

NIRMA UNIVERSITY
INSTITUTE OF TECHNOLOGY
Teaching & Examination Scheme
Bachelor of Technology (Mechanical Engineering)

Semester-VII

w. e. f. Academic Year 2025-26

Course Code	Course Title	Teaching Scheme (hours/week)				Examination Scheme			
		L	T	P	C	Duration Hours	Component Weightage		
							SEE	CE	LPW
4ME101CC25	Production Technology and Management	3	0	2	4	3	0.3	0.3	0.4
4FT901CC24	Research Methodology*	0	0	4	4	-	-	0.5	-
	Department Elective- III	3	0	2	4	3	0.3	0.3	0.4
		3	1	0			0.6	-	0.4
	Department Elective- IV	3	0	2	4	3	0.3	0.3	0.4
		3	1	0			0.6	-	0.4
	Elective Course-II under Minor	3	1	0	4	3	0.6	-	0.4
		3	0	2			0.3	0.3	0.4
		2	0	4			0.3	0.3	0.4
		2	1	2			0.3	0.3	0.4
	Total	-	-	-	20	-	-	-	-

*The course will be spread over two semesters (semester 6 and semester 7). 4 credits will be awarded on successful completion of examination components at the end of semester 7.

Department Elective-III

Sr. No.	Course Code	Course Name	L	T	P	C
1	4ME601ME25	Condition Monitoring of Mechanical Equipment	3	0	2	4
2	4ME201ME25	Operations Research	3	0	2	4
3	4ME301ME25	Refrigeration and Air Conditioning	3	0	2	4

Department Elective-IV

Sr. No.	Course Code	Course Name	L	T	P	C
1.	4ME102ME25	Additive Manufacturing	3	0	2	4
2.	4ME103ME25	Maintenance Engineering and Safety	3	0	2	4
3.	4ME302ME25	Computational Fluid Dynamics	3	0	2	4

w.e.f. for first year students admitted in 2022-23 and D to D students admitted in 2023-24 onwards.

Sr. No.	Course Code	Course Name	L	T	P	C
4.		Additive Manufacturing	3	0	2	4
5.		Maintenance Engineering and Safety	3	0	2	4
6.		Computational Fluid Dynamics	3	0	2	4

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech in Mechanical Engineering
Semester	VII
Course Code:	
Course Title:	Production Technology and Management
Course Type:	Core
Year of Introduction:	2025-26

L	T	Practical component			C
		LPW	PW	W	S
3	0	2	-	-	4

Course Learning Outcomes (CLOs):

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

- 1 classify the cutting tools, their geometries and cutting fluids used for various machining processes (BL4)
- 2 explain mechanics of machining (BL5)
- 3 identify the functions of production, planning and control (BL3)
- 4 solve the forecasting and inventory control problems. (BL6)

Unit	Contents	Teaching hours (Total 45)
Unit I	Cutting Tools and Cutting Fluids Machining of metals and non-metals, classification, tool signature of single point cutting tools, solid and inserted bit tools, tool materials, tool coatings, multi point cutting tools: types and their geometry, chip breaker, form tools, tools for dry machining, function, selection and application of cutting fluid.	10
Unit II	Theory of metal cutting Orthogonal and oblique cutting, theory of chip formation, types of chips, chip thickness ratio and shear plane angle, forces and power in machining, concept of machinability, tool wear and tool life, effect of tool wear and machining variables on the surface quality of different materials, economics of machining.	10
Unit III	Production Planning and Control	13

Introduction and importance of production and operation management, concept of production systems, types of production systems, routing and estimation, loading and scheduling. Plant location and layout, purchase and store management, material requirements planning, capacity planning.

Unit IV Forecasting and Inventory Management

12

Sales Forecasting: Importance of consumer opinions, distribution surveys, executive opinions and marketing trends in sales forecasting, Different forecasting techniques and Time series analysis, Inventory Control and Management: Cost elements, inventory carrying cost, ordering cost, shortage cost, basic inventory models, introduction to supply chain management.

Self – Study: The self-study content will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

Suggested Readings/References:

1. Kalpakjian, Serope, and Steven R. Schmid. "Manufacturing engineering." Technology; Prentice Hall: London
2. Groover, Mikell P. Fundamentals of modern manufacturing: materials, processes, and systems. John Wiley & Sons.
3. HMT, Production Technology, Tata McGraw-Hill Publishing Company Ltd
4. Elwood S. Buffa, Rakesh K. Sarin, Modern Production / Operations Management, John Wiley & Sons, Inc.
5. Dileep R. Sule, Production Planning and Industrial Scheduling: Examples, Case Studies and Applications, CRC Press

Suggested list of experiments

Sr. No.	Title	Hours
1.	To illustrate various types of single-point cutting tools and their geometry.	02
2.	To illustrate various types of multi-point cutting tools and their geometry.	02
3.	To determine the chip-thickness ratio and shear plane angle during machining.	02
4.	To measure the cutting forces in turning operation using lathe tool dynamometer under various cutting conditions.	02
5.	To measure the tool-chip interface temperature under varying cutting conditions.	02
6.	To identify the effect of cutting parameters on power consumption in turning Operation.	02
7.	To determine the effect of process parameters on surface finish in turning operation.	02
8.	To formulate and solve the Sales forecasting problem for a given product	02

9. To develop the inventory control strategy for a given situation. 02
10. To formulate and solve Facility layout for a given problem. 02
11. To solve facility location problem. 02

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech (All)
Semester	VI and VIII
Course Code:	4FT901CC24
Course Title:	Research Methodology and Seminar*
Course Type:	Core
Year of Introduction:	2024-25

Teaching and Examination Scheme:

Course Code	Seme-ster	Course Name	Teaching Scheme				Examination Scheme (Weightage)		
			L	T	P	C	Continuous Evaluation (CE)	Lab Project Work (LPW)	Sem End Exam (SEE)
4FT901CC24	VI	Research Methodology	2	-	-	-	0.5	0.5	-
	VII		0	0	4	4			-

*The course will be spread over two semesters (semester 6 and semester 7). 4 credits will be awarded on successful completion of examination components at the end of semester 7.

Course Learning Outcomes (CLOs):

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

1. formulate a research problem for a given engineering domain, (BL6)
2. analyse the available literature for given research problem, (BL4)
3. solve problems using scientific tools, (BL3)
4. develop technical writing and presentation skills, (BL3)
5. collaborate for research and articulate a document for possible publication. (BL6)

Semester VI:

Unit	Contents	Teaching hours
		(Total 30)
Unit-I	Introduction: Introduction to research problem, sources of finding a research problem, characteristics of a research problem, pitfalls in selecting a research problem, scope and objectives of research problem, approaches of investigation of solutions for research problem.	06
Unit-II	Literature review: Effective literature review approaches, literature analysis, ethics in research, data collection, analysis, interpretation, use of AI tools for literature review	06
Unit-III	Technology and computer applications: Role of technology in research, Data organization, Software selection and its applications, solving problems by using scientific software and tools, Sample programs for analysis of data	06

Unit-IV	Technical writing and presentation: Effective technical writing, thesis writing, research proposal writing, research paper writing, presentation skills, tools for technical writing and presentation	06
Unit-V	Scholarly publishing: IMRaD concept and design of research paper, citation and acknowledgment, plagiarism and measures to avoid it, reproducibility	06

Semester VII:

Suggested Work

	Title	Hrs.
1.	Formulate a research problem for a given engineering domain.	10
2.	Perform literature survey for a given engineering domain.	12
3.	Apply a suitable computer application/software to solve/optimize a research problem for a given engineering domain.	12
4.	Perform data analysis using a suitable statistical tool(s) and data representation using appropriate software	08
5.	Writing a review/research paper and communicate the same for publication	18

Suggested Readings/ References:

1. Stuart Melville, Wayne Goddard, Research Methodology: An Introduction for Science and Engineering Students, Juta & Co Ltd.
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, Pearson.
3. C. R. Kothari, Research Methodology: Methods & Techniques, Wishwa Publication
4. D K Bhattacharyya, Research Methodology, Excel Books
5. Loraine Blaxter, Christina Hughes, Molcolm Tight, How to Research, Viva Books Pvt. Ltd.
6. Paul Oliver, Writing Your Thesis, Vistaar Publication
7. Pat Cryer, The Research Student's Guide to Success, Viva Books Pvt. Ltd.
8. R. Kumar, Research methodology a step-by-step guide for beginners, Sage Publications, London
9. C.G. Thomas, Research methodology and scientific writing, Ane books, Delhi
10. D C Montgomery, Design and Analysis of Experiments, Wiley.

w.e.f. academic year 2024 - 25 and onwards

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech in Mechanical Engineering
Semester	VII
Course Code:	
Course Title:	Condition Monitoring of Mechanical Equipment
Course Type:	Department Elective
Year of Introduction:	2025-26

L	T	Practical component			C
		LPW	PW	W	
3	0	2	-	-	4

Course Learning Outcomes (CLOs):

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

- | | | |
|---|---|-------|
| 1 | explain the necessity of condition monitoring of mechanical systems | (BL5) |
| 2 | select the appropriate condition monitoring technique | (BL3) |
| 3 | adapt appropriate instrumentation for condition monitoring | (BL6) |
| 4 | analyse the signals from the machine to monitor the condition. | (BL4) |

Unit	Contents	Teaching hours (Total 45)
Unit I	<p>Introduction to Machine Condition Monitoring</p> <p>Fundamentals of friction, wear, and lubrication, Principles of Maintenance Types of maintenance, implementation of Failure Mode Effects and Criticality Analysis (FMECA) for machinery maintenance, Risk Priority Number for FMECA, fault diagnosis, fault prognosis, future needs</p>	06
Unit II	<p>Fundamental of Machinery Vibration</p> <p>Introduction, single degree of freedom motion, forced vibration response, base excitation, force transmissibility, and vibration isolation, Tuned vibration absorber, unbalanced response. Simple rigid rotor disc system, unbalanced</p>	09

response and critical speed, journal bearing, squeeze film dampers, condition monitoring in the large rotor system, mode shapes, and operational deflections, experimental modal analysis

Unit III **Digital signal processing** 09

Classification of signals, signal analysis, Frequency domain analysis, basics of fast Fourier transforms, computer aided data acquisition, signal conditioning, signal filtering, signal demodulation, signal processing, cepstrum analysis

Unit IV **Instrumentation for condition monitoring** 10

Measurement standards, measurements error, calibration principles, static and dynamic measurement, frequency response, dynamic range, basic measuring equipment, measurement of vibration, force, rotational speed, noise and temperature, Laser based measurement, current measurement, ultrasonic thickness measurements, data recorders

Unit V **Vibration and noise-based condition monitoring** 11

Principles of vibration monitoring, misalignment detection, eccentricity detection, cranked shaft, bowed and bent shaft, unbalanced shaft, looseness, rub, bearing defects, gear faults, fault in fluid machines, Acoustic terminology, noise source, sound field, anechoic chambers, reverberation chambers, noise measurements, noise source identification

Self – Study: The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

- Suggested Readings/References:
1. A R Mohanty A.R. Machinery Condition Monitoring, Principles and Practices, CRC press
 2. Lyons R, Understanding Digital Signal Processing, Person India
 3. Sujatha C., Vibration of Acoustics, Measurement and Signal Analysis, Mc Graw Hill Education
 4. Keith Mobley R., Maintenance Fundamentals, Butterworth – Heinmann
 5. Goldman Steve, Vibration Spectrum Analysis – A Practical Approach, Industrial Press

Suggested List of Experiments

Sr. No.	Title	Hours
1.	Basics of dynamic signals	02
2.	Basics of time domain analysis	02
3.	Basics of frequency domain analysis	02
4.	Joint time-frequency domain analysis	02
5.	Instrumentation for fault diagnosis – FFT analyser	04
6.	Time domain analysis of detection of faults in rolling element bearings	02
7.	Frequency domain analysis of detection of faults in rolling element bearings	04
8.	Envelope analysis for bearing fault detection	04
9.	Gear fault detection	04
10.	Application of machine learning techniques for machinery fault diagnosis	04

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech in Mechanical Engineering
Semester	VII
Course Code:	
Course Title:	Operations Research*
Course Type:	Department Elective
Year of Introduction:	2025-2026

L	T	Practical component				C
		LPW	PW	W	S	
3	-	2	-	-	-	4

Course Learning Outcomes (CLOs):

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

- | | | |
|---|--|-------|
| 1 | formulate the linear programming problem | (BL6) |
| 2 | develop mathematical models for decision making problems | (BL3) |
| 3 | analyse the network for project management | (BL4) |
| 4 | appraise the importance of replacement and queuing theories. | (BL5) |

Unit	Contents	Teaching hours
		(Total 45)
Unit I	<p>Introduction of Linear Programming Problems</p> <p>History of operations research, definition and characteristics of operation research, scope and application areas of operations research, structure of linear programming problem, mathematical formulation of linear programming problem, graphical solution of linear programming problem, special cases in linear programming problem.</p>	06
Unit II	<p>Simplex method</p> <p>Standard and other forms of linear programming problems, simplex algorithms for solution of maximization and minimization type of problem, two-phase method, Big-M method, duality in linear programming problem, dual problem</p>	10

- and Sons.
4. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill.

***Except for the students of mechanical engineering who opted “Applied Mathematics” as minor.**

Suggested list of experiments:

Sr. No.	Title	Hours
1.	To study the formulation of linear programming problem.	04
2.	To study and apply graphical method to solve the linear programming problem.	04
3.	To apply simplex method to solve the linear programming problem having less than equal to type constraints.	04
4.	To solve linear programming problem using Big M method having mixed constraints.	02
5.	To solve linear programming problem using Two-phase method having mixed constraints.	02
6.	To formulate and solve linear programming problem using Transportation techniques.	02
7.	To formulate and solve linear programming problem using Assignment method.	02
8.	To apply Critical Path Method (CPM) to solve the project/network problem having deterministic time of activities.	02
9.	To apply Programme Evaluation and Review Technique (PERT) to solve the project/network problem having probabilistic time of activities.	02
10.	To determine project completion time of project/network problem considering time-cost trade off.	02
11.	To study and solve individual and group replacement problems.	02
12.	To study and solve queuing theory problems.	02

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech in Mechanical Engineering
Semester	VII
Course Code:	
Course Title:	Refrigeration and Air Conditioning Engineering
Course Type:	Department Elective
Year of Introduction:	2025-26

L	T	Practical component				C
		LPW	PW	W	S	
3	0	2	-	-	-	4

Course Learning Outcomes (CLOs):

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

- 1 analyse various refrigeration and air conditioning systems (BL4)
- 2 select the parameters of vapour absorption refrigeration systems (BL3)
- 3 estimate the cooling load for air conditioning requirement of a space (BL5)
- 4 design the air distribution system for air conditioning. (BL6)

Unit	Contents	Teaching hours (Total 45)
Unit I	<p>Vapour Compression Refrigeration System</p> <p>Selection of refrigerants, compressors, condensers, expansion valves, evaporators and design calculations.</p> <p>Multi-pressure refrigeration systems: need, analysis of compound compression, multi-evaporator and cascade systems.</p>	10
Unit II	<p>Vapour Absorption Refrigeration System</p> <p>Vapour absorption system working, types and modifications, analysis of NH₃-H₂O and LiBr-H₂O, Electrolux refrigeration system.</p>	09
Unit III	<p>Psychrometric Processes and Thermal Comfort</p> <p>Psychrometric processes in air conditioning equipment, summer air conditioning system, winter air conditioning system, human comfort,</p>	08

ventilation requirements, indoor air quality (IAQ)

Unit IV Load Estimation and Air Distribution System 10

Design condition, instantaneous heat gain and instantaneous cooling load, heat transmission through sunlit and shaded glass, total equivalent temperature difference, cooling load due to sunlit and shaded walls, infiltration and ventilation load, miscellaneous loads.

Air distribution: requirements, important terms, types of outlets and their placement, factors affecting outlet performance.

Duct design: economic factors influencing duct layout, velocity reduction, equal friction and static regain method, use of friction chart, equivalent diameter, dynamic losses, insulation, noise reduction.

Fans: static, dynamic and total pressure, classification of fan, construction and characteristics of axial flow, forward and backward fans.

Unit V Air Conditioning Systems 08

Window, split, package and central air conditioning system, air handling unit (AHU), fan coil unit (FCU), transport air conditioning systems, district cooling system

Humidifiers: desert cooler, air washer, cooling tower -construction, working, testing and maintenance

Air conditioning controls: temperature, humidity, face and bypass control, control of cooling coil, controls for air-conditioned building, building automation system

Self – Study: The self-study content will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study content.

- Suggested Readings/References:**
1. Stoecker W. F., and Jones J.W., Refrigeration and Air Conditioning, Tata McGraw Hill.
 2. Dossat R. J. and Horan T.J., Principles of Refrigeration, Pearson Education.
 3. Arora C. P., Refrigeration & Air Conditioning, Tata McGraw Hill.
 4. ASHRAE Handbook, HVAC Fundamentals, ASHRAE.
 5. ASHRAE Handbook, HVAC Systems and Equipment, ASHRAE.

Suggested list of experiments

Sr. No.	Title	Hours
1.	To study the vapour compression refrigeration cycle with different refrigerants.	02
2.	To conduct the performance evaluation of a vapour compression refrigeration system with air-cooled and water-cooled condenser.	04
3.	To study the Electrolux vapour absorption refrigeration system.	02
4.	To conduct the performance testing of a refrigerator.	02
5.	To study the cascade refrigeration system.	02
6.	To analyse the vapour compression refrigeration cycle using commercially available simulation software.	02
7.	To conduct the performance testing of a split air conditioner test rig.	02
8.	To conduct the performance testing of a vortex tube refrigeration system.	02
9.	To conduct the performance testing of a direct and an indirect evaporative cooler.	02
10.	To conduct Air Conditioning load estimation of a building.	04

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech in Mechanical Engineering
Semester	VII
Course Code:	
Course Title:	Additive Manufacturing
Course Type:	Department Elective
Year of Introduction:	2025-26

L	T	Practical component			C
		LPW	PW	W	S
3	0	2	-	-	-

Course Learning Outcomes (CLOs):

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

- 1 select the techniques for processing of CAD models for additive manufacturing (BL3)
- 2 compare various additive manufacturing techniques (BL4)
- 3 choose appropriate tooling for the additive manufacturing process (BL5)
- 4 elaborate the role of additive manufacturing techniques for reverse engineering. (BL6)

Unit	Contents	Teaching hours (Total 45)
Unit I	Introduction Introduction to Additive Manufacturing (AM), Distinction between AM and Conventional Manufacturing Process, Generic AM process, Classification of AM, Application in Education and Industry.	05
Unit II	CAD Modelling and Data Processing for AM CAD model preparation, Data Requirements, Data formats, Data interfacing, Data Conversion, Data Validity, Data repair, Part orientation, and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation, Slicing Algorithms.	07
Unit III	Liquid AM Systems	07

Photopolymerization, Stereo Lithography (SL), SL resin curing process, SL scan patterns, Micro stereo lithography, applications of Photo polymerization Processes.

Unit IV	Solid AM Systems	12
	Hybrid AM, Direct digital manufacturing, Fused deposition modelling (FDM), MIG wire arc additive manufacturing (MIG-WAAM), TIG wire arc additive manufacturing (TIG-WAAM), Electron beam based wire AM (WBAM), Laser metal wire AM (LMAM), Selective laser sintering (SLS), Powder fusion mechanism and powder handling.	
Unit V	Additive Manufacturing Tooling and Reverse Engineering	08
	Conventional tooling vs. AM tooling, Classification of AM tooling, Direct and indirect tooling methods, Basic concept of reverse engineering, Methodologies and techniques, digitization techniques, Model reconstruction.	
Unit VI	AM Applications in Industries	06
	Pre-processing, processing, post-processing errors, Part building errors, Design applications, Engineering analysis applications, Planning applications, Medical applications, space applications of AM, Recent developments in AM technologies.	

Self – Study: The self-study content will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

Suggested Readings/References:

1. Chua, C.K., Leong, K.F., Chu, S.L., Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific.
2. Gibson, D.W., and Brent, S., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.
3. Noorani, R., Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons.
4. Hilton, P., and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press.
5. Liou, W.L., and Liou, F.W., Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press.
6. Kamrani, A.K., and Nasr, E.A., Rapid Prototyping: Theory and practice, Springer.
7. Hopkinson, N., Haque, R., and Dickens, P., Rapid Manufacturing: An Industrial Revolution for a Digital Age: An Industrial Revolution for the Digital Age, Wiley.
8. Bartolo, P.J., Virtual and Rapid Manufacturing: Advanced Research in Virtual and Rapid Prototyping, Taylor and Francis.

9. Venuvinod, P.K., and Ma, W., Rapid Prototyping – Laser based and other technologies, Kluwer.

Suggested list of experiments

Sr. No.	Title	Hours
1.	To create solid model and generation of CAD data.	04
2.	To study the techniques for manipulation in STL file	02
3.	To study the construction and working of an FDM based 3D printer.	02
4.	To process STL file for 3D printing in Ultimaker Cura.	02
5.	To compare various process parameters of FDM based 3D printing process.	02
6.	To design and develop an Engineering component through SLA 3D printer.	02
7.	To study MIG welding and submerged arc welding for additive manufacturing.	02
8.	To design and develop a low-cost additive manufacturing setup.	02
9.	To study 3D printing of a composite material for the given application.	02
10.	To study the selective laser sintering process for composite material manufacturing.	02
11.	To study Additive manufacturing modules in ANSYS Software.	02
12.	To demonstrate the 3D scanning process for reverse engineering.	02

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech in Mechanical Engineering
Semester	VII
Course Code:	
Course Title:	Maintenance Engineering and Safety
Course Type:	Department Elective
Year of Introduction:	2025-26

L	T	Practical component			C
		LPW	PW	W	
3	0	2	-	-	4

Course Learning Outcomes (CLOs):

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

- 1 compare various maintenance systems and maintenance procedures for given machines (BL4)
- 2 appraise the importance of reliability and failure analyses in the maintenance of engineering systems (BL5)
- 3 apply the condition monitoring techniques for industrial systems (BL3)
- 4 elaborate the necessity of safety management and accident prevention. (BL6)

Unit	Contents	Teaching hours (Total 45)
Unit I	<p>Introduction to Maintenance and Reliability</p> <p>Necessity of maintenance in an organisation; Types and importance of maintenance strategies such as failure-based maintenance, contractual maintenance, reliability-centred maintenance, predictive maintenance, time-based maintenance, conditioning-based maintenance (CBM); Computer-managed maintenance system (CMMS).</p> <p>Introduction to reliability; Machine life cycle, mean time between failure, mean time to failure, mean time to repair, availability and maintainability; Reliability system; Depreciation and replacement analysis of machines.</p>	10
Unit II	<p>Maintenance of Mechanical Systems</p> <p>Hand tools and power tools for maintenance; Assembly – disassembly,</p>	12

maintenance, and fault tree analysis of mechanical systems such as pumps, compressors, bearings, gearbox, shaft alignment, etc; Wear and corrosion, its prevention methods.

Importance of lubrication in maintenance, classification, characteristics, additives, selection and testing.

Unit III Total Productive Maintenance (TPM) 06

TPM evolution; Definition; Objectives; Pillars of TPM; Major losses and its types; 5S; Steps to adopt TPM in an organisation; Maximising overall equipment effectiveness (OEE); small group activities on TPM.

Unit IV Condition-based Maintenance (CBM) System 10

Introduction to CBM systems; Types of CBM systems; Vibration-based CBM systems; Basics of machinery vibration for condition monitoring; Limits and standards of vibration for machines; Computer-aided data acquisition systems; Signal processing techniques for fault finding in machine using CBM systems, time and frequency domain analysis; Machinery fault diagnosis using vibration analysis; Instrumentation for condition monitoring, CBM for predictive maintenance. Introduction to other advanced condition monitoring techniques like noise, thermography, oil analysis, wear debris analysis, applications of IOT in maintenance.

Unit V Safety Management 07

History and need for safety; Safety rules, regulations, and standards, Safety codes, Safety management and its significance, Accidents and their types, Principles of accident prevention.

Self-Study: The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

- Suggested Readings/References:**
1. Mobley K., Maintenance Fundamentals, Butterworth-Heinemann.
 2. Scheffer C. and Girdhar P., Practical Machinery Vibration Analysis and Predictive Maintenance, Elsevier Newnes.
 3. Cheremisinoff N., Practical Guide to Industrial Safety: Methods for Process Safety Professionals, CRC Press.
 4. Heinrich H.E., Peterson D., Nester R., Industrial Accident Prevention, McGraw-Hill Inc.

5. Nakajima S., Introduction to TPM: Total Productive Management, Productivity Press.

Suggested list of experiments

Sr. No.	Title	Hours
1.	To demonstrate common maintenance tools and their applications.	04
2.	To work out failure mode effects and criticality analysis for a given mechanical system.	02
3.	To carry out shaft alignment for a given mechanical assembly.	02
4.	To exercise assembly – disassembly and maintenance procedure of mechanical systems.	06
5.	To perform servicing and overhauling of IC engine.	04
6.	To demonstrate lubrication systems in various machine tools.	02
7.	To investigate effects of lubricant on the wear rate of machine component using the Pin-on Disc apparatus.	02
8.	To find fault in a given machine using the fault tree analysis method.	02
9.	To evaluate the useful life of a machine using the replacement analysis method.	02
10.	To exhibit the importance of safely using augmented reality/virtual reality (AR/VR).	02
11.	To diagnose the condition of a machine using various condition-based maintenance approaches.	02

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech in Mechanical Engineering
Semester	VII
Course Code:	
Course Title:	Computational Fluid Dynamics
Course Type:	Department Elective
Year of Introduction:	2025-26

L	T	Practical component				C
		LPW	PW	W	S	
3	0	2	-	-	-	4

Course Learning Outcomes (CLOs):

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

- 1 examine the governing equations and concepts in fluid mechanics and heat transfer (BL4)
- 2 make use of grid generation and matrix solution methods for CFD analysis (BL3)
- 3 elaborate finite difference and finite volume technique for solving the problems pertaining to fluid flow and heat transfer (BL6)
- 4 interpret the concepts of turbulence modelling for industrial applications. (BL5)

Unit	Contents	Teaching hours (Total 45)
Unit I	Introduction to CFD The need for CFD, applications, state-of-the-art, challenges, future directions. Introduction to Navier-Stokes (NS) equations, physical and mathematical classification of PDEs, system of equations, some key PDEs of interest in CFD.	07
Unit II	Finite Difference Method Numerical approximation of derivatives using Taylor series, order-of-accuracy, finite difference representation of a PDE, truncation error, consistency, stability, FDM for parabolic, hyperbolic and elliptic PDE's.	10
Unit III	Finite Volume Methods Finite Volume Method for diffusion and convection-diffusion problems,	10

solution algorithm for pressure-velocity coupling in steady flows, finite volume method for unsteady flows

Unit IV Matrix Solution Methods and Grids for CFD Analysis 09

Solution of Discretized Equations, Matrix solution methods, Tridiagonal matrix (Thomas) algorithm, Jacobi, Gauss-Siedel and relaxation methods, multigrid techniques.

Grid and its generation, body fitted coordinate grids, cartesian and curvilinear grids, block-structured and unstructured grids, adaptive grids. Staggered and co-located grid arrangements.

Unit V Turbulence and its modelling 09

Reynolds-averaged Navier-Stokes (RANS) equations and classical turbulence models. Introduction to commercial CFD software and applications.

Self – Study: The self-study content will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

- Suggested Readings/References:**
1. Anderson J., Computational Fluid Dynamics The Basics with Applications, McGraw Hill Book Company.
 2. Versteeg H. K., Malalasekara W, An Introduction to Computational Fluid Dynamics The Finite Volume Method, Pearson.
 3. Patankar S. V., Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing.
 4. Chung, T. J., Computational Fluid Dynamics, Cambridge University Press.
 5. Hirsch Charles, Numerical Computation of Internal and External Flows, Butterworth-Heinemann.

Suggested list of experiments

Sr. No.	Title	Hours
1.	To study different grid generation techniques in ANSYS	04
2.	Analyse the laminar flow (flow in pipe) in ANSYS Fluent	02
3.	Analyse the heat transfer in laminar flow (flow in pipe) in ANSYS Fluent	02
4.	To study flow in lid driven cavity using ANSYS Fluent	02
5.	To study natural convection in lid driven cavity using ANSYS Fluent	02
6.	Analyse laminar external flow (flow over stationary cylinder)	04
7.	Analyse laminar flow over rotating cylinder	04
8.	Analyse heat transfer over heated cylinder	04
9.	To carry out CFD analysis of cooling of mother board of a laptop (analysis of turbulent flow)	04
10.	Introduction to OpenFOAM platform	04

