical examination shall be conducted and its assessment shall be as follows:

Assessment Component	Marks
Examination	**15**
Viva Voce	**10**
Total	**25**

The ***examination*** *shall evaluate the* ***practical skills*** *viz. experimentation setup, conduction, troubleshooting, taking results, analysis, its interpretation, drawing conclusions etc. For software related practical courses innovative methods of examination viz. through pseudo codes, debugging, testing of pre-written codes, preparation of flowcharts, UML diagrams etc. may be incorporated in assessment.*

Whereas, the ***viva voce*** *shall evaluate the* ***depth of knowledge and practical understanding*** *of the complete course based on a comprehensive oral based assessment.*

Academic/Industry Expert External Examiner shall be involved in practical Examination wherever required.

Failed/ Absent Students:

For the students who have failed in the course or remained absent in the practical examination, ***a resit examination*** *of* ***25 marks*** *against* ***the practical examination*** *shall be conducted for such students, the timetable of which shall be scheduled by the Controller of Examination in consultation with the Head of the Department.*

Detention Students:

The Institute's detention rules will be applicable.

Revision	BoS Meeting	Date	W. E. F.
-	10th	29/03/2025	2025-26