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

Semester-VI

w. e. f. Academic Year 2024-25

Course Code	Course Title	Teaching Scheme (hours/week)				Examination Scheme			
		L	T	P	C	Duration Hours	Component Weightage		
						SEE	CE	LPW	SEE
3ME403CC24	Energy Systems	3	0	2	4	3	0.3	0.3	0.4
3ME604CC24	Machine Design	3	0	2	4	3	0.3	0.3	0.4
4FT901CC24	Research Methodology and Seminar*	2	0	0	-	-	-+	-	-
	Department Elective-II	3	0	2	4	3	0.3	0.3	0.4
		3	1	0			0.6	-	0.4
	Core Course-III 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
	Elective Course-I 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**	-	-	-	-
Internship									
Summer Internship**		-	-	-	**6**		1	-	-

*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.
** Compulsory Summer Internship of 6 weeks duration in summer break between Semester VI and VII

L: Lectures, P/T: Practicals / Tutorial, C: Credits
LPW/PW: Laboratory / Project Work
SEE: Semester End Examination
CE: Continuous Evaluation

Department Elective–II

Sr. No.	Course Code	Course Name	L	T	P	C
1.	3ME605ME24	Finite Element Analysis	3	0	2	4
2.	3ME204 ME24	Work Study	3	0	2	4
3.	3ME304 ME24	Design of Heat Exchangers	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

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech in Mechanical Engineering
Course Code:	
Course Title:	Energy Systems
Course Type:	Core
Year of Introduction:	2024-25

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 assess various subsystems of IC engine and analyse its performance (BL5)
2 analyse various refrigeration and air-conditioning systems and their performance (BL4)
3 explain the performance parameters of steam and gas turbine power plants (BL2)
4 evaluate the performance of various compressors and pumps (BL5)
5. summarise various renewable energy systems. (BL2)

Unit	Contents	Teaching hours (Total 45)
Unit I	**IC Engine and its Sub-systems** Revision of ideal and actual I. C. Engine cycle, Four-stroke and two-stroke petrol and diesel engines, valve timing diagram, fuels and its properties, subsystems of IC engine - fuel supply system, ignition system, cooling system, lubricating system, supercharging and turbocharging. Testing of I. C. engine and its performance curves, emissions.	08
Unit II	**Refrigeration and Air-conditioning** Revision of vapour compression refrigeration (VCR) cycle, effects of various operating parameters on performance of VCR cycle, refrigerants and its properties, simple vapour absorption refrigeration, air cycle refrigeration, Psychometric properties and processes.	12
Unit III	**Power Plant Engineering** Revision of Rankine cycle, performance improvement method such as superheating, reheating, regenerative feed water heating, Construction and	13

working of steam power plant components**.**

Steam nozzles – Types, concept of critical pressure, effect of variation of backpressure. Steam turbines **–** Principle of operation, types, constructional details**,** compounding of steam turbine, flow of steam through and reaction bladings, velocity diagram, blade efficiency, Steam turbine governing – Types, part load performance. Revision of gas turbine cycle, constructional and operational details, means of improving performance, Combined cycle power plant.

Unit IV **Compressors, Pumps and Hydro-turbines** 09

Classification, construction, working and performance of reciprocating, centrifugal, axial, rotary compressors. Hydraulic Pumps – types, construction, working and performance of centrifugal pump. Hydro-Turbines: construction, operation and performance of Pelton, Francis and Kaplan turbines.

Unit V **Renewable Energy Systems** 03

Importance of renewable energy sources, solar-thermal and photovoltaic systems, wind energy systems, wave, tidal, geothermal and biomass energy systems.

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. Som S.K, Biswas G., Chakraborty S., Fluid Mechanics and Fluid Machines, McGraw Hill Education.
2. Eastop T.D. McConkey A., Applied Thermodynamics for Engineering Technologists, Pearson.
3. Stoecker W., Jones J. W., Refrigeration and Air Conditioning, McGraw Hill Publication.
4. Arora C. P., Refrigeration and Air Conditioning, Tata McGraw Hill Publication.
5. Nag P. K., Power Plant Engineering, Tata McGraw-Hill.
6. Sorenson B., Renewable Energy, Academic Press.
7. Heywood J. B., Internal Combustion Engine Fundamentals, McGraw Hill Publication.
8. Sukhatme S. P., Nayak J. K., Solar Energy, McGraw Hill Publication.

Laboratory Work: Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Suggested list of experiments

Sr. No.	Title	Hours
1.	To study 4-S, 2-S, SI and CI engines, and valve timing diagram.	04
2.	To prepare the energy balance sheet of a 4-S Diesel engine.	02
3.	To find the cooling and heating COP of VCR cycle.	02
4.	To find COP and capacity of split air-conditioner.	02
5.	To study the construction and working of steam power plant components.	02
6.	To study the compounding of steam turbine.	02
7.	To design a steam nozzle.	02
8.	To carry out the performance analysis of centrifugal pump.	02
9.	To carry out the performance analysis of hydro-turbines.	02
10.	To demonstrate various renewable energy systems.	02
11.	To analyse the emission characteristics of I.C. engines.	02
12.	To determine the friction power and mechanical efficiency of an I.C. engine using Morse test.	02

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech in Mechanical Engineering
Course Code:	
Course Title:	Machine Design
Course Type:	Core
Year of introduction:	2024-25

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

Course Learning Outcomes (CLOs):

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

1	design mechanical systems like hydraulic press, clutch and brakes	(BL6)
2	make use of the design concepts for IC engine components, struts and column	(BL3)
3	select rolling contact bearings and design sliding contact bearings	(BL3)
4	evaluate the power transmission elements and systems.	(BL5)

Unit	Contents	Teaching hours (Total 45)
Unit I	**Design of clutches and brakes** Types of clutches-mechanical, hydraulic and electro-magnetic. Design of various mechanical clutches like single plate, multiple plate, centrifugal clutch etc., Design of various mechanical brakes like block brake, band brake, internal expanding shoe brake etc.	06
Unit II	**Design and selection of bearings** Rolling contact bearings, Classification and selection, factors affecting bearing Life. Design of hydrodynamic journal bearings. Classification, material selection, Sommerfeld number and use of charts for the estimation of minimum film thickness, temperature rise, flow quantity etc.	06

Unit III	**Design of IC engine components** Design of IC engine cylinder, design of piston and associated component, design of connecting rod, design of crankshaft, design of valve gear mechanism.Design of components subjected to buckling such as connecting rod push rod and piston rods	12
Unit IV	**Design of Pressure Vessels and Material Handling Equipment** Thin and thick pressure vessels, compound cylinders with internal and external pressures. ASME Codes for design of pressure vessels. Design of Material Handling Equipment: Selection of steel wire rope for hoists and cranes, crane hooks, design of hook block, sheaves and rope winding drums.	12
Unit V	**Design of gear drives** Classification of gears, static and dynamic consideration for design of gears, Design of gear drives-spur, helical, bevel and worm gear drives, Rating of gears as per I.S. and AGMA standards. Design of gear box.	09

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.
Laboratory Work:	Laboratory work will be based on above syllabus with one major design project
Suggested Readings/References:	1. Shigley, Budnyas, Nisbett, Mechanical Engineering Design, Tata McGraw Hill. 2. Norton R.L., Machine Design, Pearson Education. 3. Juvinall R. C., Marshek K. M., Fundamentals of Machine Component Design, John Wiley & Sons. 4. Apple J. M., Material Handling System Design, John-Wiley and Sons Publication. 5. Bhandari V. B., Design of Machine Elements, Tata McGraw Hill.

Suggested list of major design project:

Sr. No.	Title	Hours
1.	Design of various types of clutches	30
2.	Design of different types of brakes	30
3.	Design of speed reducers using spur, helical, bevel and worm gear drives	30
4.	Design of hydraulic components for various applications such as cotton bailing press, hydraulic tail stock, scissor lift etc.	30
5.	Design of various component material handling equipment such as cranes, hook assemble, wire ropes etc.	30

Note: A student shall be assigned one design project out of the above list.

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	B. Tech. (All)
Semester:	VI and VII
Course Code:	
Course Title:	Research Methodology and Seminar*
Course Type:	Core
Year of Introduction:	2024-25

Teaching and Examination Scheme:

Course Code	Semester	Course Title	Teaching Scheme				Examination Scheme (Weightage)		
			L	T	P	C	Continuous Evaluation (CE)	Lab Project Work (LPW)	Sem End Exam (SEE)
	VI	Research Methodology and Seminar*	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):

At the end of the course, students 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:

Syllabus: **Total Teaching hours: 30**

Unit	Contents	Teaching hours
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	06

	problems by using scientific software and tools, Sample programs for analysis of data	
Unit-IV	Technical writing and presentation: Effective technical writing, thesis writing, research proposal writing, research paper writing, presentation skills, tools for technical writing and seminar 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 and / or making seminar presentation.	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.
11. Research papers / web articles in the field of research methodology

L = Lecture, T = Tutorial, P = Practical, C = Credit

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech in Mechanical Engineering
Course Code:	
Course Title:	Finite Element Analysis
Course Type:	Department Elective
Year of introduction:	2024-25

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

Course Learning Outcomes (CLOs):

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

1 formulate the structural engineering and heat transfer problems into finite element model (BL6)

2 determine the stiffness matrix, displacement matrix and load vectors for one/two dimensional structural and heat transfer problems (BL5)

3 make use of finite element software to solve mechanical engineering problem (BL3)

4 solve the axisymmetric problems using FEA. (BL6)

Unit	**Contents**	**Teaching hours (Total 45)**
Unit I	**Introduction to FEM** General applicability, Engineering Applications, General description of Finite Element Method (FEM), Comparison of FEM with other methods of analysis. General procedure of finite elements method. Discretization, interpolation polynomials, formulation of element characteristic matrices & vectors –direct approach, variational approach, weighted residual approach. Assembly of element matrices & vectors and derivation of system of equations, solution of FE equations, computation of element resultants.	12
Unit II	**Iso-parametric Formulation** Higher order and iso-parametric element formulations, continuity conditions, numerical integration, Load considerations, error analysis, mesh refinement, plane stress problems, effect of element geometry, Validity of iso-parametric formulation, Patch Test.2D and 3D applications of iso-parametric formulation of	10

element, characterisation matrices using iso-parametric formulation.

Unit III	**Solid and Structural Mechanics Applications** One dimensional problems static analysis of trusses. Analysis of plates, solid of revolution, and Dynamic analysis: Dynamic equations of motion, consistent & lumped mass matrices, consistent mass matrices in global co-ordinate system, free vibration analysis, Eigen value problems, dynamic response calculations.	08
Unit IV	**Scalar fields problems** Steady state heat transfer (two-dimensional problems), torsion, potential flow seepage, fluid flow in ducts, Applications of FEA in metal forming & metal cutting problems.	05
Unit V	**Axi-symmetric Solid Elements** Introduction to solid of revolution, Elasticity relations for axial symmetry, axisymmetric solid elements. Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads, angular velocity, pressure vessels.	10

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.
Laboratory Work:	Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated
Suggested Readings/References:	1. Becker E. B., Carey G. F. and Oden J. T., Finite Elements: An Introduction, Volume I, Prentice Hall. 2. Cook R. D., Malkus D. S. and Plesha M. E., Concepts and Applications of Finite Element Analysis, John Wiley. 3. Seshu P., Textbook of Finite Element Analysis, PHI learning Pvt. Ltd. 4. Reddy J. N., An introduction to the Finite Element Method, McGraw-Hill. 5. Rao S.S., The Finite Element Method in Engineering., B H Publication.

Suggested list of experiments:

Sr. No.	Title	Hours
1.	To formulate 1D problem Link and Beam element using FEA software.	04
2.	To model 2D problems (Plane stress, plane strain, Axisymmetry) using FEA software.	02
3.	To solve 1D problems using FEA software.	02
4.	To explore capabilities of FEA software to solve 2D problems.	02
5.	To demonstrate use of FEA software for 3D problems.	02
6.	To perform mesh quality checking.	04

7.	To solve heat transfer problems using FE analysis approach.	04
8.	To perform modal analysis using FE approach.	04
9.	To perform dynamic analysis of mechanical element using FEA.	04
10.	To solve sheet metal forming problem using FEA.	04

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech in Mechanical Engineering
Course Code:	
Course Title:	Work Study
Course Type:	Department Elective
Year of introduction:	2024-25

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	appraise the importance of productivity for the organization	(BL5)
2	apply the tools of method and motion study to streamline the production	(BL3)
3	elaborate the different techniques of work measurement	(BL6)
4	compare various wage and incentive schemes for the improvement of productivity.	(BL4)

Unit	**Contents**	**Teaching hours (Total 45)**
Unit I	**Productivity** Concept and importance of work study, introduction and concept of productivity, measurement of productivity, factors influencing productivity, causes of low productivity, productivity measurement models, productivity improvement techniques, case study on productivity, productivity and its relation with work study.	05
Unit II	**Method Study** Objective and procedure of method study, questioning techniques, recording techniques: charts and diagrams such as outline process charts, flow process charts, multiple activity charts, two handed process chart, string diagram, travel chart; critical examination and questioning techniques.	12

Unit III	**Motion Study** Classification of movements, principle of motion economy, basic elements of motion, therbligs, motion analysis, SIMO charts. Ergonomics: basic concept, industrial ergonomics, psycho physiological data, anthropometry, normal and maximum work areas, location of control knobs, visual display, fatigue in industry, environmental requirements.	10
Unit IV	**Work measurement** Objectives and uses of work measurement, work measurement techniques, time study: basic procedure of time study, time study equipment, concept of rating and allowances, concept of qualified worker, standard time. Work sampling, standard data, synthesis, predetermined motion time systems, analytical estimating.	12
Unit V	**Wage Administration** Concept of wage and incentives, relation between incentives and productivity, characteristics of a good incentive plan, wage and incentive schemes: straight piece rate, differential piece rate and time & piece rate methods, efficiency and premium bonus schemes.	06

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.
Laboratory Work:	Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated
Suggested Readings/References:	1. Introduction to Work Study: International Labor Office (ILO), Geneva. 2. Barnes R. M., Motion and Time Study Design and Measurement of Work, John Wiley and Sons. 3. Groover M. P., Work Systems and the Methods, Measurement, and Management of Work, Prentice Hall 4. Sandera M and McCormick E, Human Factors in Engineering and design, McGraw-Hill

Suggested list of experiments:

Sr. No.	Title	Hours
1.	To develop an incentive scheme of wage payment.	02
2.	To construct an operation process chart from the given data.	02
3.	To develop a flow process chart from the given data.	02
4.	To construct multiple activity chart from the given data.	02
5.	To construct left hand and right-hand chart from the given data.	02
6.	To apply pin board study for the given operation.	02
7.	To apply the SIMO Chart for the given process.	02
8.	To determine performance rating during walking and dealing of cards.	02
9.	To implement performance rating practice by films.	02
10.	To evaluate time study on a lathe machine and to determine standard time for turning and facing operation	02
11.	To analyze method to improve the assembly of a bolt, a nut and three washers	02
12.	To apply work sampling and PMTS to establish standard time.	02
13.	To analyze production study of repetitive job.	02
14.	To evaluate the variety of manual lifting tasks/ calculation of lifting index during an activity.	02

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech in Mechanical Engineering
Course Code:	
Course Title:	Design of Heat Exchangers
Course Type:	Department Elective
Year of Introduction:	2024-25

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	explain the basic thermo-hydraulic design principles for heat exchanger	(BL2)
2	design the tube-in-tube and shell and tube heat exchangers	(BL6)
3	interpret the principles of design for furnaces and two-phase heat exchangers	(BL5)
4	examine the thermo-hydraulic performance of compact heat exchanger	(BL4)
5	make use of the mechanical aspects of heat exchanger design.	(BL3)

Unit	**Contents**	**Teaching hours (Total 45)**
Unit I	**Basic Design Methodology** Classification of heat exchangers, basic design methods for heat exchangers (LMTD and effectiveness-NTU), performance enhancement of heat exchangers, fouling of heat exchangers, testing, evaluation and maintenance of heat exchangers, various correlations for heat transfer coefficient (laminar, turbulent flow) and friction factor.	07
Unit II	**Design of Tube-in-Tube and Shell and Tube Heat Exchangers** Design of tube in tube heat exchanger (Kern's Method), design of shell and tube heat exchangers (Bell Delaware method), designation as per TEMA standard, heat exchangers for heat recovery at low, medium and high temperatures, computerized methods for design and analysis of heat exchangers.	14

Unit III	**Design of Furnace and Two-phase Heat Exchangers**	12
	Design principles for condenser and evaporator for thermal power plant and refrigeration systems, different types of boiler design as per IBR, furnace and water walls design for thermal power plant.	
Unit IV	**Compact Heat Exchangers**	08
	Design of air preheater, plate heat exchangers, fin and tube heat exchangers, radiators.	
Unit V	**Mechanical Design of Heat Exchangers**	04
	Design aspects, codes (ASME) and computer software for mechanical design of heat exchangers.	

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.

Laboratory Work: Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Suggested Readings/References:

1. Kakac S., Heat Exchanger Selection, Rating and Thermal Design, CRC Press.
2. Shah R.K., Fundamental of Heat Exchanger Design, John Wiley and Sons.
3. Kays W. M. and London A.L., Compact Heat Exchangers, McGraw Hill.
4. Kern D.Q., Process Heat Transfer, McGraw Hill.
5. Hewitt G. F., Shires, G. L., Bott T. R., Process Heat Transfer, CRC Press.
6. Serth R. W. and Lestina T., Process Heat Transfer, Academic Press.

Suggested list of experiments:

Sr. No.	Title	Hours
1.	To develop the methodology to evaluate LMTD and NTU for heat exchangers.	02
2.	To design (thermo-hydraulic) a tube in tube heat exchanger.	04
3.	To design a shell and tube heat exchanger as per TEMA guidelines.	04
4.	To design a condenser and an evaporator.	04
5.	To design a boiler as per India Boiler Regulations (IBR).	04
6.	To design a furnace and a water wall.	04
7.	To design a compact heat exchanger.	04
8.	To design (mechanical) different heat exchangers.	04