UG Curriculum - 2024
of
B. Tech. in Mechanical Engineering

Course Structure of B. Tech. in Mechanical Engineering, Approved in 2024-2025 and w.e.f. Admission Batch: 2024

Program Educational Objectives (PEOs)

1. To prepare the graduates with strong foundation in science and engineering for successful careers in core mechanical and interdisciplinary industries, higher education and research.
2. To prepare graduates who can become entrepreneur/innovators to design and develop system/process/product/service to address social and industrial challenges.
3. To prepare graduates with leadership qualities, strong communication skills, professional and ethical values.
4. To prepare lifelong learners graduates to excel in their professional career as well as to pursue higher education.

Program Outcomes (POs)

1. **Engineering knowledge:** An ability to apply knowledge of mathematics, science, and engineering in solving/analyzing problems in industries, research and development institutions, public sector units, higher education and in academia.
2. **Problem Analysis:** An ability to design and conduct experiments, as well as to analyze and interpret data in mechanical engineering theory and practice at various industrial work-places.
3. **Design/ Development of solutions:** An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, health and safety, manufacturability, and sustainability.
4. **Multidisciplinary Approach:** An ability to function on multidisciplinary teams.
5. **Modern tool usage:** An ability to identify, formulate, and solve engineering problems using modern tools and techniques.
6. **Communication:** An ability to communicate effectively.
7. **The Engineer and Society:** The broad education necessary to understand the impact of mechanical engineering solutions in a local, global, economic, environmental, and societal context.
8. **Life-long learning:** A recognition of the need for, and an ability to engage in life-long learning.
9. **Investigations of complex problem:** Use of Applied research including design of experiments, analysis and interpretation of data, synthesis of the information to provide valid solutions with the knowledge of contemporary issues.
10. **Project Management:** An ability to apply engineering knowledge and management principles skills to manage engineering projects.
11. **Environment and Sustainability:** An ability to design sub-systems, systems, components and processes to fulfil demand of environmental sustainability.
12. **Ethics:** Apply engineering principles toward the professional values and ethics.

Program Specific Outcomes (PSOs)

1. To **analyze the problems** and **create solution** by applying engineering knowledge with a multidisciplinary approach in the area of vehicle function, vehicle design and vehicle performance.
2. To analyze, interpret and provide solutions for the technical challenges faced by the Automobile Industry **using engineering software/tools.**
3. **To work effectively in a team** to address **complex issues** by engaging in **lifelong learning** and following **ethical and environmental** practices.

COURSE STRUCTURE FOR B.TECH. Mechanical Engineering FIRST YEAR SEM – I (w. e. f 2024-25)

SEMESTER-I (Subjects)				B.TECH. MECHANICAL ENGINEERING Sem-I											
Sr. No	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
									Theory			Practical		Total	
				L	T	P	C	Hrs/wk	MS	ES	CE	LE	LE/Viva	Marks	
1	BSC	24MA101T	Mathematics - I	3	1	0	4	4	25	25	50	-	-	100	
2	BSC	24PH102T	Engineering Physics	3	0	0	3	3	25	25	50	-	-	100	
3	BSC	24PH102P	Engineering Physics Laboratory	0	0	2	1	2	-	-	-	25	25	50	
4	BSC	24BT102T	Biology for Engineers	2	0	0	2	2	25	25	50	-	-	100	
5	BSC	24CV101T	Environmental Science	2	0	0	2	2	25	25	50	-	-	100	
6	ESC	24CP101T	Computer Programming - I	1	0	0	1	1	25	25	50	-	-	100	
7	ESC	24CP101P	Computer Programming - I Laboratory	0	0	2	1	2	-	-	-	25	25	50	
8	ESC	24ME101P	Workshop Practices	0	0	2	1	2	-	-	-	25	25	50	
9	ESC	24ME102P	Engineering Graphics	0	0	4	2	4	-	-	-	25	25	50	
10	HSC	24HS101T	English Communication	2	0	0	2	2	25	25	50	-	-	100	
11	HSC	24HS102T	Universal Human Values	1	0	0	1	1	25	25	50	-	-	100	
			Total	**14**	**1**	**10**	**20**	**25**							

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COURSE STRUCTURE FOR B.TECH. Mechanical Engineering FIRST YEAR SEM – II (w. e. f. 2024-25)

SEMESTER-II (Subjects)				B.TECH. MECHANICAL ENGINEERING Sem-II											
Sr. No	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
									Theory			Practical		Total	
				L	T	P	C	Hrs/wk	MS	ES	CE	LE	LE/Viva	Marks	
1	BSC	24MA103T	Mathematics - II	3	1	0	4	4	25	25	50	-	-	100	
2	BSC	24CH101T	Engineering Chemistry	3	0	0	3	3	25	25	50	-	-	100	
3	BSC	24CH101P	Engineering Chemistry Laboratory	0	0	2	1	2	25	25	50	-	-	100	
4	ESC	24CP102T	Computer Programming - II	1	0	0	1	1	-	-	-	25	25	50	
5	ESC	24CP102P	Computer Programming - II Laboratory	0	0	2	1	2	25	25	50	-	-	100	
6	ESC	24EE101T	Elements of Electrical and Electronics Engineering	3	0	0	3	3	-	-	-	25	25	50	
7	ESC	24EE101P	Elements of Electrical and Electronics Engineering Laboratory	0	0	2	1	2	-	-	-	25	25	50	
8	HSC	24HS103T	Indian Knowledge System	2	0	0	2	2							
9	HSC	24HS104T	Organizational Behaviour	1	0	0	1	1	25	25	50	-	-	100	
10	HSC	24HS105T	Professional Communication	2	0	0	2	2	25	25	50	-	-	100	
11	HSC	24YOG101	Yoga, Health and Hygiene	0	0	2	1	2	-	-	-	25	25	50	
		24NSS101	National Service Scheme (NSS)												
		24NCC101	National Cadet Corps (NCC)												
Total				**15**	**1**	**08**	**20**	**24**							

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COURSE STRUCTURE FOR B.TECH. Mechanical Engineering SECOND YEAR SEM – III (w. e. f. 2024-25)

SEMESTER-III (Subjects)				B.TECH. MECHANICAL ENGINEERING Sem-III											
Sr. No	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
									Theory			Practical		Total	
				L	T	P	C	Hrs/wk	MS	ES	CE	LE	LE/Viva	Marks	
1	PRO	24INT151	Civic and Social Service Internship	0	0	0	1	0	-	-	-	-	-	-	
2	BSC	24MA201T	Mathematics – III	3	1	0	4	4	25	25	50	-	-	100	
3	PCC	24ME201T	Introduction to Artificial Intelligence	3	0	0	3	3	25	25	50	-	-	100	
4	PCC	24ME202T	Engineering Mechanics	3	0	0	3	3	25	25	50	-	-	100	
5	PCC	24ME203T	Thermodynamics	3	0	0	3	3	25	25	50	-	-	100	
6	PCC	24ME203P	Thermodynamics Laboratory	0	0	2	1	2	-	-	-	25	25	50	
7	PCC	24ME204T	Mechanical Measurement and Metrology	3	0	0	3	3	25	25	50	-	-	100	
8	PCC	24ME204P	Mechanical Measurement and Metrology Laboratory	0	0	2	1	2	-	-	-	25	25	50	
9	PCC	24ME205P	Mechanical Drawing Laboratory	0	0	2	1	2	-	-	-	25	25	50	
			Total	**15**	**1**	**6**	**20**	**22**							

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COURSE STRUCTURE FOR B.TECH. Mechanical Engineering SECOND YEAR SEM – IV (w. e. f. 2024-25)

SEMESTER-IV (Subjects)				B.TECH. MECHANICAL ENGINEERING Sem-IV											
Sr. No	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
									Theory			Practical		Total	
				L	T	P	C	Hrs/wk	MS	ES	CE	LE	LE/Viva	Marks	
1	OE	24ME221T	Renewable Energy	3	0	0	3	3	25	25	50	-	-	100	
2	IND	24ME205T	Industry 4.0	2	0	0	2	2	25	25	50	-	-	100	
3	IND	24ME205P	Industry 4.0 Laboratory	0	0	2	1	2	-	-	-	25	25	50	
4	PCC	24ME206T	Fluid Mechanics	3	0	0	3	3	25	25	50	-	-	100	
5	PCC	24ME206P	Fluid Mechanics Laboratory	0	0	2	1	2	-	-	-	25	25	50	
6	PCC	24ME207T	Design and Kinematics of Machines	3	0	0	3	3	25	25	50	-	-	100	
7	PCC	24ME207P	Design and Kinematics of Machines Laboratory	0	0	2	1	2	-	-	-	25	25	50	
8	PCC	24ME208T	Engineering Metallurgy	3	0	0	3	3	25	25	50	-	-	100	
9	PCC	24ME208P	Engineering Metallurgy Laboratory	0	0	2	1	2	-	-	-	25	25	50	
10	PCC	24ME209T	Strength of Material	3	0	0	3	3	25	25	50	-	-	100	
11	PCC	24ME209P	Strength of Material Laboratory	0	0	2	1	2	-	-	-	25	25	50	
12	NCC	24INT251	Industrial Orientation	0	0	0	0	0	-	-	-	-	-	-	
			Total	**17**	**0**	**10**	**22**	**27**							

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COURSE STRUCTURE FOR B.TECH. Mechanical Engineering THIRD YEAR SEM – V (w. e. f. 2024-25)

SEMESTER-V (Subjects)				B.TECH. MECHANICAL ENGINEERING Sem-V											
Sr. No	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
									Theory			Practical		Total Marks
				L	T	P	C	Hrs/wk	MS	ES	CE	LE	LE/Viva	
1	HSC	24HS301T	Engineering Economics	3	0	0	3	3	25	25	50	-	-	100
2	OE	MOOC	NPTEL / SWAYAM / MOOC Course	3	0	0	3	3	25	25	50	-	-	100
3	PE	24ME331T	Introduction to Composite Materials	3	0	0	3	3	25	25	50	-	-	100
		24ME332T	Renewable and Sustainable Energy Technologies						25	25	50	-	-	100
		24ME333T	Fluid Machinery						25	25	50	-	-	100
		24ME334T	Laser and Electron Beam Material Processing						25	25	50	-	-	100
4	PCC	24ME301T	Heat Transfer	3	0	0	3	3	25	25	50	-	-	100
5	PCC	24ME301P	Heat Transfer Laboratory	0	0	2	1	2	-	-	-	25	25	50
6	PCC	24ME302T	Dynamics of Machine	3	0	0	3	3	25	25	50	-	-	100
7	PCC	24ME302P	Dynamics of Machine Laboratory	0	0	2	1	2	-	-	-	25	25	50
8	PCC	24ME303T	Manufacturing Processes - I	3	0	0	3	3	25	25	50	-	-	100
9	PCC	24ME303P	Manufacturing Processes - I Laboratory	0	0	2	1	2	-	-	-	25	25	50
			Total	**18**	**0**	**6**	**21**	**24**						

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COURSE STRUCTURE FOR B.TECH. Mechanical Engineering THIRD YEAR SEM – VI (w. e. f. 2024-25)

SEMESTER-VI (Subjects)				B.TECH. MECHANICAL ENGINEERING Sem-VI											
Sr. No	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
									Theory			Practical		Total	
				L	T	P	C	Hrs/wk	MS	ES	CE	LE	LE/Viva	Marks	
1	OE		Open Elective 3 (From Other Department of FoET)	3	0	0	3	3	25	25	50	-	-	100	
2	PE	24ME335T	Mechanical Vibration	3	0	0	3	3	25	25	50	-	-	100	
		24ME336T	Additive Manufacturing						25	25	50	-	-	100	
		24ME337T	Production and Operation Management						25	25	50	-	-	100	
		24ME338T	Heat Exchanger Design						25	25	50	-	-	100	
3	PCC	24ME304T	Refrigeration and Air Conditioning	3	0	0	3	3	25	25	50	-	-	100	
4	PCC	24ME304P	Refrigeration and Air Conditioning Laboratory	0	0	2	1	2	-	-	-	25	25	50	
5	PCC	24ME305T	Machine Design -I	3	0	0	3	3	25	25	50	-	-	100	
6	PCC	24ME305P	Machine Design -I Laboratory	0	0	2	1	2	-	-	-	25	25	50	
7	PCC	24ME306T	Manufacturing Processes - II	3	0	0	3	3	25	25	50	-	-	100	
8	PCC	24ME306P	Manufacturing Processes - II Laboratory	0	0	2	1	2	-	-	-	25	25	50	
9	PCC	24ME307T	Robotics	3	0	0	3	3	25	25	50	-	-	100	
10	PCC	24ME307P	Robotics Laboratory	0	0	2	1	2	-	-	-	25	25	50	
			Total	**18**	**0**	**8**	**22**	**26**							

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COURSE STRUCTURE FOR B.TECH. Mechanical Engineering FOURTH YEAR SEM – VII (w. e. f. 2024-25)

SEMESTER-VII (Subjects)				B.TECH. MECHANICAL ENGINEERING Sem-VII											
Sr. No	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
									Theory			Practical		Total	
				L	T	P	C	Hrs/wk	MS	ES	CE	LE	LE/Viva	Marks	
1	PRO	24INT451	Summer Internship	0	0	0	2	0	25	25	50	-	-	100	
2	OE		Open Elective 4 (From Other Department of FoET)	3	0	0	3	3	25	25	50	-	-	100	
3	PE		Professional Elective - 3 (select from the below table)	3	0	0	3	3	25	25	50	-	-	100	
4	PE		Professional Elective - 4 (select from the below table)	3	0	0	3	3	25	25	50	-	-	100	
5	PE		Professional Elective - 5 (select from the below table)	3	0	0	3	3	25	25	50	-	-	100	
6	PCC	24ME401T	Optimization Techniques	3	0	0	3	3	25	25	50	-	-	100	
7	PCC	24ME402T	Project Management	3	0	0	3	3	25	25	50	-	-	100	
8	PCC	24ME403P	Computational Engineering Laboratory	0	0	4	2	4	-	-	-	25	25	50	
9	PRO	24PRME451	Seminar	0	0	0	1	0	-	-	-	25	25	50	
Total				**18**	**0**	**4**	**23**	**22**							

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Program Elective 3:

Course Code	Course Name
24ME431T	Exergy Analysis of Thermal Systems
24ME432T	Machine Design-II
24ME433T	Micro and Nano Manufacturing

Program Elective:4

Course Code	Course Name
24ME434T	Cryogenics
24ME435T	CAD

Program Elective 5:

Course Code	Course Name
24ME436T	Welding for Metal Joining, Surfacing and Additive Manufacturing
24ME437T	Automobile Engineering
24ME438T	Computer Aided Manufacturing
24ME439T	Non-Destructive Testing and Failure Analysis
24ME440T	Material and Procurement Management

COURSE STRUCTURE FOR B.TECH. Mechanical Engineering FOURTH YEAR SEM – VIII (w. e. f. 2024-

SEMESTER-VIII (Subjects)				B.TECH. MECHANICAL ENGINEERING Sem-VIII											
Sr. No	Category Code	Course Code	Course Name	Teaching Scheme					Exam Scheme						
									Theory			Practical		Total	
				L	T	P	C	Hrs/wk	MS	ES	CE	LE	LE/Viva	Marks	
1	Pro	24PRME452	Major Project	0	0	0	12	0	-	-	-	50	50	100	
		24PRME453	Comprehensive Project	0	0	0	12	0	-	-	-	50	50	100	
Total				0	0	0	12	0							

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering,
Semester – I

24MA101T					Mathematics – I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	-	-	100

Course Objectives

1. To be able to evaluate problems related to differential and integral calculus of complex functions.
2. To be able to obtain area, volume using integral calculus.
3. To be able to formulate and solve various engineering problems using the calculus.
4. To study the properties of sequence and series and to check the convergence and divergence.

Unit – I: Sequence and Series **12 Hrs**

Definition. Convergent, divergent, bounded & monotone sequences. Infinite sums: Basics, Convergence and divergence, Tests for convergence for positive term series, Alternating series – Leibnitz test, Absolute convergence, conditional convergence. Convergence of power series.

Unit – II: Partial Derivatives and its Applications **08 Hrs**

Partial derivative and its application - Euler's theorem - Total derivatives - Jacobians – Maxima and Minima of two variables using Lagrange's multipliers. Taylor's series.

Unit – III: Multiple Integrals and its Applications **12 Hrs**

Definition and evaluation of double integral (Cartesian – Polar form) – Change of orders - Change of variables – Evaluation of triple integral, change of variables (Cartesian to spherical – and cylindrical) – Applications, area – volume – center of mass – center of gravity by double and triple integral.

Unit – IV: Vector Calculus **12 Hrs**

Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector Integration – Simple problems on line, surface and volume integrals – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (without proofs) – Simple application involving cubes and rectangular parallelepipeds.

Total **42 Hrs**

Course Outcomes

On completion of the course, student will be able to:

CO1: Identify the use of convergence of infinite series in engineering aspects.
CO2: Understand the concept of Directional derivative, Irrotational and Solenoidal vector fields.
CO3: Apply the concept of differential and integral calculus in engineering problems.
CO4: Analyze the obtained solution in linear and non-linear domains.
CO5: Appraise mathematical problems from complex domain.
CO6: Evaluate problems on Green's, Stokes' and Divergence theorems.

Text/Reference Books

1. B. S Grewal, "Higher Engineering Mathematics", Khanna Pub., Delhi.
2. R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Alpha Science.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley.
4. G. Strang, "Linear Algebra and its applications", Cengage Learning.
5. K. Hoffman and R. A. Kunze, "Linear Algebra", Prentice Hall of India.
6. B.V. Ramana, "Higher Engineering Mathematics", McGraw Hill.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering,
Semester – I

24PH102T					Engineering Physics (For ME, Civil)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	-	-	100

Course Objectives

1. To master the concepts of vector algebra and the fundamentals of mechanics.
2. To explore the principles of elasticity in solids, band theory of solids and the Physics of semiconductors.
3. To investigate the behaviour of waves and oscillations, along with their applications in acoustics and ultrasonics.
4. To gain insights into thermal physics, covering conduction, convection, and radiation, and their practical applications.

Unit – I: Mechanics **12 Hrs**

Introduction to vector algebra, Vector fields and scalar fields, Concepts of gradient, Divergence and Curl, Gauss-Divergence Theorem, Stokes' theorem and its applications, The everyday forces of Physics, Work-energy theorem, Rigid body motion and the conservation of angular momentum, Center of mass, Center of gravity, Moment of inertia: Definition, Moment of inertia of simple planar laminas.

Unit – II: Physics of Solids **10 Hrs**

Elasticity, Stress & Strain, Hook's law, Young's modulus, Poisson's ratio, Rigidity modulus, Relationship between elastic constants, Properties of solids, electrical conductivity, Wiede-mann Franz Law, Band structure of conductor, insulator and semiconductor, Intrinsic and extrinsic semiconductor, Conductivity of semiconductors, charge concentrations, Hall effect, LED and Solar cells, Magnetism and its origin, Magnetic properties of solids, Physics of superconductors, Applications.

Unit – III: Waves, Oscillations and Acoustics **08 Hrs**

Waves and oscillations: Types of waves, Simple harmonic motion, Damped simple harmonic motion, types of damping, Forced oscillation, Resonance, Energy Transport in Wave motion. Acoustics & Ultrasonic: Introduction to Sound, Sabine's reverberation theory, Acoustical defects and their remedies, Doppler Effect, Ultrasonic waves, Methods of their generation and detection, Properties and applications of ultrasonic waves.

Unit – IV: Thermal Physics **12 Hrs**

Thermodynamic systems (closed and open), Thermodynamic properties and equilibrium, Concepts of heat and work, Laws of thermodynamics, Carnot cycle, Heat transfer-thermal expansion of solids and liquids, Conduction in solids, Thermal conductivity, Forbe's method, Lees' disc method, Thermal insulation and its applications, Thermal Convection and its applications, Newton's law of cooling, Thermal Radiation – emission and absorption radiation, emissive power, Black body radiation, Stefan's laws, Wien's law.

Total **42 Hrs**

Course Outcomes

On completion of the course, student will be able to:

CO1: Describe fundamental concepts of mechanics, such as vector algebra, everyday forces of Physics, Moment of inertia, etc.
CO2: Explain the principles underlying the physics of solids, including elasticity and the behavior of energy bands.
CO3: Solve problems involving mechanics, solids, waves, oscillations, and acoustics.
CO4: Analyze the behavior of waves, oscillations, and thermal phenomena, including their practical applications.
CO5: Critically evaluate the significance of thermodynamic laws and superconductivity theories in solving real-world problems.
CO6: Develop solutions and innovative applications in mechanics, solids, waves, and thermal physics by integrating concepts and principles learned throughout the course.

Text/Reference Books

1. D. Kleppner and R. J. Kolenkow, An Introduction to Mechanics, Tata McGraw-Hill.
2. D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, John Wiley & Sons.
3. Sears and Zemansky, University Physics, Pearson publications.
4. M. N. Avadhanulu, P.G. Kshirsagar, A textbook of Engineering Physics, S Chand & Co. Ltd.
5. F. M. A. Wahab, Solid State Physics: Structure and Properties of Materials, Narosa Publishing House Pvt. Ltd.
6. Richard, Oscillations and Waves: An Introduction, Taylor & Francis.
7. Y. A. Cengel, Introduction to Thermodynamics and Heat Transfer, Tata McGraw-Hill.
8. B. Lal and N. Subramaniyam, Heat and Thermodynamics, S Chand & Co. Ltd.

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Semester – I

24PH102P					Engineering Physics Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

Course Objectives

1. To comprehend the operation of diverse electrical, mechanical, and optical instruments utilized within the laboratory setting.
2. To grasp fundamental principles of Physics and apply them effectively in the execution of experiments.
3. To acquire hands-on experience in Physics through experimental work, fostering practical understanding.

List of Experiments

1. To determine the acceleration due to gravity 'g' using a simple pendulum.
2. To determine the acceleration due to gravity 'g' using a bar pendulum.
3. To determine the electrical conductivity of metals.
4. To study the characteristics of Si solar cells.
5. To explore the usage of Digital Oscilloscope.
6. To study the phenomenon of photoconductivity using CdS photo-resistor.
7. To determine linear thermal expansion coefficient of solid bodies.
8. To study the phenomenon of Hall Effect.
9. To determine volumetric coefficient of expansion of liquids.
10. To study the reflection of ultrasonic waves.
11. To demonstrate/investigate resonance in forced oscillations.
12. To study the principle of heat pump.
13. To determine energy band gap of semiconductor using four probe method.
14. To measure the slit width of single, blade and double slits.
15. To determine e/m using Thomson's method.

** Any 10 experiments will be conducted.

Course Outcomes

On completion of the course, student will be able to:

CO1: Apply mathematical reasoning to analyze the concepts of mechanics.
CO2: Compare and contrast experimental results to determine electrical and thermal conductivity.
CO3: Demonstrate and implement the concepts of waves and oscillations.
CO4: Investigate the electrical properties of a given semiconductor device.
CO5: Examine the charge transport mechanism in different conductors.
CO6: Analyze the behavior of waves, oscillations, and thermal phenomena in experiments.

Text/Reference Books

1. D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, John Wiley & Sons.
2. C. Kittel, Introduction to Solid State Physics, John Wiley.
3. C.S. Robinson, R, Das, Textbook of Engineering Physics Practical, University Science Press.
4. Kittel, Knight and Ruderman, Mechanics - Berkeley Physics Course, Tata McGraw-Hill.
5. Avadhanulu, A text book of engineering Physics, S. Chand & Company, Ltd.
6. Brij Lal, N. Subrahmanyam, Heat and Thermodynamics, S. Chand & Company, Ltd

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering,
Semester – I

24BT102T					Biology For Engineers					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	--	--	100

Course Objectives

1. To understand the basic biological concepts and their engineering applications.
2. To introduce the students with an understanding of biodesign principles to create novel devices and structures.
3. To provide the students an appreciation of how biological systems can be re-designed as substitute products for natural systems.
4. To study the development of interdisciplinary vision of biological engineering

Unit I: Introduction To Biomolecules — 7 Hrs.

Cell as a basic unit of life, prokaryotic and eukaryotic cells, microbes, plant and animal cells; Cell organelles – structure and function; Cell membrane. Vitamins and Minerals, Carbohydrates, Lipids, Amino Acids and proteins, Nucleic Acids (DNA and RNA).

Unit II: Nature-Bioinspired Mechanisms — 7 Hrs.

Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics). The eye functions as a camera. Heart as a pump system, The ear and nose as signal transmission models. Lungs operate as an exchange model, kidneys function as a filtration system. Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro).

Unit III: Trends In Bioengineering — 7 Hrs.

Stem cell and its applications, Bio printing techniques and materials. Applications of Bioinformatics, Artificial Intelligence for diagnosis and detection of communicable and non-communicable diseases, Biosensors in healthcare, Environmental monitoring, Food Safety and Biosecurity.

Unit IV: Engineering Perspectives Of Biological Sciences — 7 Hrs.

Biology and engineering crosstalk – At cell level: Hybridoma technology, At tissue level: Plant Tissue Culture, Animal Tissue Culture; Tissue Engineering, Introduction to Biomimetics and Biomimicry, Nanobiotechnology, Introduction to Radiology, High-throughput diagnostics in clinics: Molecular Diagnostics (PCR), DNA chips.

Total 28 Hrs

Course Outcomes

On completion of the course, student will be able to:

- **CO1:** Gain fundamental knowledge of origin of life.
- **CO2:** Demonstrate the involvement of major organs and systems in the human body as models for bioengineering design.
- **CO3:** Analyse the scope and opportunities of Implementing bioengineering concepts relates to advanced imaging and diagnostic techniques for clinical diagnosis and disease management.
- **CO4:** Get acquainted with concepts of bioengineering trends including biosensors, AI , Imaging techniques in disease diagnosis and treatment
- **CO5:** Focus on implications of Bioinspired designs, Bioengineering trends including, tissue engineering and molecular diagnostics.
- **CO6:** Think critically towards exploring innovative biobased solutions for socially relevant problems.

Text/Reference Books

1. Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M., Biology for Engineers, Tata McGraw-Hill, New Delhi.
2. Arthur T. Johnson, Biology for Engineers, CRC Press, Taylor and Francis.
3. Geoffrey M.Cooper, The Cell: A molecular Approach, ASM Press.
4. Sohini Singh and Tanu Allen, Biology for Engineers", Vayu Education of India, New Delhi.
5. Yoseph Bar-Cohen, "Biomimetics: Nature-Based Innovation, CRC Press.
6. Stuart Fox, Krista Rompolski, Human Physiology", McGraw-Hill (eBook).
7. D. Floreano and C. Mattiussi, Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, MIT Press.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering,
Semester – I

24CV101T					Environmental Science					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	-	-	100

Course Objectives

1. To develop a comprehensive perspective of environment and sustainable development
2. To understand the causes and effects of various types of pollution
3. To develop an understanding of the various strategies for controlling the pollution
4. To introduce the emerging environmental domains

Unit I : Introduction To Environment — 05 Hrs.

Sustainable Development; Sustainable Development Goals; Environmental Studies – Its importance and Multidisciplinary nature, Introduction to Environmental Parameters and their standards (air, water, soil, noise, etc.); Ecosystem and its types, Ideal ecosystem, Biodiversity : Its importance and conservation.

Unit II : Multi-Scale Environmental Pollution (Global, Regional And Local) — 06 Hrs.

Pollution, Causes and Effects of different types of pollution : Air Pollution, Water Pollution, Soil Pollution, Solid Waste (organic and Inorganic) Pollution, Hazardous Waste Pollution, Marine Pollution, Noise Pollution, Thermal Pollution, Radioactive Pollution; Introduction to man-made disasters like floods, heat waves, landslides, etc., Introduction to the various instruments for measuring air pollution, water pollution, noise, etc.

Unit III : Environmental Pollution Control Strategies — 09 Hrs.

Multi-approaches for reducing various types of pollution: Introduction to Water and Wastewater treatment technologies, Air and Noise pollution control techniques, Introduction to different environmental management concepts like Swachh Bharat Mission, Mission LiFE (Lifestyle For Environment), etc. Indian Culture and Traditional Wisdom for managing environment

Unit IV: Emerging Environmental Managements Domains — 08 Hrs.

Concept of Zero Liquid Discharge (ZLD) and the reuse of the treated wastewater, Green Credit Rules - 2023, Clean Development Mechanisms (CDM) and Carbon Credits, Green Buildings, Carbon Footprint and Water Footprint, Green Business, International Environmental Laws, Environmental Auditing.

Total 28 Hrs

Course Outcomes

On completion of the course, student will be able to:

- **CO1:** Demonstrate comprehension of sustainable development and environmental aspects.
- **CO2:** Recognize the interdisciplinary characteristics inherent in Environmental studies.
- **CO3:** Evaluate the impact of various pollutants on the environment.
- **CO4:** Assess the efficacy of different technologies for environmental pollution control.
- **CO5:** Analyze different environmental management policies and their implications.
- **CO6:** Synthesize knowledge about emerging environmental management paradigms.

Text/Reference Books

1. Bharucha Erach, Textbook for Environmental Studies, UGC New Delhi.
2. Daniel B. Botkin & Edwards A. Keller, Environmental Science, Wiley India edition.
3. Miller T. G. Jr., 2006. Environmental Science, Clengage Learning.
4. R. Rajagopalan, Environmental Studies, Oxford University Press.
5. Gilbert Masters and Wendell P. Ela, Introduction to Environmental Engineering and Science, PHI.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering,
Semester – I

24CP101T					Computer Programming – I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
1	0	0	1	1	25	50	25	-	-	100

Course Objectives

1. To understand the usage of operators and data types.
2. To apply different types of Conditional and looping statement.
3. To create different types of data collections.
4. To implement user defined function.
5. To perform different operations upon files.

Unit – I: Basics of Programming **03 Hrs**

Introduction to Computer Programming, Features of C language, Structure of C program, program execution flow, C Tokens, variables, Data types, Operators, Decision control statements-if, switch, go to statement. Loop control structures- while, do-while, for loop, Break statement, Continue statement.

Unit – II: Derived Data types **04 Hrs**

Array: one dimensional and multidimensional array, Declaration, initialization, Array Manipulations. Matrix operations, String-Basic Concepts, Inbuilt String manipulation Functions, Pointer, Pointer arithmetic, Pointer to pointer, Array of Pointers

Unit – III: Functions and Structures **04 Hrs**

Introduction to user defined functions, Types of Functions, Call by value-call by reference, recursion, pointers to functions, Structures, Array of Structure, Union.

Unit – IV: Files Handling **03 Hrs**

File handling in C, Different types of files, Operations on Files such as File creation, File deletion, File access modes such as read, write, append, File concatenation, File handling using seek function..

Total **14 Hrs**

Course Outcomes

On completion of the course, student will be able to:

- **CO1:** Understand basics of programming.
- **CO2:** Identify different programming constructs for a problem.
- **CO3:** Apply appropriate derived data type for data storage.
- **CO4:** Prepare a user defined data type based on data attributes.
- **CO5:** Construct user defined functions for problem solving.
- **CO6:** Analyse different data structure based on application requirement.

Text/Reference Books

1. Kernighan & Ritchie, C Programming Language, PHI
2. K. N. King , C Programming: A Modern Approach, W.W. Nortorn
3. David Griffiths and Dawn Griffiths, Head First C: A Brain-Friendly Guide, O'Reilly
4. E.Balaguruswamy, Programming in ANSI C, McGraw-Hill
5. Y.P. Kanetkar, Let us C, BPB Publication
6. Y.P. Kanetkar , Pointers in C, BPB Publications

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering,
Semester – I

24CP101P					Computer Programming Laboratory – I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

Course Objectives

1. To implement basic programming concepts.
2. To create different types of data collections.
3. To implement user defined function.
4. To perform different file handling operations.

List of Experiments:

1. **Introduction to Computer Programming**: Understanding compilation process through a simple C program, program execution flow, C Tokens, variables and keywords and identifiers, types of C constants and variables.
2. **Simple and formatted Input Output Operations:** Data types, Operators, Input /output statements in C, Formatted I/O, format specifiers, escaper sequences
3. **Decision making and branching:** if, if-else, if-else ladder, switch, go to statement, conditional operator statement
4. **Looping control structures:** while, do-while, for loop, Break statement, Continue statement
5. **Derived Data Type: Array and Strings:** One dimensional and multidimensional array, Declaration, initialization, Array Manipulations. Matrix operations, Basic Concepts, Inbuilt String manipulation with and without using inbuilt functions.
6. **Derived Data Type: Structure and Union:** structure, arrays and structures, structures and functions, pointer to structure, typedef, unions
7. **Functions:** Introduction to user defined functions, Types of Functions, Call by value-call by reference, header file creation, recursion, pointers to functions, arrays and functions
8. **Pointers:** Pointer's basics, use of &, * operator in context to pointers, Pointer arithmetic, Array and String processing using pointer, pointer to pointer, Array of Pointers
9. **File Handling in C:** File handling in C, Different types of files, Operations on Files, File handling functions.

Course Outcomes

On completion of the course, student will be able to:

CO1: Identify the use of appropriate naming conventions and programming style including appropriate comment density.
CO2: Implement a basic C program using appropriate control structure.
CO3: Apply appropriate derived data types based on data attributes.
CO4: Develop solutions with pointers and utilize them to access strings and structures.
CO5: Design user defined functions for problem solving and reuse them across different programs.
CO6: Apply suitable file handling functions and operations.

Text/Reference Books

1. Kernighan & Ritchie, C Programming Language, PHI.
2. K. N. King , C Programming: A Modern Approach, W.W. Norton.
3. E. Balaguruswamy, Programming in ANSI C, McGraw-Hill.
4. Y.P. Kanetkar,Let us C, BPB Publication.
5. Y.P. Kanetkar, Pointers in C, BPB Publication.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering,
Semester – I

24ME101T					Workshop Practice					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

Course Objectives:

1. To understand safety in various manufacturing processes.
2. Learn how to use various measuring tools for engineering applications.
3. Hands on training and preparation of job using wood, metal and sheet as per drawing.
4. Understand various manufacturing processes like machining, welding, soldering and 3D printing for prototypes.

List of Experiments

1 Introduction to Workshop safety, layout and identification of various materials- plastic, wood, metals-ferrous and nonferrous, rubber, glass etc.
2 Use of measuring tools for engineering applications
3 Fitting job: Detailed drawing of work piece, use of fitting tools and job preparation.
4 Carpentry job: Detailed drawing of work piece, use of carpentry tools and job preparation.
5 Sheet metal job: Detailed drawing of work piece, use of sheet metal working tools and job preparation.
6 Plumbing job: Internal/External threading, piping network using Tees, Elbows, Reducer, Bends etc
7 Hands on training on mini lathe and milling machine
8 Demonstration of welding, brazing and soldering
9 Soldering and desoldering for PCB
10 3D printing using polymer and metal.

Course Outcomes

On completion of the course, student will be able to:

CO1 : Define workshop safety and various engineering materials
CO2 : Understand various measuring equipment
CO3 : Apply various workshop tools in preparing job for carpentry, fitting, sheet metal and plumbing
CO4 : Examine various manufacturing operations like welding and machining
CO5 : Evaluate soldering operation for PCB
CO6 : Create prototype using 3D printing

Text/Reference Books

1. S. K. Hajra Choudhury, Elements of Workshop Technology, Vol. I & II, Media Promoters and Publishers.
2. H. S. Bawa, Workshop Practice, Tata-McGraw Hill.
3. Kalpakjian S. And Steven S. Schmid, Manufacturing Engineering and Technology, Pearson Education India Edition.
4. Rao P.N., Manufacturing Technology, Vol. I and Vol. II, Tata McGraw Hill House.

24ME102T					Engineering Graphics - Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	4	2	4	--	--	--	50	50	100

Course Objectives

1. To cover the fundamental of engineering drawing and standards used in drawing.
2. To explain the students to communicate ideas using orthographic and isometric projection methods.
3. To help students to use CAD software to prepare drawings.
4. To demonstrate the presentation of drawing using sketching and 3D modelling in CAD tool.

List of Experiments

1 Introduction to Engineering Graphics: Principles of engineering graphics and their significance, drawing instruments & accessories, lettering and numbering, types of lines, dimensioning methods, basic geometric drawing, reading a drawing.

2 Orthographic Projection: Introduction to projection, types of projection, 1st angle and 3rd angle projection

3 Isometric Projection: Principles of isometric projection – isometric scale, isometric views, conventions, conversion of isometric views to orthographic views and vice-versa

4 Projection of Solids and Development of Surface: Classification of solids, projections of solids like cylinder, cone, pyramid, and prism with its inclination to reference plane, development of surfaces of right regular solids - prism, pyramid, cylinder and cone.

5 Introduction of Computer Aided Engineering Drawing: Demonstrating knowledge of the theory of CAD software, use of software in drawing, CAD software user interface, commands, Coordinate System, menus and toolbars, planes, dimensioning, saving of files, Select and erase objects, zoom tools, and others

6 Basic sketching using CAD tool: Sketch entities using tools – origin, points, lines, circle, arcs, polygons, fillets and chamfer, trim, extend and offset, copy, cut, delete and others

7 Advanced sketching using CAD tool: Sketching entities using relation constrains, Mirror, Patterning, full definition of drawing and others

8 Basic 3D modelling using CAD tool: Extrude, cut, drawing on different planes, editing, symmetric, revolving, and others

9 Computer aided drawing sheets: Preparing drawing sheets, creating different views, section view, drawing templates, and others

Course Outcomes

On completion of the course, student will be able to:

CO1 : Recalling the fundamentals of engineering graphics by considering basic rules of drawing, dimensioning, and labelling.
CO2 : Explain the principle of projection using orthographic and isometric projection.
CO3 : Represent the 2-dimensional drawing using CAD tool.
CO4 : Construct the 3-dimensional geometries using CAD tool.
CO5 : Apply the concept of engineering drawing by organizing drawing views and applying necessary dimensions by preparing drawing sheets
CO6 : Analyse the intricate details of solid using projection of solid, sectioning of solid and development of lateral surfaces.

Text/Reference Books

1. Bhatt N.D., Panchal V.M. & Ingle P.R., Engineering Drawing, Charotar Publishing.
2. Shah P.J., Engineering Graphics, S. Chand Publishing.
3. Agrawal, B. & Agrawal C. M., Engineering Drawing, Tata McGraw Hill Publishers.
4. Hanifan R, Perfecting Engineering and Technical Drawing, Springer International Publishing Switzerland.
5. Corresponding Set of CAD Software Theory and User Manuals.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering,
Semester – I

24HS102T					Universal Human Values					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
1	0	0	1	1	25	50	25	--	--	100

Course Objectives

1. To understand the need of nurturing human values through the process in value-based education system.
2. To understand and develop a holistic perspective on self-exploration and being in harmony with family, society and nature.
3. To facilitate the students in understanding harmony at all the levels and applying in their profession and work place to lead an ethical life.

Unit I: Human Values And Process Of Value Education **04 Hrs.**

Human values, human aspirations and the ultimate goal, understanding happiness and prosperity, appraise the meaning of satisfaction and happiness in current scenario, harmony and compatibility, values imbibed education system and process

Unit II: Knowing Self - Harmony With Self **04 Hrs.**

Understanding self, capabilities and challenges, understanding material (physical facilities) and spiritual needs - need of mind and body, understanding body as an instrument, harmony between mind and body, synchronizing physical health and mental health, practicing healthy habits for healthier me

Unit III: Harmony In Relationship – Family, Society And Nature **03 Hrs.**

Harmony in relationships, values for harmony in any human-human interaction, harmony in family, and society, trust and respect for others, self esteem and ego, equality, equity, inclusion and liberation, concept of '*Vasudhaiva Kutumbakam',* understanding co-existence and sync with nature

Unit IV: Harmony In Profession And Ethical Behavior **03 Hrs.**

Ethical human conduct, acceptance and respect, appraising the qualities of others, professional competence for enabling harmony in system and enabling universal human order, scope of eco-friendly systems, strategies to reach the harmonious ecosystem to reach Universal Human Order 'Sarvabhauma Vyavastha'

Total **14 Hrs**

Course Outcomes

On completion of the course, student will be able to:

CO1: Understand the significance of human values, its need, and process of value education.
CO2: Appraise the meaning of happiness and prosperity as short- and long-term goal of life. Understand them and in context of the current scenario
CO3: Distinguish between the mind and body, physical and spiritual wellbeing for harmony within self
CO4: Assess the value of harmonious relationship based on trust, respect and enduring its role in all human-human relationships to build harmonious society
CO5: Understand the importance of harmony with nature and appreciate co-existence for harmonious ecosystem.
CO6: Create the perfect professional place and work environment following the ethical practices and strategize to uphold the human values at all the levels and interactions.

Text/Reference Books

1. R. R. Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and Professional Ethics, Excel books.
2. A. Nagraj, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.
3. A. N. Tripathi, Human Values, New Age Intl. Publishers.
4. M. K. Gandhi. The Story of My Experiments with Truth, Fingerprint Publishing.
5. Ivan Illich, Energy & Equity, The Trinity Press, Worcester, and Harper Collins.
6. E. F. Schumacher, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
7. Sussan George, How the Other Half Dies, Penguin Press.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – II

24MA103T					Mathematics – II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. Understand and apply principles of complex differentiation and integration effectively.
2. Solve systems, find eigenvalues, and apply transformations confidently.
3. Solve various ODEs, apply methods, and tackle engineering problems.
4. Analyze periodic functions, derive series, and apply in diverse applications.

UNIT 1 Complex Differentiation and Integration — 12 Hrs.

Limit, Continuity, Differentiability of the function of a complex variable, Analytic function, Cauchy-Riemann equation (in Cartesian coordinates), Harmonic function and its significance, Singularities, Definition of a Complex line integral, Contour integrals, Cauchy integral theorem, Cauchy Integral formula (CIF), CIF for derivatives, Taylor's series and Laurent Series , Calculation of residues, Cauchy Residue theorem, Applications of residues to evaluate real definite integrals..

UNIT 2 Matrix Algebra and Its Applications — 10 Hrs.

Solution of system of algebraic equation - Rank of a matrix, consistency of system of equation - Characteristic equation of a square matrix- Eigen values and Eigenvectors of a real matrix - Properties of Eigen values and Eigen vectors - Cayley-Hamilton theorem (without proof) - finding inverse of a matrix - Diagonalization of a matrix.

UNIT 3 Ordinary Differential Equations With Applications — 10 Hrs.

Differential equations of Higher-order differential equations with constant coefficients, Rules for finding C.F. and P.I., Method of variation of parameters, Cauchy and Legendre's linear equations, Simultaneous linear equations with constant coefficients (Operator method), applications of higher-order differential equations in solving engineering problems.

UNIT 4 FOURIER SERIES — 10 Hrs.

Periodic functions, Odd and even functions, Euler's formulae for Fourier series in an interval of length 2 pi, Change of interval, Dirichlet's conditions, Half range Sine and Cosine series, Complex Fourier series, Parseval's identity and its applications.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES:

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

CO1 : Recall fundamental concepts of complex differentiation, matrix algebra, differential equations, and Fourier series.
CO2 : Understand the significance of complex differentiation, integration, Matrix, ODE and Fourier series in respective contexts.
CO3 : Apply the concept of complex function, Matrix, ODE and Fourier series to extract the solutions of engineering problems
CO4 : Analyze the use of complex variable Matrix, ODE and Fourier series in engineering problems.
CO5 : Assess the significance and effectiveness of mathematical concepts and theorems in solving real-world problems, particularly in engineering and scientific applications.
CO6 : Design and construct solutions to complex mathematical problems using a variety of techniques, including transformations, mappings, and advanced methods in differential equations.

TEXT/REFERENCE BOOKS

1. R.V. Churchill and J. W. Brown, "Complex variables and applications", McGraw-Hill.
2. J. M. Howie, "Complex analysis", Springer-Verlag.
3. R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Alpha Science.
4. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley.
5. G. Strang, "Linear Algebra and its applications", Cengage Learning.
6. K. Hoffman and R. A. Kunze, "Linear Algebra", Prentice Hall of India.
7. B.V. Ramana, "Higher Engineering Mathematics", McGraw Hill.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – II

24CH101T					Engineering Chemistry					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	T			L		Total marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To develop the fundamental understanding about traditional materials.
2. To provide the knowledge about structural features, synthesis, properties of various categories of advanced materials.
3. To develop the knowledge and skills for different characterization techniques of materials.
4. To provide the knowledge about the role of chemistry in modern engineering applications.

UNIT I: CHEMISTRY OF ENGINEERING MATERIALS **12 Hrs.**

Traditional Materials: Introduction and classification of materials; metallic materials, polymeric, ceramic materials Advanced Materials: Introduction to nanomaterials: Properties and application; Carbonaceous materials (fullerene, carbon nanotube, graphene, etc.); Composite materials; Liquid crystals: Classification and Application

UNIT II: MODERN ANALYTICAL TECHNIQUES **10 Hrs.**

Instrumentation, principle and characterization of materials: X-ray diffraction (XRD), Electro analytical techniques; FTIR, UV-visible spectroscopy; Thermal analysis (TGA-DTA-DSC); Chromatographic techniques (GC, HPLC)

UNIT III: ADSORPTION, CATALYSIS AND KINETICS **10 Hrs.**

Adsorption - Characteristics, Classification, Application , Adsorption isotherms- Freundlich, Langmuir & BET Chemical Kinetics - Rate law, Arrhenius equation, Transition state theory, Collision theory; Complex reactions Catalysis - Homogeneous and Heterogeneous Catalysis; Mechanism of Catalysis; Industrial Applications of catalysts

UNIT IV: CHEMISTRY OF ENERGY DEVICES **10 Hrs.**

Principles of primary and secondary batteries, Fuel Cells and their operation principles, Principles and uses of supercapacitors; Photocatalytic hydrogen production: Principles and challenges; Traditional and new generation solar cells.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES:

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

CO1 : Remember the structural features and properties of different classes of traditional materials
CO2 : Classify advanced materials like nanomaterials, carbonaceous and composite materials, and liquid crystals
CO3 : Apply the skills by understanding various instrumental techniques for characterisation of materials.
CO4 : Analyse the key concepts in engineering chemistry viz. adsorption and chemical kinetics and laterally ponder over the applications of such concepts in engineering challenges.
CO5 : Justify the important insights into the industrial application of different types of catalysis via analysing mechanisms of catalysis.
CO6 : Develop the knowledge on the role of chemistry in various modern engineering applications such as in energy devices.

TEXT/REFERENCE BOOKS

1. W.D. Callister, An Introduction to Materials Science & Engineering, John Wiley & Sons.
2. MW Barsoum, Fundamental of Ceramics, IOP publishing.
3. T. Pradeep, Text book of Nanoscience and Nanotechnology, Mc. Graw Hill Education.
4. Murty, Shankar, B Raj, Rath, Murday, Textbook of Nanoscience and Nanotechnology", Springer.
5. V. Raghavan, Materials Science and Engineering, Prentice-Hall of India Private Limited.
6. A. Douglas, Donald Skoog, M.West, Principles of Instrumental Analysis, Cengage.
7. Jain & Jain, Engineering Chemistry, Dhanpat Rai Publishing Company.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – II

24CH101P					Engineering Chemistry Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To enhance and develop scientific and analytical skills
2. To relate concepts learned in chemistry and engineering to the real-world situations.
3. To acquire skills to perform laboratory experiments.
4. To demonstrate safe and proper use of standard chemistry glassware and equipment.

LIST OF EXPERIMENTS

1 **Iodometry**– To determine the strength of given copper sulphate solution by titrating against N/20 sodium thiosulphate (hypo) solution
2 **Iodimetry**– To determine the strength of given ascorbic acid by titrating against standard N/10 iodine solution
3 **Complexometric Titration**– To determine the total, permanent and temporary hardness of given water by complexometric titration using standard 0.01M EDTA solution
4 **pH metric titration**– To determine the strength of given HCl solution using a standard NaOH solution by performing a pH-metric titration
5 **Conductometric titration**– To determine the strength of given HCl solution using a standard NaOH solution by performing a conductometric titration
6 **Chemical Kinetics**– To study the kinetics of decomposition of sodium thiosulphate by a mineral acid
7 **Drawing chemical structures** - To Draw Chemical Structures of organic molecules using ChemDraw
8 **Colorimetric determination**: To determine the concentration of copper present in the effluent of electroplating industries by using colorimeter.
9 **Detection of biomolecule**: Detection of the presence of carbohydrates in test solution by using Benedict's reagent
10 **Preparation of drug molecule**: Preparation of Aspirin from salicylic acid
11 **Polymerization**– To prepare a polymer (Nylon 6,10), identify the functional groups by FT-IR

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Recall the concepts learned in chemistry and engineering to the real-world situations.
CO2 : Show the ability to identify, analyse and interpret the results from the experiments.
CO3 : Experiment with the instrumental method using conductometer and pH meter.
CO4 : Analyse compounds by titrimetric, gravimetric and instrumental methods.
CO5 : Determine the concentration of unknown solutions by spectrophotometric method.
CO6 : Predict the reaction rate and predict the order and rate constant.

TEXT/REFERENCE BOOKS

1. V. K. Ahluwalia, S Dhingra, A. Gulati, College Practical Chemistry, Universities Press.
2. J.B. Baruah, P Gogoi, Foundations of Experimental Chemistry, PharmaMed Press.
3. S. S. Sawhney, M. S. Jassal, S.P. Mittal, A Text Book of Chemistry Practical, Vol. I & II, APH Publishing Corp.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – II

24CP102T					Computer Programming II (For ME/CL/CH/BT)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
1	0	0	1	1	25	50	25	-	-	100

COURSE OBJECTIVES

1. To develop a greater understanding of the foundational principles of the Python programming language
2. To acquaint with the data structures offered in Python.
3. To inculcate functional and logical problem-solving skills through programming.

UNIT 1: Fundamentals of Python Programming — 4 Hrs.

Introduction- History of python, Silent features, Advantage and Applications, Tools and its Framework, Variables, Input and Output

UNIT 2: Decision and Control Statements — 4 Hrs.

Operators in Python, Decision statements- If statements, If-else statements, Nested If-else statements, Control Statements - For, While, For-Else, While-Else, Continue and Break statements

UNIT 3: Data Structures and Collection — 3 Hrs.

String manipulation, List and slicing, Tuple, Set and Dictionary, Numpy and Dataframes

UNIT 4: Function and File Handling — 3 Hrs.

Built-in and user defined functions, Actual and Formal Parameters, Scope, Create, Read and Write text files

14 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basics of python programming such as syntax, datatypes, variable declarations.
CO2 - Understand the fundamental of data structures in python such as list, tuple, set, dictionary and strings.
CO3 - Understand the use of built-in functions, custom modules and packages.
CO4 - Apply Python's features to solve problems and implement decision-making and loops.
CO5 - Evaluate the effectiveness of functions and judge Python code quality.
CO6 - Evaluate Python scripts, create functions, and design programs for file handling tasks.

TEXT/REFERENCE BOOKS

1. John V Guttag, Introduction to Computation and Programming Using Python, PHI.
2. Allen Downey, Jeffrey Elkner and Chris Meyers, How to think like a Computer Scientist, Learning with Python, Green Tea Press.
3. Martin C. Brown, Python: The Complete Reference, Osborne, McGraw-Hill.
4. R. Nageswara Rao, Core Python Programming", Dreamtech Press.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – II

24CP102P					Computer Programming II Laboratory (For ME/CL/CH/BT)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
1	0	0	1	1	25	50	25	-	-	100

COURSE OBJECTIVES

1. To develop a greater understanding of the foundational principles of the Python programming language
2. To acquaint with the data structures offered in Python.
3. To inculcate functional and logical problem-solving skills through programming.

LIST OF EXPERIMENT

1. **Installation:** Installing Python on Windows, Mac, and Linux.
2. **Introduction of Different Tools & Framework:** Introduce and utilizes different tools and frameworks for python program development
3. **Fundamentals of Python Programming**
   Variable declaration, initialization, different syntax and keywords, Input/output operations
4. **Decision Statements**: Operators- Arithmetic, Logical, etc., Decision-making - if, if-else, and nested if-else statements.
5. **Control Statements:** Control statements such as for loops, while loops, and their application, Continue and break statement
6. **Data Structure:** Demonstrate string manipulation techniques, including string concatenation, list, slicing, and formatting.
7. **Python Collection:** Implement programs that illustrate the characteristics and usage of tuples, sets, and dictionaries, numpy, dataframes.
8. **Function:** Develop Python functions to perform common tasks, including mathematical operations, string manipulation, and data processing, Built-in and user-defined functions, parameter actual and formal parameters, Implement functions with different scopes.
9. **File Handling:** Develop Python scripts that create, read, and write text files, showcasing file handling operations such as opening, reading, writing, and closing files.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 - Apply Python basics tools, laying the foundation for practical usage.
CO2 - Apply Python's features to manipulate data structures effectively for solving real-world problems.
CO3 - Apply decision-making and looping to solve practical challenges.
CO4 - Analyze Python code to select appropriate constructs and data structures for optimal performance.
CO5 - Evaluate function effectiveness in Python programs for code quality and efficiency.
CO6 - Develop Python scripts and programs with robust file handling, utilizing modular functions for enhanced organization and reusability.

TEXT/REFERENCE BOOKS

1. John V Guttag, Introduction to Computation and Programming Using Python, PHI.
2. Allen Downey, Jeffrey Elkner and Chris Meyers, How to think like a Computer Scientist, Learning with Python, Green Tea Press.
3. Martin C. Brown, Python: The Complete Reference, Osborne, McGraw-Hill.
4. R. Nageswara Rao, Core Python Programming", Dreamtech Press.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – II

24EE101T					Elements of Electrical and Electronics Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart knowledge on DC and AC circuits.
2. To learn construction, working principle and characteristics of transformer and induction machines.
3. To introduce students to various means for electrical safety, protection of electrical installations and Batteries
4. To understand rectification through p-n junction diode, applications of diode and Transistor Characteristics

UNIT I: BASICS OF ELECTRONICS **10 Hrs**

Semiconductor Diodes and Applications, Diode as a Switch, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Breakdown Mechanisms, Zener Diode – Operation and Applications; Opto-Electronic Devices–LEDs, Photo Diode and Applications; Silicon Controlled Rectifier (SCR) – Operation, Construction, Characteristics, Ratings, Applications.
Transistor Characteristics covering, Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Field Effect Transistor (FET) – Construction, Characteristics of Junction FET.

UNIT II: DC CIRCUITS **10 Hrs**

Electrical circuit elements (R, L and C), voltage and current sources, dependent and independent sources, Ohms Law, temperature co-efficient of resistance, Kirchhoff current and voltage laws, voltage and current divider circuit, Thevenin and Norton Theorems and their equivalents, maximum power transfer and superposition theorems, nodal and mesh analysis, star-delta transformation, Time domain analysis/natural response of first order RL and RC Circuit.

UNIT III: AC CIRCUITS **10 Hrs**

Generation of AC voltage, representation of sinusoidal waveforms, RMS values of different sinusoidal waveforms, Rectangular and Polar representation of phasor, Sinusoid representation in time and frequency domain, Analysis of single-phase ac series circuits consisting of R, L, C, RL, RC, RLC combinations, instantaneous power, average power and reactive power, complex power and power factor.AC parallel circuit and its solution in admittance form, resonance in AC series and parallel circuits, polyphase circuits, star and delta representation of polyphase circuits, power measurement in polyphase circuits.

UNIT IV: INTRODUCTION TO ELECTRICAL MACHINES AND ELECTRICAL INSTALLATION **12 Hrs**

Magnetic materials and its B-H characteristic, Faraday's Law of Electromagnetic Induction; **Single Phase Transformers:** Construction, working principle, types, EMF equation, ideal transformer, practical transformer, Operation of transformer on no-load and load, **Induction Machine:** construction, types of 3-phase induction motors, working principle, production of rotating magnetic field, operation, starting and running torques, Torque-slip characteristics, Power Stages in an induction motor.
Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing, Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, Electrical safety rules.

s TOTAL HOURS **42 Hrs**

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Demonstrate application of different diodes in circuits and Understand the Transistor characteristics
CO2 – Understand electrical circuits using network theorems.
CO3 – Compare the behaviour of R, L and C and their combinations in AC circuits.
CO4 – Analyze balanced polyphase systems in star and delta configurations
CO5 – Understand the construction, working and basic characteristics of transformer and induction machines
CO6 – Recognize the importance of protective devices, electrical safety measures and characteristics of Batteries

TEXT/REFERENCE BOOKS

1. J. Bird, **"Electrical Circuit Theory and Technology"**, Routledge, Tailor and Francis Group
2. D. P. Kothari and I. J. Nagrath, **"Basic Electrical Engineering"**, Tata McGraw Hill
3. B. L. Theraja, **"Electrical Technology",** Vol. 1, S. Chand Publication, New Delhi.
4. Surjit Singh, **"Electrical Estimating and Costing"**, Dhanpat Rai and Co.
5. Boylestad and Nashlesky, "**Electronic Devices and Circuit Theory**", PHI

Pandit Deendayal Energy University, School of Technology
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Semester – II

24EE101P					Elements of Electrical and Electronics Engineering – Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To gain practical knowledge on DC and AC circuits
2. To learn operation of electrical instruments and electrical machines
3. To introduce students to various means for electrical safety, protection of electrical installations
4. To understand characteristics and applications of semiconductor diodes and transistors.

LIST OF EXPERIMENTS

1. Introduction to elements of electrical engineering laboratory and to study different electrical measuring instruments.
2. To Verify Ohm's law with linear resistors and find power dissipation in resistor.
3. To validate Thevenin's and Norton theorem for DC circuits.
4. To validate Superposition and Maximum Power Transfer theorem for DC circuits.
5. To evaluate the AC R, L and R-L series circuit performance and to measure the active power, the reactive power and the apparent power connected with single phase AC supply.
6. To evaluate performance of AC R-L parallel circuit and to measure the active power, the Reactive power and the apparent power connected with single phase AC supply.
7. To perform a direct load test on a single-phase transformer and determine the efficiency and voltage regulation at different loads.
8. To measure three phase power using two wattmeter method.
9. To draw the time-current characteristics of MCB and study the function of ELCB.
10. To obtain the VI characteristic of silicon and germanium diodes.
11. To obtain reverse characteristics of Zener diode.
12. To study half wave, full wave and bridge rectifiers.
13. To determine the DC Characteristics of BJT in CE Configuration.
14. To study the types of batteries and their characteristics

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – To understand the basic operation of electrical equipment's & measuring instruments.
CO2 – To perform various network theorems for DC circuits.
CO3 – To understand the performance of AC circuit with R, L load.
CO4 – To evaluate star and delta configuration of polyphase system and measure power in polyphase system.
CO5 – To evaluate the performance of single phase transformer.
CO6 – To understand the working principle of semiconductor diodes, transistor characteristics and its applications.

TEXT/REFERENCE BOOKS

1. J. Bird, **"Electrical Circuit Theory and Technology"**, Routledge, Tailor and Francis Group
2. D. P. Kothari and I. J. Nagrath, **"Basic Electrical Engineering"**, Tata McGraw Hill
3. B. L. Theraja, **"Electrical Technology",** Vol. 1, S. Chand Publication, New Delhi.
4. Surjit Singh, **"Electrical Estimating and Costing"**, Dhanpat Rai and Co.
5. Boylestad and Nashlesky, "**Electronic Devices and Circuit Theory**", PHI

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Semester – II

24HS103T					Indian Knowledge System					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	2	2	25	50	25	-	-	100

COURSE OBJECTIVES

1. To connect with the tradition of IKS
2. The students will be able to define Philosophical foundations of IKS:
3. To understand Fundamentals of Art and Architecture, Traditional and Historical Town Planning & Ancient Indian Art & Architecture

UNIT I: INTRODUCTION TO IKS **07Hrs**

What is IKS? Historical and philosophical foundations
Knowledge Framework and classifications in IKS
Indian scheme of knowledge , The knowledge triangle
Framework for establishing valid knowledge
Deductive or inductive logic framework
Potential fallacies in the reasoning process

UNIT II: IKS AND ENGINEERING DISCIPLINES **07Hrs**

Engineering marvels of ancient India: Civil engineering: Urban planning, water management
Materials engineering: Sustainable materials, traditional construction techniques Material science and Metallurgy in IKS
Mechanical engineering: Robotics and automation in ancient India
The role of IKS in addressing climate change challenge
IKS principles for resource management and conservation

UNIT III: IKS AND MATHEMATICS **07Hrs**

IKS and Indian Mathematics, Algebra, Geometry, Trignometry, Binary Mathematics, Magic
IKS and Indian Astronomy, Pañcāṅga – The Indian calendar system
Astronomical Instruments -Yantra

UNIT IV: IKS AND OTHER DISCIPLINES **07Hrs**

Indian Administration , Concept of state, Anushashan Parwa of Mahabharat,
Kautilya's Arthshastra
Social and Political Philosophies of Ancient India
IKS and Medicine: Ayurveda - A Holistic Approach to Health and Wellbeing

TOTAL HOURS: 28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Define the fundamental concepts of Indian Knowledge System
CO2 – Describe various cost concepts of IKS relevant from engineering perspective.
CO3- To Apply Mathematics in the Vedas and Śulva SūtraSystems employed for representing numbers Spherical trigonometry &Celestial Sphere
CO4- To Analyse the science of Astronomy and the different units of time discussed in the texts
CO5- To be able to weigh the IKS systems vis s vis the current applications in various spheres of understanding
CO6To design applications and processes by incorporating thebl traditional knowledge to the present day concerns

TEXT/REFERENCE BOOKS

1. Introduction To Indian Knowledge System: Concepts and Applications by by B. Mahadevan, Nagendra Pavana, Vinayak Rajat Bhat.
2. The Vedas by Sri Chandrasekharendra Saraswati/Sankaracharya of Kanchi Kamakoti Peetham (Author)
3. Indian Knowledge Systems – Vol 1 & 2 by Avadhesh K. Singh, Kapil Kapoor

Pandit Deendayal Energy University, School of Technology
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Semester – III

24MA201T					Mathematics – III					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. The primary objective of this course is to provide students with a comprehensive understanding of advanced mathematical transforms and their applications in engineering.
2. To use the concept of Laplace transform and its significance in solving differential equations.
3. Understand the fundamental concepts of difference equation and Z-transform.
4. To use this basic course in upcoming courses in respective specializations in higher classes.

UNIT 1 Laplace Transform — 10 Hrs.

Piecewise continuous functions and exponential functions, Definition, Existence and Properties of Laplace transforms, Heaviside function, Impulse function, Inverse Laplace transform, Properties of inverse Laplace transforms, Convolution theorem, Applications of Laplace Transforms in solving differential equations.

UNIT 2 Difference Equation and Z-Transform — 11 Hrs.

First and second order difference equation with constant coefficient, Solution of difference equation-complementary function-Particular integral, Z - transform, Properties of Z-transforms, Convolution of two sequences, inverse Z-transform, Solution of Difference equations using Z-transform

UNIT 3 Fourier Transform — 10 Hrs.

Fourier Integral, Fourier Cosine and Sine transform, Discrete Fourier Transform, Continuous Fourier Transform, Linearity, time shifting, frequency shifting, and convolution properties, Applications in image processing, communication systems, and quantum mechanics.

UNIT 4 Partial Differential Equations

Formation of Partial Differential Equations (PDEs), Solutions of PDEs of the first order, Cauchy problem for first-order PDEs, Lagrange's method, Charpit and Jacobi methods for solving first-order nonlinear PDEs. Classification of second order PDEs, one-dimensional heat equation, wave equation, and Laplace equation, Applications of PDE's to wave analysis.

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES:

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

- **CO1** : Define the partial differential equations of first and second order in order to model or understand the Engineering applications.
- **CO2** : Understand the techniques of Laplace transforms, Z-transforms, and Fourier transforms to solve critical mathematical problems.
- **CO3** : Apply the methods of Transform techniques to solve differential equations involving piecewise continuous and exponential functions.
- **CO4** : Classify the partial differential equations of different orders and solve those using different techniques.
- **CO5** : Appraise engineering or scientific problems that can be addressed using transform techniques.
- **CO6** : Formulate and create various application problems in engineering using series and Transform techniques.

TEXT/REFERENCE BOOKS

1. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – III

24ME201T					Introduction to Artificial Intelligence in Mechanical Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	0	0	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the utility of Artificial Intelligence for mechanical engineering applications.
2. To understand the machine learning framework.
3. To formulate and implement machine learning methods for real world applications.
4. To explore advanced AI topics in mechanical engineering.

UNIT I: FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE IN MECHANICAL ENGINEERING **08 Hrs.**

Introduction to Artificial Intelligence, Machine Learning, Deep Learning, Artificial Intelligence Vs Automation, Architecture of AI implementations in Mechanical Engineering, Basics of data preprocessing and feature engineering for mechanical engineering dataset.

UNIT II: MACHINE LEARNING TECHNIQUES IN MECHANICAL ENGINEERING **11 Hrs.**

Supervised, Unsupervised learning and semi supervised learning, Regression and Classification algorithms, Evaluation metrics in ML, Feature selection and extraction techniques, Principal Component Analysis, Singular Value Decomposition.

UNIT III: IMPLEMENTATION OF MACHINE LEARNING MODELS **11Hrs.**

Implementation of Linear Regression, Logistic Regression, Naive Bayes, Linear Discriminant Analysis, K-Nearest Neighbour, Artificial Neural Network, Support Vector Machine. Applications of deep learning in mechanical engineering for classification, regression, image processing and time series data.

UNIT IV: ADVANCED TOPICS IN ARTIFICIAL INTELLIGENCE FOR MECHANICAL ENGINEERING **10Hrs.**

Principles of predictive maintenance using AI techniques, Fault diagnosis methods and algorithms for mechanical systems, AI-driven control and decision-making in robotic systems, Applications of vision system and object detection in real-world applications.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Understand AI fundamentals and its framework.
CO2 : Implement and Analyze data preprocessing techniques.
CO3 : Interpret classification and regression in mechanical engineering applications.
CO4 : Implement diverse machine learning algorithms for various applications.
CO5 : Apply machine learning for systematic design analysis.
CO6 : Develop comprehensive strategies for integrating AI and ML techniques into mechanical engineering processes.

TEXT/REFERENCE BOOKS

1. E. Alpaydin, "**Introduction to Machine Learning**", Pearson.
2. S. Rogers & M. Girolami, "A First Course in Machine Learning", Chapman & Hall.
3. C. M. Bishop, "**Pattern Recognition and Machine Learning**", Springer.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – III

24ME202T					Engineering Mechanics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart the concept of equilibrium condition of loaded members.
2. To obtain centre of gravity, area and mass moment of inertia of different sections.
3. To get acquainted with the kinetics, kinematics and dynamics of particles and rigid bodies.
4. To get accustomed to concept of work-energy methods and its applications.

UNIT I: FREE BODY DIAGRAMS, EQUILIBRIUM AND TRUSS 10Hrs.

Principles of statics, coplanar, concurrent and non-concurrent, parallel and non-parallel forces, Conditions of Rigid body Equilibrium, Equations of Equilibrium, Two and Three force members, Equilibrium in three dimensionsTruss Simple determinate plane trusses and analysis for member forces using methods of joints and methods of sections. Types of beams and loads, Basics of Shear Force Diagram (SFD) and Bending Moment Diagram (BMD)

UNIT II: DISTRIBUTED FORCES, CENTER OF GRAVITY AND MOMENT OF INERTIA 8Hrs.

Center of gravity of lines, plane areas, volumes and bodies, Pappus – Guldinus theorems, moment of inertia, polar moment of inertia & radius of gyration of areas, parallel & perpendicular axes theorems.

UNIT III: FRICTION AND VIRTUAL WORK 12Hrs.

Theory of friction, static and sliding friction, friction and its applications including rolling friction, belt-pulley, brakes, clutches, screw jack, wedge, vehicles. Principle of Virtual work for a particle and rigid body & System of a connected rigid bodies, Conservative Forces, Potential Energy, potential Energy criterion for equilibrium, Stability of Equilibrium

UNIT IV: KINETICS OF A RIGID BODY 10 Hrs.

Kinematics and dynamics of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Determine equilibrium equations of a body subjected to system of forces.
CO2 : Calculate the location of centroid, moment of inertia, polar moment of inertia of standard sections.
CO3 : Apply the theory of friction to different mechanical applications.
CO4 : Estimate the energy criterion for equilibrium condition.
CO5 : Analyse the kinematics and dynamics of a body undergoing translatory, rotary and rigid motion.
CO6 : Evaluate the linear and angular moment of system of particles and rigid body.

TEXT/REFERENCE BOOKS

1. R.C. Hibbeler, Ashok Gupta **" Engineering Mechanics Statics & Dynamics"**, Pearson Publication
2. Ferdinand P. Beer,E. Russell Johnston Jr. **"Vector Mechanics For Engineers Statics And Dynamics"**, Tata Mcgraw hill publication
3. R. C. Hibbeler, **"Mechanics of Materials SI"**, Pearson Publication
4. Beer and Johnston, **"Mechanics of Materials"**, Tata Mcgraw hill publication
5. S S Bhavikatti, **"Engineering Mechanics"**, New Age Publication

Pandit Deendayal Energy University, School of Technology
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Semester – III

24ME203T					Thermodynamics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To learn and understand the basic principles of thermodynamics systems and its properties, energy exchange, reversible, quasi-static, and irreversible processes.
2. To understand the first and second of laws of thermodynamics, concepts of entropy and exergy and its significance in energy efficiency of thermal systems
3. To develop problem-solving abilities, formulate and solve thermodynamics problems using thermodynamic principles and develop the ability to interpret results.

UNIT I: INTRODUCTION AND PROPERTIES OF PURE SUBSTANCE 11Hrs

Introduction: Role and applications of thermodynamics in engineering, concepts of a system and surrounding, Properties of a system, equilibrium, the zeroth law of thermodynamics, heat and work, various thermodynamic processes, **1st law of thermodynamics:** Concept of energy and various forms of energy; internal energy; enthalpy; specific heats; application of first law to closed and open systems; **Properties of pure substances:** Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-v-T behaviour of simple compressible substances, thermodynamic property tables and charts, ideal and real gases, ideal gas and van der Waals equation of state; law of corresponding states, compressibility factor and generalized compressibility chart, Joule-Thomson coefficient of volume expansion, adiabatic and isothermal compressibility

UNIT II: 2ND LAW OF THERMODYNAMICS, ENTROPY, AND EXERGY 11Hrs

Second law of thermodynamics: Limitations of the first law of Thermodynamics, concept of heat engines and heat pumps/refrigerators, Kelvin-Planck & Clausius statement and their equivalence; reversible and irreversible processes; Carnot cycle and Carnot principles/theorems; Thermodynamic temperature scale, Carnot efficiency; **Entropy**: Calusius inequality and concept of entropy; microscopic interpretation of entropy, the principle of increase of entropy, T-s diagrams; **Exergy**: entropy, second law analysis for a control volume, irreversibility and availability, exergy balance and exergy analysis, exergy analysis of open and closed system

UNIT III: THERMODYNAMIC CYCLES 10Hrs

Compressor: classification of compressors, Comparison of adiabatic, polytropic, and isothermal compression process; isothermal, isentropic, mechanical, and volumetric efficiency of a compressor, multistage compression, applications; **Vapour power cycle:** Carnot vapor cycle, Rankine cycle, comparison of Carnot and Rankine cycle, calculation of cycle efficiencies, variables affecting efficiency of Rankine cycle, reheat cycle, regenerative cycle, reheat-regenerative cycle, feed water heaters; **Gas power cycles:** Recapitulation of Carnot, Otto and Diesel cycle, dual cycle, comparison of Otto, Diesel and dual cycles, air standard efficiency, mean effective pressure, brake thermal efficiency, relative efficiency, ideal Brayton cycle

UNIT IV: GAS MIXTURES AND COMBUSTION 8Hrs

Ideal gas mixtures: Dalton's and Amagat's laws, properties of ideal gas mixtures; simple thermodynamic processes involving gas mixtures; **Combustion:** Introduction, combustion reaction equations and stoichiometric air-fuel ratio, low and high calorific values, bomb calorimeter and Junkers gas calorimeter

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Understand and use thermodynamic terminology correctly; identify type of systems and various sources of energy involved
CO2 : Apply the first law of thermodynamics and analyse energy interactions across the thermodynamic system and its boundary
CO3 : Evaluate feasibility of thermodynamic processes using concepts of 2nd law of thermodynamics
CO4 : Apply knowledge of entropy and exergy to evaluate the energy conversion processes and systems
CO5 : Apply knowledge of thermodynamic power cycles and refrigeration cycle to solve numerical problems
CO6 : Apply knowledge of combustion stoichiometry to determine air-fuel ratios for various fuels

TEXT/REFERENCE BOOKS

1. Cengel, Y. A. and Bole. M. A., ***"Thermodynamics: An Engineering Approach"***, 8th Edition, McGraw Hill (2014)
2. Nag, P. K., ***"Engineering Thermodynamics"***, 6th Edition, McGraw Hill (2017)
3. Rajput, R. K., ***"Engineering Thermodynamics"***, 5th edition, Laxmi Publications, 2019
4. Rayner, J, ***"Basic Engineering Thermodynamics"***, 5th edition, Pearson (2008)
5. Borgnakke, Claus and Sonntag, Richard, ***"Fundamentals of Thermodynamics"***, 8th edition, John Wiley & Sons, Inc. (2014)

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Semester – III

24ME203P					Thermodynamics Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To gain insight into basic concepts learned in Thermodynamics theory course by performing hands on experiments.
2. To develop essential experimental skills including proper handling of equipment, data collection techniques, measurement accuracy, and data analysis
3. To grasp thermodynamic principles in a tangible way, reinforcing comprehension of these principles beyond theoretical study

LIST OF EXPERIMENTS

1 Construction and working of reciprocating air compressors
2 Performance test on a reciprocating air compressor
3 Measurement of calorific value of a liquid fuel by bomb calorimeter
4 To study working of a single cylinder 4-stroke diesel engine
5 Load test on a four-stroke single cylinder Mahindra diesel engine
6 Heat balance test on a four stroke single cylinder Mahindra diesel engine
7 Measurement of dryness fraction by separating calorimeter, throttling calorimeter, and separating-throttling calorimeter
8 Study of Rankine cycle for steam power plant
9 Study vapour compression refrigeration cycle
10 Exergy analysis of reciprocating air compressor

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Develop skill to perform quality experiments and get knowledge on experimental uncertainties
CO2 : Apply first and second laws of thermodynamics to various thermal systems
CO3 : Evaluate the performance of thermodynamic systems
CO4 : Construct charts and graphs for data representation
CO5 : Prepare good quality lab reports
CO6 : Develop presentation and team work skills

TEXT/REFERENCE BOOKS

1. Thermodynamics Lab Manual, PDEU
2. Cengel, Y A and Bole M A, ***"Thermodynamics: An Engineering Approach"***, 8th Edition, McGraw Hill (2014)
3. Nag, P K, ***"Engineering Thermodynamics"***, 6th Edition, McGraw Hill (2017)
4. Rajput, R K, ***"Engineering Thermodynamics"***, 5th edition, Laxmi Publications, 2019

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – III

24ME204T					Mechanical Measurements and Metrology					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. Introducing and acquainting individuals with various industrial terminologies related to measurement systems and metrology.
2. Exploring diverse techniques for measuring physical quantities like pressure, force, torque, etc.
3. Introducing the principles of quality control and assurance and emphasizing the importance of measurement within it.
4. Demonstrating the use of automated inspection and machine vision techniques for precise measurements.

UNIT I: FUNDAMENTALS OF MEASUREMENT SYSTEMS 10Hrs.

Principal of measurements, metrology: introduction and types, methods of measurements, basic terminology of measurements. Standard of measurement: Roles of standards in measurement, material standards, types of standards, subdivision of standards, calibrations. Transducers for Measurement: Introduction to Transducers, its classification, Quality Attributes

UNIT II: LIMITS, FITS, TOLERANCE, AND LIMIT GAUGING 13Hrs.

Principle of Interchangeability, Selective Assembly, Tolerances, allowance, Maximum and Minimum Metal Conditions, Fits, System of Limits and Fits, Hole basis and shaft basis systems, Design of Limit gauging: Taylor's Principle. Measurement of Force: load cell, proving ring; Measurement of Torque: dynamometer; Pressure Measurement Scales, Ring Balance, Inverted Bell Manometer, Dead-weight Pressure Gauge, Measurement of Vacuum, High-Pressure Measurement. Measurement of Strain: Strain Gauge Material, Backing or Carrier Materials, Adhesives, Protective Coatings, Bonding of Gauges.

UNIT III: LINEAR AND ANGULAR METROLOGY 12Hrs.

Linear measurement instruments: verniers and micrometers; Angle measurement instruments: bevel protector, sine bar and center, clinometers, collimator; Calibration of the instruments, slip gauges. Comparators: Need for comparators, characteristics of comparators, and their classifications. Measurement of surface roughness: terminology of surface texture, symbolic representation, measurement techniques

UNIT IV: QUALITY CONTROL AND MISCELLANEOUS METROLOGY 10Hrs.

Introduction to Inspection and Quality Control, Quality Control and Quality Assurance, Statistical Quality Control. Uncertainty of Measurement-Uncertainty Issues, Uncertainty Calculations, Total Quality Management, Six Sigma, Quality Standards. Precision Instrumentation Based on Laser Principles, Coordinate Measuring Machines, Machine Tool Metrology- Nano-technology instrumentation, Automated Inspection, Machine Vision.

TOTAL HOURS: 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to:

1. Understand the fundamentals of measuring systems, their terminology, and the roles of standards and Transducers
2. Analyze the measurement techniques for force, pressure, torque, strain, speed, and temperature systems.
3. Apply the principles of limits, fits, and tolerance for designing of industrial gauges.
4. Apply the concepts of Linear and angular metrology to study the functioning of different comparators.
5. Appraise the Understand the measurement system for roughness measurement and texture
6. Evaluate the different aspects of quality assurance and control and the role of measurement in it.

TEXT/REFERENCE BOOKS

1. D. S. Kumar, "**Mechanical Measurements and Control"**, Metropolian publisher.
2. R. K. Jain, "**Engineering Metrology"**, Khanna Publisher.
3. A.K. Sawhney, "**Mechanical Measurement and Instrumentation**", Dhanpat Rai Publication.
4. G. T. Smith, "**Machine tool metrology-An industrial handbook**", Springer

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – III

24ME204P					Mechanical Measurements and Metrology Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To learn the working principles of different measuring devices and their precision.
2. To familiarize with various types of measurements, methods, errors, and their limitations.
3. To develop an ability to validly use measuring instruments.
4. To appreciate the importance of measurements and metrology on the quality of a product/component.

LIST OF EXPERIMENTS

1 To measure the various dimensions of the given workpiece by various measuring Instruments.
2 Introduction to generalized measurement system and Terminology.
3 To study the working of the instruments used for measuring environmental parameters and analysis of environmental parameters at different locations
4 To study Statistical analysis (regression analysis, Linear fit, exponential fit, and polynomial fit) of experimental data using EXCEL.
5 To study and calibrate the precision measuring instruments like Vernier caliper, Micrometre, and Dial gauge.
6 To get acquainted with the sine bar.
7 Surface analysis of various manufacturing processes.
8 To measure the fundamental dimensions of a gear using a contour (profile) projector.
9 To study different types of the comparators.
10 To demonstrate different types of Limit Gauges.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Understand the working principles and operations of various instruments.
CO2 : Analyse the effect of different parameters on the measurements and methodologies.
CO3 : Demonstrate the significance of different instruments for different measurements.
CO4 : Judge the uses of appropriate techniques for different measurement applications in practical life.
CO5 : Appraise the limitations of each measurement technique and the methodologies followed.
CO6 : Evaluate the qualitative significance of the quantitative results obtained.

TEXT/REFERENCE BOOKS

1. Lab manual PDEU
2. R. K. Jain, "**Engineering Metrology"**, Khanna Publisher.
3. A. K. Sawhney, "**Mechanical Measurement and Instrumentation**", Dhanpat Rai Publication.
4. G. T. Smith, "**Machine tool metrology-An industrial handbook**", Springer

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – III

24ME205P					Mechanical Drawing Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To be able to draw computer-aided mechanical drawings of components and
2. To be able to perform assemblies of industrial machines, machinery parts and other mechanical equipment by CAD software

LIST OF EXERCISES:

1. Recapitulate concepts of sketch entities and tools, 3D features
2. Use advanced 3D features like lofted base, revolved base, sweep, draft, wrap, and mirroring features.
3. To create different mechanical elements (Trusses, beams, columns, cylinders, patterns, etc.)
4. To create a 3D assembly of mechanical systems and edit parts in the assembly.
5. Create and edit Bill of Materials (BOM)
6. Use a motion study tool to animate the assembly and detect interference/clearance.
7. To create threads using ANSI standards. To study thread features, such as internal and external threads, threaded blind holes, and thread pitch.
8. Tolerance – Limit tolerance, angular tolerance, and geometric tolerances.
9. Fit Tolerances – Clearance fits, hole basis & shaft basis, Interference fits
10. Basic introduction of bearing toolbox
11. To create gears and gear assembly.
12. To study power transmission from shaft to gears and create bearing-gear assembly
13. Assembly drawings using industry standards

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1 : Demonstrate competency with multiple drawing and modification commands in SolidWorks.
CO2 : Create three-dimensional solid models.
CO3 : Create three-dimensional assemblies of mechanical systems with permissible tolerances.
CO4 : Apply industry standards in the preparation of technical mechanical drawings.
CO5 : Communicate and present ideas and solutions to design problems using an interactive motion study tool.
CO6 : Design/draft the next innovative thing

TEXT/REFERENCE BOOKS

1. Zeid, Ibrahim, "**Mastering Solidworks**". Prentice Hall Press, 2010.
2. Weber, Matt, and Gaurav Verma, "**SolidWorks 2015 Black Book**". CreateSpace Independent Publishing Platform, 2014.
3. Rao, Posinasetti Nageswara, "**CAD/CAM: principles and applications**". Tata McGraw-Hill Education, 2004

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – IV

24ME205T					Industry 4.0 for Mechanical Engineers					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	0	0	0	2	25	50	25	--	--	100

COURSE OBJECTIVES

1. To Understand the Foundations and Architectural Principles of Industry 4.0.
2. To Explore the Internet of Things (IoT) and Data Analytics in Industrial Applications.
3. To Gain Insight for Digital Twin and Virtual Prototyping Technologies.
4. To Apply Advanced Automation and Robotics within Industry 4.0 Frameworks

UNIT I: INTRODUCTION TO INDUSTRY 4.0 **10Hrs.**

Introduction to Industry 4.0, Definition, General framework, Application areas, Introduction to the Evolution of Industrial revolutions, Key features, Need and benefits, Introduction to Industry 4.0 core technologies: Big data, Advanced Robotics, Simulation, Integration, Internet of Things (IoT), Artificial Intelligence (AI), Cybersecurity, Cloud computing, Additive manufacturing and Augmented Reality. Overview of machine learning for Industry 4.0. Transformation of industrial processes through the integration of modern technologies such as sensing and actuation, communication, and computational processing.

UNIT II: THE INTERNET OF THINGS AND DATA ANALYTICS **10Hrs.**

Fundamentals of IoT and its components, Sensor Technology and Data Acquisition in IoT-enabled Systems, Types and Functions of Sensors: temperature, pressure, vibration, gas and flow sensors. Connectivity solutions for industrial applications. Techniques for complex data analysis in mechanical engineering. Fundamentals of Image Processing and Object detections.

UNIT III: DIGITAL TWINS AND VIRTUAL PROTOTYPING **10Hrs.**

Basics of Digital Twins, Building Digital Twins, Integration with IoT, digital twins for predictive maintenance and operational efficiency, Fundamentals of Augmented and Virtual Reality, Augmented and Virtual Reality in design, assembly, and maintenance. Developing AR/VR Applications, Integration with real time applications, Future Trends.

UNIT IV: ADVANCED AUTOMATION, ROBOTICS, AND FUTURE TECHNOLOGIES **10Hrs.**

Automation in Supply Chain and Logistics, Automated warehousing and inventory management, Human-Robot Collaboration, Edge computing vs. cloud computing in industrial applications, Integrating IoT devices with digital twins through cloud services. Real-world applications focusing on automation and smart manufacturing.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Remember and Understand Industry 4.0 Principles
CO2 : Apply IoT and Data Analytics in Industrial Systems.
CO3 : Analyze Sensor Data for Mechanical Engineering Applications.
CO4 : Design Digital Twins and Virtual Prototypes.
CO5 : Evaluate Advanced Automation and Robotics Solutions.
CO6 : Synthesize Knowledge to Innovate in Smart Manufacturing.

TEXT/REFERENCE BOOKS

1. K. Palanikumar et al.,"**Machine Intelligence in Mechanical Engineering** ", Elsevier.
2. A. Gilchrist, "**Industry 4.0: The Industrial Internet of Things**", APress.

S. Mishra et al., "**Introduction to Industrial Internet of Things and Industry 4.0**", Routledge

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – IV

24ME205P					Industry 4.0 Laboratory for Mechanical Engineers					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. Equip students with foundational programming skills in Python and Open CV.
2. To learn the architectures of Arduino and Raspberry Pi platforms.
3. Provide hands-on experience with Arduino and Raspberry Pi platforms.
4. To apply Industry 4.0 architectures in real industrial applications.

LIST OF EXPERIMENTS

1. Introduction to Python and Machine Learning Libraries.
2. To understand the principles of linear regression and its application in predictive modelling.
3. Introduction to Computer Vision with OpenCV.
4. To utilize Pre-trained Models for object detection.
5. Introduction to Arduino and its architectures.
6. To design and develop a line follower autonomous vehicle model.
7. To monitor and display pressure values in a pneumatic system.
8. Introduction to Raspberry Pi and its architectures.
9. To develop an environmental monitoring system in manufacturing industry.
10. Project 1 submission using Open CV.
11. Project 2 submission using Python.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Understand the principles and applications of Python programming and Open CV.
CO2 : Apply machine learning models for industrial applications.
CO3 : To understand and utilize Arduino and Raspberry Pi for various applications.
CO4 : Demonstrate the ability to integrate sensors with Arduino and Raspberry Pi.
CO5 : To identify and apply sensors in various industrial settings.
CO6 : Evaluate the performance and reliability of sensor-integrated systems.

TEXT/REFERENCE BOOKS

1. H Jake VanderPlas, "**Python Data Science Handbook: Essential Tools for Working with Data**", O'Reilly Media.
2. Adrian Kaehler and Gary Bradski, "**Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library**", O'Reilly Media.
3. Simon Monk, "**Programming the Raspberry Pi: Getting Started with Python**", McGraw-Hill Education.
4. Massimo Banzi and Michael Shiloh, "**Getting Started with Arduino: The Open-Source Electronics Prototyping Platform**", Maker Media, Inc.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – IV

24ME206T					Fluid Mechanics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To develop the basic understanding of fluid static, kinematics and dynamics.
2. To develop understanding to apply continuity, energy and momentum equations to engineering problems involving flow measurement and energy losses.
3. To develop analytical skills to deal with various types of fluid flow problems.

UNIT 1 FLUID STATIC AND KINEMATICS 10Hrs.

Fluid Statics: Properties of fluids, Archimedes Principle, Buoyancy and stability of floating and submerged bodies, Meta-centric height. Manometers. Kinematics: Types of flow, Concept of continuum, Pressure and stress tensor. **Fluid Kinematics:** Lagrangian and Eulerian description, Streamline, Streakline and Pathline, Acceleration of a fluid element, Continuity equation, Stream function, Rotation and angular deformation, Irrotational flow, Velocity potential.

UNIT 2 FLUID DYNAMICS 11Hrs.

Integral Flow Analysis: Reynolds transport theorem, Conservation of mass/continuity equation, Conservation of linear and angular momentum for a control volume in inertial and accelerating reference frames, Energy equation, Bernoulli's equation and engineering applications. **Differential Analysis of Flow:** Stokes law of viscosity and Navier-Stokes equations.

UNIT 3 VISCOUS FLOW 11Hrs.

Reynolds experiment: laminar and turbulent flow. Plane Poiseuille flow, Couette flow, Hagen-Poiseuille flow; Friction factor and Moody's diagram, Losses in pipes, Pipe fittings and losses.

UNIT 4 DIMENSIONAL ANALYSIS AND BOUNDARY-LAYER THEORY 10Hrs.

Dimensional Analysis and Similitude: Buckingham-PI theorem, Non-dimensional parameters, Problem-solving using non-dimensionalization; Similitude and Non-dimensional numbers.

Boundary-Layer Theory: Boundary layer development and Boundary layer thicknesses, Characteristics of Boundary Layer, Boundary Layer Equations. Flow around bluff bodies, development of drag and lift on aerofoil.

Max. 42 Hrs.

COURSE OUTCOMES:

On completion of the course, student will be able to:

CO1: Understand the properties of fluid and apply the laws of fluid statics to determine buoyancy and stability of floating and submerged bodies.
CO2: Evaluate transport properties of fluid for internal and external flows.
CO3: Apply conservation principles of mass, linear momentum, and energy to fluid flow systems to determine flow quantities and energy losses in fluid flow systems.
CO4: Evaluate and arrive at reasonable approximations for a fluid flow problem where flow is governed by the continuity equation and Navier-Stokes equation.
CO5: Design simple pipe systems to deliver fluids under specified conditions.
CO6: Apply dimensional analysis to predict physical parameters that influence the flow in fluid mechanics.

TEXT/REFERENCE BOOKS

1. F. White, **"Fluid Mechanics",** Tata-McGraw Hill publishers, 2011.
2. Y. A. Cengel and J. M. Cimbala, **"Fluid Mechanics Fundamentals and Applications",** Tata-McGraw Hill Publishers, 2015.
3. R. Fox and A. McDonald, **"Introduction to Fluid Mechanics",** John Wiley Publishers, 2011.
4. V. Streeter and Benjamin, **"Fluid Mechanics: First SI-Metric",** McGraw-Hill, Auckland 2001.
5. Currie, I.G., **"Fundamental Mechanics of Fluids",** 4th Edition, CRC Press, 2012.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – IV

24ME206P					Fluid Mechanics Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To impart knowledge on construction and working principle of various flow measuring devices.
2. To impart practical exposure on the performance evaluation methods of various flow measuring equipment and energy losses fluid flow through pipe.
3. To develop understanding on experimental data analysis, technical report writing and work in teams.

LIST OF EXPERIMENTS

Experiment 1: Measurement of viscosity

Experiment 2: Verification of Bernoulli's principle

Experiment 3: Discharge coefficient of Venturimeter

Experiment 4: Discharge coefficient of Orificemeter

Experiment 5: Calibration of Rotameter

Experiment 6: Reynolds apparatus

Experiment 7: Flow measurement with Pitot tube

Experiment 8: Friction losses in circular pipe

Experiment 9: Effect of pipe diameter and length on friction losses in pipe

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Apply mass and energy conservation principles to fluid flow systems to estimate energy losses.
CO2: Evaluate the coefficient of discharge and calibration of flow measuring devices.
CO3: Identify flow patterns and flow types for internal flow systems.
CO4: Evaluate, compare and contrast experimental results of major and minor losses for internal flow systems with theoretical trends, and to attribute observed discrepancies to various errors.
CO5: Design and conduct experiments, analyze and interpret data for fluid flow systems.
CO6: Compile and interpret the experimental data under various operation conditions.

TEXT/REFERENCE BOOKS

1. F. White, **"Fluid Mechanics",** Tata-McGraw Hill publishers, 2011.
2. Y. A. Cengel and J. M. Cimbala, **"Fluid Mechanics Fundamentals and Applications",** Tata-McGraw Hill Publishers, 2015.
3. C.S.P. Ojha, R.Berndtsson, P.N. Chandramouli, **"Fluid Mechanics and Machinery",** Oxford University Press, 2012

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – IV

24ME207T					Design and Kinematics of Machines					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To learn the fundamentals of design and kinematics.
2. To comprehend joint and spring design principles for different mechanical applications.
3. To acquire proficiency in designing shafts, keys, and couplings to ensure strength and rigidity.
4. To apply kinematic synthesis techniques for creating linkages and achieving precise motion control in mechanisms

UNIT I: INTRODUCTION TO DESIGN, KINETICS AND KINEMATICS 10Hrs.

Introduction: Design procedure, coding of materials, factors of safety, standards, aesthetics, ergonomics, design aspects in selection of materials and in manufacturing, fundamentals of kinematics and mechanisms, kinematic link, types, kinematic pair, types of motions, kinematic pairs and chain, types of joints, mechanism, machine, degree of freedom (mobility), inversions of simple mechanisms, Grashoff's law, role of design in industry 4.0, concurrent engineering, CAE, CAD, simulation, various computation tools used to design, modelling and analysis

UNIT II: DESIGN OF JOINTS AND SPRING 10Hrs.

Design of cotter joint and knuckle joint, Design riveted and welded joints: Terminology of a riveted joint, types of rivets and riveted joints, design of a riveted joint, joint efficiency, eccentrically loaded riveted joint, types of welded joints, stresses in welded joints and design of it. Design of mechanical springs: Types of springs, materials for springs, stresses, deflection and buckling of helical springs, helical springs of non-circular cross-sections, helical tension spring, energy storage capacity, helical torsion springs, co-axial springs, leaf springs

UNIT III: DESIGN OF SHAFTS, KEYS AND COUPLINGS 10Hrs.

Design of Shafts, Keys and Couplings: Shaft Material, Design of solid and hollow shafts for strength and rigidity, Design of shafts for combined bending and axial loads, Types of couplings, Design of flange coupling, Design of keys

UNIT IV: KINEMATIC SYNTHESIS 10Hrs.

Synthesis of Linkages: Type, number and dimensional synthesis. Path, function and motion generation (Body guidance). Precision Positions, Chebyshev spacing, Crank Rocker mechanisms, Analytical synthesis: Derivation of Freudenstein's equation, Three-position function generation using Freudenstein's equation.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : **Recall** the fundamentals of design and the theory of kinematics and mechanisms.
CO2 : **Explain** the various mechanical components such as rivets, welded joints, shafts, couplings, springs and synthesis of mechanisms.
CO3 : **Apply** the various mechanical design and kinematics principles to design various mechanical components.
CO4 : **Analyse** the position of machines and their components.
CO5 : **Estimate** the dimensions and position of various mechanical components.
CO6 : **Formulate and design** rivets, welded joints, shafts, couplings, springs and various mechanisms.

TEXT/REFERENCE BOOKS

1. V. Bhandari, **"Machine Design"**, Tata-McGraw Hill Publishers.
2. J. Shigley, C. Mischke, R. Budynas, **"Mechanical Engineering Design"**, Tata-McGraw Hill Publishers.
3. S. S. Ratan, **"Theory of Machines"**, Tata Mc Graw-Hill publications, New Delhi
4. R. Norton, **"Machine Design: An Integrated Approach"**, Pearson Education Publishers.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – IV

24ME207P					Design and Kinematics of Machines Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. Learn to design power screws and levers effectively.
2. Analyze and design cam profiles for desired motion control
3. Develop proficiency in graphical analysis techniques for simple mechanisms.
4. Apply synthesis methods to achieve specific motion requirements in mechanisms.

LIST OF EXPERIMENTS

1. Design and drawing of power screw
2. Design and drawing of lever
3. Design and analysis of cam profile through follower displacement diagrams
4. Analysis and drawing of simple mechanisms by relative velocity method
5. Analysis and drawing of simple mechanisms by instantaneous center method
6. Analysis and drawing simple mechanisms by acceleration diagram and coriolis component of acceleration,
7. Graphical synthesis: two and three position synthesis using relative pole method
8. Graphical synthesis: inversion method for single slider crank and four bar mechanism,
9. Three position motion synthesis of four bar mechanism.
10. Development of prototype of simple mechanism

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : **Recall** the fundamentals of design and the theory of kinematics and mechanisms.
CO2 : **Explain** the various mechanical components such as lever, power screws, cams and velocity-accelerations of mechanisms and synthesis of mechanisms.
CO3 : **Apply** the various mechanical design and kinematics principles to design various mechanical components.
CO4 : **Analyse** the design of motion of machines and their components.
CO5 : **Estimate** the dimensions, velocity and acceleration of various mechanical components.
CO6 : **Formulate and design** cams, power screws and various mechanisms.

TEXT/REFERENCE BOOKS

1. V. Bhandari, **"Machine Design"**, Tata-McGraw Hill Publishers.
2. J. Shigley, C. Mischke, R. Budynas, **"Mechanical Engineering Design"**, Tata-McGraw Hill Publishers.
3. S. S. Ratan, **"Theory of Machines"**, Tata Mc Graw-Hill publications, New Delhi
4. R. Norton, **"Machine Design: An Integrated Approach"**, Pearson Education Publishers.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – IV

24ME208T					Engineering Metallurgy					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To know the importance of metallurgy in manufacturing.
2. To learn different types of mechanical properties and their evaluations.
3. To study microstructural features in metallic materials.
4. To acquire knowledge of different types of metallic materials.

UNIT 1 Testing of metals **9Hrs.**

Concept of stress and strain, strength, elasticity, plasticity, stiffness, resilience, toughness, malleability, ductility, and brittleness. Mechanical testing: tensile, compression, hardness, fatigue, wear, creep, impact. NDT: visual inspection, dye penetration test, radiography, edy current, ultrasonic. DBT curve. ASTM standards for mechanical testing.

UNIT 2 Structure Property Relation **10 Hrs**

Engineering metals and alloys, Elastic and plastic deformation, deformation in a single crystal and polycrystalline metal, Critical resolved shear stress, plastic deformation mechanisms-slip and twin, effect of defects on deformation mechanism, work hardening, fracture in metals, changes in properties due to deformation, re-crystallization, cold working and hard working. Metallography: Optical and electron microscopy (OM, SEM, EBSD, TEM, XRD).

UNIT 3 Ferrous and Non-Ferrous materials **10 Hrs.**

Ferrous metals and Designation: Wrought and cast components, allotropy of iron, iron-carbon diagram, plain carbon steels, limitations of plain carbon steel, and advantages of alloy steels. Effect of alloying elements on mechanical properties of steel, alloy steels, tool steels, stainless steels, cast irons. Designation of steels and cast iron. Corrosion in metallic materials. Non- ferrous metals and alloys: Al, Cu, Mg, Ti, and Ni.

UNIT 4 Heat treatment and advanced materials **10 Hrs.**

Effect of non- equilibrium cooling on microstructure and properties of steel, TTT diagram for 0.8% carbon steel, Isothermal treatments, continuous cooling transformation curves, critical cooling rate & heat treatments like annealing, normalizing, hardening and tempering. Hardenability of steels, jominey end quench test, surface hardening treatment scarburizing. Nitriding, carbonitriding, tufftride, sursulf, induction hardening and flame hardening. Advanced materials: types and properties of composite materials, high temperature materials, cryogenic materials, shape memory alloy.

Total 39 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 Define mechanical properties of materials.
CO2: Understand fundamental understanding of Mechanical, Metallurgical and NDT testing.
CO3: Distinguish Ferrous and non-ferrous materials.
CO4: Evaluate relation between structure and properties.
CO5: Analyse importance of the heat treatment processes.
CO6: Remember ASTM Standards and its relevance for mechanical testing

TEXT/REFERENCE BOOKS

1. William D Callister, Jr., Materials Science and Engineering, Wiley India (P) Ltd.
2. F.C. Compbell, Elements of Metallurgy and Engineering Alloys, ASM International, Ohio.
3. George Dieter, Mechanical metallurgy, McGraw-Hill.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – IV

24ME208P					Engineering Metallurgy Lab					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	2	1	2	-	-	-	25	25	50

COURSE OBJECTIVES

1. To learn the practical significance of different types of mechanical testing of materials and their interpretation
2. To develop an understanding on the methods followed for visualizing the microstructures and constituent phases of the materials, their analysis and their impact on the observed properties
3. To study the materials and their properties while correlating their microstructures and defects with different types of manufacturing processes and their parameters

UNIT 1 Mechanical Testing of Materials

Familiarize with ASTM Standards - E6, E8, E21, E23, E92, E190, E290, and G65

1. Generate both Engineering and True Stress Vs Strain curves and measure the tensile properties of the materials including modulus of resilience, and interpret the importance of each property
2. Correlate the tensile strength with hardness data and understand the variability of material properties.
3. Hardness measurements - Micro and Macro, including Knoop hardness test, and study the variations in micro and macro hardness of the welded steel samples using Vickers hardness test.
4. Correlate the Impact energy to the temperate and understand the importance of Ductile-to-Brittle Transition behaviour of the materials
5. Develop S-N curves for steels and determine their fatigue life & fatigue strength

UNIT 2 Metallography and Property Correlation

Familiarize with ASTM Standards – E340 and E527

1. Over view of Metallography procedures, and Metallurgical microscopes their construction, applications and limitations
2. Overview of Scanning Electron Microscopy and its advantages over optical microscopy
3. Metallographic examination of steels and alloys, their phase analysis, application of lever rule in phase analysis and correlating to the phase diagrams
4. Number Familiarize with ASTM Grain size chart and determine the ASTM Grain Size
5. Metallography of weldments - Macro and Microstructures
6. Metallographic examination of Ferrous Metals including Stainless Steels
7. Metallographic examination of Non Ferrous Metals - Aluminium and Copper
8. Fractrographay of different materials (Tensile, Brittle, Fatigue and Creep)
9. Wear Testing of Metallic Samples (ASTM G65)
10. Super plasticity of metallic materials and elevated temperature tensile tests of metallic materials (ASTM E 21)
11. In-situ NDT tool for health assessment, and practical demonstration of various NDT methods
12. Effect of heat treatments on microstructures

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the working principles and operations of various instruments.
CO2 - Analyse the effect of different parameters on the measurements and methodologies.
CO3 - Demonstrate the significance of different instruments for different measurements.
CO4 - Judge the uses of different techniques for different applications in practical life.
CO5 - Appraise the limitations of each technique and methodologies followed.
CO6 - Case study the materials and correlate to their properties

TEXT/REFERENCE BOOKS

1. Donald C. Zipperian, METALLOGRAPHIC HANDBOOK, PACE Technologies, USA
2. William D. Callister, Jr. Materials Science and Engineering an Introduction
3. Various ASTM standards and Lab Manual - PDPU

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – IV

24ME209T					Strength of Material					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart the knowledge of fundamental concepts of stresses and strains.
2. To obtain the analytical and graphical solutions of principle stress and strain.
3. To get acquainted with the theories on flexural stresses and bean deflections.
4. To get accustomed to the torsional forces in solid and hollow shafts.

UNIT I: STRESS, STRAIN AND STRESS TRANSFORMATION 9 Hrs.

Stress, strain, types, stress-strain diagram, practical example of failures associated with stress/strain, role of stress/strain/failures in mechanical design, factor of safety, statically indeterminate bars. Principal stresses and strains: stresses on an inclined section of a bar under axial loading, compound stresses: normal and tangential stresses on an inclined plane for biaxial stresses. Two perpendicular normal stresses accompanied by a state of simple shear, Stress transformation, Mohr's circle stresses- Principle stresses, maximum shear stresses and strains- analytical and graphical solutions.

UNIT II: FLEXURAL STRESSES IN BEAMS 10 Hrs.

Shear force and bending moment by taking examples of S.F and B.M diagrams for beams subjected to concentrated loads, uniformly distributed loads (U.D.L) and uniformly varying loads (U.V.L.) and their combinations, Point of contra flexure.Flexural stresses: Theory of simple bending, Assumptions, Derivation of bending equation (moment-curvature equation), Neutral axis, Determination bending stresses (flexural formulae), section modulus of rectangular and circular sections (Solid and Hollow), T, I, Angle, Channel sections, Design of simple beam sections.

UNIT III: SHEAR STRESS IN BEAMS AND TORSION OF SHAFT 10 Hrs.

Shear Stress: Shear stress variation, applicability to beam, shear stress distribution for various sections such as rectangle, solid circle, hollow circle, T section, I section. Torsion: Introduction torsion, comparison between solid and hollow shaft with regard to their strength and weight, Shaft in parallel and series.

UNIT IV: DEFLECTION OF BEAMS AND ENERGY METHODS 11 Hrs.

Bending into a circular arc, slope, deflection and radius of curvature, Differential equation for the elastic line of a beam, Determination of slope and deflection using Macaulay's methods. Energy Methods: Strain energy, Strain energy for Normal, shear and bending stress, Castigliano's theorm.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Define stresses, strains and stress transformation.
CO2 : Explain slope and deflection of beam.
CO3 : Apply the pure bending and pure twisting theories to beam and shaft respectively.
CO4 : Analyse the shear force and stress, and bending moment and stress diagrams of beams.
CO5 : Estimate the bending and shear stresses of beams.
CO6 : Evaluate deflection in beams and torsional stresses in shaft.

TEXT/REFERENCE BOOKS

1. James M Gere, **"Mechanics of Materials"**, Cengage publication.
2. Beer and Johnston, **"Mechanics of Materials"**, Tata Mc Graw hill..
3. R. C. Hibbeler, **"Mechanics of Materials"**, Prentice Hall, Pearson, India.
4. S. S. Ratan, **"Strength of Materials"**, Tata Mc Graw hill.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – IV

24ME209P					Strength of Materials Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To gain the fundamental knowledge of engineering in finding the strength of mechanical element subjected to various type of loadings.
2. To identify, formulate and solve the engineering problems exist in mechanical element under damage.
3. To understand the failure behavior of structural element and impact of usage of material in various application.
4. To learn about the physical aspect related to hardness, toughness, stress, impact, fatigue, tension, compression, torsion and fatigue.

LIST OF EXPERIMENTS

1. To study the stress-strain characteristics of mild steel, aluminum by conducting tensile test on UTM.
2. To determine the Young's modulus of the material by conducting deflection test on a simply supported beam.
3. To determine the Modulus of rigidity by conducting Torsion test on Solid shaft.
4. To find the Brinnell's hardness numbers of (a) Steel (b) Brass (c) Aluminum (d) Copper by conducting hardness test.
5. To find the Rockwell hardness numbers of (a) Steel (b) Brass (c) Aluminum (d) Copper by conducting hardness test.
6. To find compressive strength of wood and concrete by conducting compression test.
7. To find impact strength of (a) steel (b) aluminum by conducting Izod impact test.
8. To find impact strength of (a) steel (b) aluminum by conducting Charpy impact test.
9. To study and demonstrate the stress field using digital image correlation system.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Illustrate the behaviour of material under impact condition.
CO2 : Understand the deflection of different sections at different loading conditions.
CO3 : Sketch stress- strain curve of ductile material under tensile loading.
CO4 : Compare compression strength between wood and concrete.
CO5 : Estimate the hardness of metals.
CO6 : Evaluate elastic constants using flexural and torsion test.

TEXT/REFERENCE BOOKS

1. James M Gere, **"Mechanics of Materials"**, Cengage publication.
2. Beer and Johnston, **"Mechanics of Materials"**, Tata Mc Graw hill..
3. R. C. Hibbeler, **"Mechanics of Materials"**, Prentice Hall, Pearson, India.
4. S. S. Ratan, **"Strength of Materials"**, Tata Mc Graw hill.
5. R.K.Rajput, **"Strength of Materials"**, S.Chand & Co, New Delhi.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – V

24ME331T					Introduction to Composite Materials					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the concept of composites, types, and properties.
2. To learn the role and selection of reinforcement and matrix
3. To study the various fabrication methods of composites.
4. To study advanced applications of composites.

UNIT I: INTRODUCTION 10 Hrs.

Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Types of matrix, Types of Reinforcements/Fibers: Role and Selection or reinforcement materials, Types of fibres, Mechanical properties of fibres. Material properties that can be improved by forming a composite material and its engineering potential.

UNIT II: COMPOSITE CLASSIFICATION 10 Hrs.

Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites, Isotropic, Anisotropic, symmetric, Unsymmetric laminates, Introduction to micromechanics of composites and failure criterion.

UNIT III: MANUFACTURING PROCESSES OF COMPOSITES 10 Hrs

Manufacturing Processes: Selection and Considerations, Hand Lay-up, Prepreg Lay-up, Bag Molding, Autoclave Processing, Compression Molding, Resin Transfer Molding, Vacuum Assisted Resin Transfer Molding, Pultrusion, Filament Winding, Carbon matrix Composites or Carbon-Carbon Composites, Nanocomposites.

UNIT IV: ADVANCED APPLICATION OF COMPOSITES 10 Hrs.

Aircraft: Composite Components in Aircraft, Specific Aspects of Structural Resistance, Large Carriers, Regional Jets, Light Aircraft, Fighter Aircraft, Turbine Blades in Composites, Helicopters, Composite Materials and the Manufacturing of Automobiles, Composites in Naval Construction, Sports and Recreation.

TOTAL HOURS: 40 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Recall the fundamental of metals and composites.
CO2 : Explain the selection and role fibres and matrix and its properties.
CO3 : Demonstrate different advanced application of composites.
CO4 : Apply the various fabrication techniques to manufacture composites.
CO5 : Classify the different types of composites.
CO6 : Decide specific type of composite applicable to different applications.

TEXT/REFERENCE BOOKS

1. Krishna K Chawla, "Composite Materials Science and Engineering", Springer.
2. B. D. Agrawal, "Analysis and Performance of Composites" Wiley.
3. Gay, Daniel, "Composite materials: design and applications" CRC press.
4. "Materials characterization", Vol. 10, ASM hand book

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – V

24ME332T					Renewable and Sustainable Energy Technologies					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart the knowledge of basics of different sustainable type energy sources
2. To identify the sustainable energy technologies applicable in mechanical industries

UNIT I: SOLAR ENERGY **12 Hrs.**

Principles of solar radiation - physics of the sun, the solar constant, extra-terrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data, **Solar energy collection** - Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors, **Solar energy storage and applications** - Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, **Photovoltaic energy conversion** - Photovoltaic, p-n junction, solar cells, PV systems, Stand-alone, Grid connected solar power

UNIT II: BIOMASS ENERGY **10 Hrs.**

Biogas - Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, **Biomass gasification** - Biomass conversion technologies, Constructional details of gasifier, **Biofuels** - Introduction and perspective of biofuels, biofuel production and applications, energy plantation, environmental impact of biofuel, Biofuel operated I.C. Engine operation and economic aspects, Biomass pallets and its applications

UNIT III: WIND ENERGY **10Hrs.**

Principle of wind energy conversion, Basic components of wind energy conversion systems - Lift and Drag– Effect of density, frequency variances, angle of attack, and wind speed - design considerations of horizontal and vertical axis wind machines - analysis of aerodynamic forces acting on wind turbine blades and estimation of power output - wind data and site selection considerations, speed control devices for wind turbine

UNIT IV: OTHER RENEWABLE ENERGY **10Hrs**

Energy from Ocean – Basic cycles of Ocean Thermal Energy Conversion, basic principle of tidal power, wave energy conversion devices, **Fuel Cells** - Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells, **Geothermal Energy** - nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India, **Hydrogen Energy** - Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles

TOTAL HOURS: 42 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : **Understand** the principle of solar radiation and its availability at various locations
CO2 : **Evaluate** the ways to use solar energy for various applications like heating, cooling, water distillation and electricity and evaluate their performance.
CO3 : **Interpret** and **classify** the ways to harness the energy from Biomass.
CO4 : **Understand** and **analyze** the Wind and wave energy conversion.
CO5 : **Summarize** the ways to harness energy from other renewable energy sources like geothermal, ocean, Fuel cell, hydrogen etc.
CO6 : **Recognize** the need and ability to **engage** in lifelong learning for further developments in this field

TEXT/REFERENCE BOOKS

1. Sukhatme, S.P. and Nayak, J.K., **"Solar Energy",** McGraw-Hill Education.
2. Duffie, J.A., Beckman, W.A. and Worek, W.M., **"Solar Engineering of Thermal Processes (Vol. 3)",** New York: Wiley.
3. Zobaa, A.F. and Bansal, R.C., **"Handbook of Renewable Energy Technology"** World Scientific.
4. Kothari, D.P., Singal, K.C. and Ranjan, R., **"Renewable Energy Sources and Emerging Technologies",** PHI Learning Pvt. Ltd.
5. Desai, A.V., **"Nonconventional Energy",** New Age International.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – V

24ME333T					Fluid Machinery					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand basics of the energy conversion in fluid machines
2. To understand working and performance of various machines.
3. How to compare and chose fluid machines for various operations.

UNIT I: FUNDAMENTALS OF FLUID MACHINES **8Hrs.**

Introduction: Definition and classification of turbo machines; Principles of operation; Energy transfer in turbo machines. Momentum Principles: Action of jets on stationary and moving flat plates and curved vanes; Angular momentum principle; Torque and efficiency of roto-dynamic machines

UNIT II: TURBINES **11Hrs.**

Classification; Impulse; Reaction; Radial, Axial, mixed and tangential flow turbines; Pelton, Francis turbines; Runner profiles; Velocity triangles; Head and efficiency; Draft tube theory; Similarity laws; Concept of specific speed and unit quantities; Selection of Turbines; Operational characteristics. Introduction to Turbines used in Renewable energy system such as Wind and Tidal Turbines

UNIT III: HYDRAULIC PUMPS **11Hrs.**

Working principles and classification of pumps; Centrifugal Pumps:; working principle of roto-dynamics pumps; Manometric head, Losses and efficiencies; velocity vector diagrams and work done; Priming; Performance and characteristic curves; NPSH and Cavitation; Similarity relations and specific speed; design considerations; multi-stage pumps. Reciprocating Pumps: Construction and operational details; work and power input; volumetric efficiency and slip; separation; air vessels and their utility; maximum speed of the rotating crank; characteristic curves, regenerative pumps and its application.

UNIT IV: AIR COMPRESSOR, FAN AND BLOWER **10Hrs.**

Air Compressor: Working principles and classification; Reciprocating air compressor: compression process, work of compression, single and multi-stage compression, volumetric efficiency, air motors. Rotary compressor: centrifugal and axial flow compressor, positive displacement compressor, velocity diagram, Analysis, Design and construction features. Compressor characteristics, surging and choking. Fans & Blowers: Working principles; types; velocity diagrams; stage parameters, design parameters, losses, screw compressor and its application. Integration of CFD: modules on CFD techniques for analysing the fluid flow within machinery.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

- CO1 : Understand Fundamentals - Grasp energy conversion, classification, and operation of fluid machinery, including momentum principles and energy transfer in turbo machines
- CO2 : Analyze Turbines - Examine hydraulic turbines (Pelton, Francis, etc.) using velocity triangles, efficiency, and draft tube theory to understand design and operation.
- CO3 : Evaluate Pumps - Assess centrifugal and reciprocating pumps' principles, efficiencies, and performance, focusing on NPSH, cavitation, and air vessels.
- CO4 : Assess Compressors and Blowers - Analyze air compressors, fans, and blowers' classification, principles, and design, including efficiency and performance characteristics.
- CO5 : Synthesize for Selection - Use knowledge to evaluate and select suitable fluid machines for different operations, considering performance and operational characteristics
- CO6 : Create Optimized Designs - Develop optimized designs for turbines and pumps by incorporating multi-stage pumping, specific speed, and unit quantities to enhance efficiency.

TEXT/REFERENCE BOOKS

1. Shepherd, D. G., "**Principles of Turbo machinery**", Collier Macmillan.
2. S. L. Dixon, "**Fluid Mechanics, Thermodynamics of Turbomachinery**", Pergamon Press Ltd.
3. R. K. Turton, "**Principles of Turbomachinery**", Springer.
4. Wright, T., "**Fluid Machinery: Performance, Analysis and Design**", CRC Press.
5. S.M. Yahya, "**Turbines, Compressor and Fan**", McGraw-Hill, 2010.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – V

24ME334T					Laser & electron beam Material Processing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	--	0	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To Introduce to practical engineering applications of Laser and electron(L & E) beam for material processing .
2. To **understand the** need and study the characteristics of L & E beam.
3. To study and appreciate different manufacturing processes processed by L & E beam.
4. To develop mathematical models for the L & E beam manufacturing processes and **Solve** them.

UNIT 1 — 10Hrs.

Main industrial laser and their output beam characteristics; laser beam delivery systems. Laser beam interaction with metal, semiconductor and insulator, Ultra-short laser pulse interaction, heat flow theory and metallurgical considerations. Laser Material Processing Applications: Laser. Fundamental Properties of Electron Beam; Generation and focussing of electron beam in Vacuum and non-vaccum Fundamental Properties of Electron Beam. Electron beam material processing application. Application of L & E beam to various manufacturing processes welding, cutting, drilling, etc. Process characteristics.

UNIT 2 — 10Hrs.

L & E beam welding: Process mechanisms like keyhole and plasma effect, operating characteristics and process variation. L & E surface modifications, Laser rapid manufacturing. Laser metal forming. Laser peening: Laser Shock Processing. Heat transfer and fluid flow, microstructure selection during the solidification processes, Residual, Solidification governing equations and microstructure selection. Phase-change. Nucleation and Growth kinetics, Rapid solidification

UNIT 3 — 12Hrs.

Theoretical and modelling of L & E beam material processing: Welding, Cutting, Drilling, surface modification, etc. On-line Process monitoring & control: sensors for process modelling and processing of sensor outputs for various laser and process parameters, and workpiece characteristics. L & E beam Safety. Mathematical modelling of different manufacturing processes with L & E beams, considerations in transport. N procedures to solve coupled mass, momentum, energy, and solute equation.

UNIT 4 — 12Hrs.

Additive manufacturing technologies/Rapid prototyping using L & E beam: Liquid-Based System, Powder based systems and solid based systems. Powder bed fusion, wire arc additive manufacturing, Direct material deposition using both beams: comparison of both the technologies. High energy density beams for 3D printing for metals, semiconductors, polymers, etc. Medical and nano technology applications for L & E beam material processing. Case-studies: Thermal simulations and analysis for manufacturing processes I & E beam material processing. Verification, validation and benchmarking. Inverse heat transfer problems. Microstructure modelling

Max. 44 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – To **understand and developing insight** into the physical phenomenon of laser-matter and electron beam interaction
CO2 – To **Study** Laser and electron beam technologies for material processing at micro macro scales.
CO3 – **Choose, Understand, implement** appropriate numerical solidification/melting model to solve problems.
CO4 – **Development** of first order mathematical descriptions for select laser & electron based manufacturing processes.
CO5 - **Understand the** capabilities and limitations of various processes processed by Laser and electron beam.
CO6 – **Choose** respective process parameters for appropriate process: Justify the process-parameter selection, design for manufacturing and quality control

TEXT/REFERENCE BOOKS

1. Kannatey-Asibu Jr, Elijah. *Principles of Laser Materials Processing: Developments and Applications*. John Wiley & Sons, 2023.
2. Steen, William M., and Jyotirmoy Mazumder. Laser material processing. springer science, 2010.
3. Gong, Shuili, et al. *Electron Beam Wire Deposition Technology and Its Application*. Springer, 2022.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – V

24ME301T					Heat Transfer					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To develop the fundamental principles and laws of heat transfer.
2. To formulate the models necessary to study, analyse and design heat transfer systems through the application of these principles.
3. To develop the problem-solving skills essential to good engineering practice of heat transfer in real-world applications.

UNIT 1 CONDUCTION **12 Hrs.**

Introduction: Modes, mechanisms and basic concepts of heat transfer; Fourier's law, thermal conductivity, thermal diffusivity. **Heat Conduction:** Generalized (3D) heat conduction equation in the Cartesian, cylindrical and spherical coordinates; One dimensional steady state solutions (with and without heat generation); temperature profile and heat transfer equations; Boundary conditions; wall, cylinder, sphere and composites; electrical analogy; overall heat transfer coefficient; Variable thermal conductivity; Critical radius of insulation. **Extended surfaces:** Fin performance parameters. **Transient heat conduction:** Lumped system analysis; approximate analytical and graphical solutions for plane walls and semi-infinite solids.

UNIT 2 CONVECTION **11 Hrs.**

Heat Convection: Classification, physical mechanism and dimensional analysis applied to forced and free convection; local and average heat transfer coefficients and dimensionless numbers; Thermal and hydrodynamic boundary layers; Differential convection equations and solutions for flat plate; Analogies between momentum and heat transfer; Laminar and turbulent heat flow correlations for external flow. **Internal forced convection:** Concept of average velocity and temperature; entrance region; General thermal analysis for laminar flow in a tube; heat transfer correlations for laminar and turbulent flow. **Free convection:** Equation of motion and the Grashof number; natural convection over surfaces and inside enclosures; combined natural and forced convection. **Boiling and Condensation:** Boiling regimes and the boiling curve; Film and drop wise condensation; correlations. flow boiling

UNIT 3 RADIATION **09 Hrs.**

Thermal Radiation: Concept of radiation, absorptivity, reflectivity & transmissivity, blackbody, grey surfaces, emissive power & emissivity. Laws of radiation – Planck, Stefan – Boltzman, Wein's displacement, Kirchoff. Intensity of radiation & solid angle, Lambert's cosine law, shape factor. Radiation heat exchange between black bodies, heat exchange between diffuse-grey bodies-radiation shield, heat exchange between enclosed grey surfaces, electrical analogy to simple problems

UNIT 4 HEAT EXCHANGERS **10 Hrs.**

Heat Exchangers: Classification, heat exchange performance analysis, LMTD for parallel & counter flow heat exchanger, overall heat transfer coefficient, fouling, correction factor for multi-pass arrangement, effectiveness and number of transfer unit for parallel and counter flow heat exchanger, cross flow, TEMA standards.

Max. 42 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1: Comprehend modes of heat transfer and apply principles of heat transfer to solve engineering problems.
CO2: Analyze and Solve problems involving steady and unsteady heat conduction through solids.
CO3: Evaluate convection heat transfer problems for a variety of flow conditions using appropriate convection correlations.
CO4: Analyze heat exchanger performance using LMTD and NTU methods.
CO5: Evaluate radiative heat exchange between two or more surfaces of different geometries.
CO6: Understand the basic principles of heat transfer in boiling and condensation.

TEXT/REFERENCE BOOKS

1. Yunus A. Cengel and Afshin J. Ghajar, **"Heat and Mass Transfer: Fundamentals and Applications",** McGraw Hill Education. Fifth Edition, 2017.
2. F. P. Incropera and D. P. DeWitt, **"Introduction to Heat Transfer",** Wiley, , New York, 5th edition, 2006.
3. J. P. Holman, **"Heat Transfer",** Tata McGraw Hill Education, 10th Edition, 2017.
4. F. White, **"Heat and Mass Transfer",** Pearson Education (US), 1988.
5. S. P. Sukhatme**, "A Textbook of Heat Transfer",** Universities Press, 4th Edition, 2005.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – V

24ME301P					Heat Transfer Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To analyse, differentiate and evaluate different modes of heat transfer through various mediums.
2. To evaluate steady and transient state properties of heat transfer mediums.
3. To calculate and compare the performance of heat exchangers.

LIST OF EXPERIMENTS

1. To Identify the Thermal Conductivity of Metal Rod
2. To Identify the Thermal Conductivity of Insulating Powder
3. To Identify the Convective Heat Transfer of Air In Natural Convection Mode
4. To Identify the Convective Heat Transfer of Air In Force Convection Mode
5. To Identify the Emissivity of A Test Material
6. To Verify the Stefan Boltzmann Constant
7. To Evaluate the Performance of Tube-In-Tube Heat Exchanger Under Parallel And Counter Flow Conditions
8. To Evaluate the Performance of Shell And Tube Heat Exchanger Under Various Flow Conditions
9. To Evaluate the Performance of Plate Heat Exchanger Under Various Flow Conditions

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Understand the engineering examples of different modes of heat transfer.
CO2: Evaluate and verify heat transfer modelling through experimentation.
CO3: Understand and analyse emissivity of a given materials.
CO4: Understand and analyse thermal conductivity of a given insulating powder.
CO5: Examine the performance of heat exchangers.
CO6: Compile and interpret the experimental data at steady state condition

TEXT/REFERENCE BOOKS

1. Yunus A. Cengel and Afshin J. Ghajar, **"Heat and Mass Transfer: Fundamentals and Applications,"** McGraw Hill Education. Fifth edition, 2017.
2. F. P. Incropera and D. P. DeWitt, **"Introduction to Heat Transfer",** Wiley, , New York, 5th edition, 2006.
3. J. P. Holman, **"Heat Transfer",** Tata McGraw Hill Education, 10th Edition, 2017.
4. F. White, **"Heat and Mass Transfer",** Pearson Education (US), 1988.
5. S. P. Sukhatme, **"A Textbook of Heat Transfer",** Universities Press, 4th Edition, 2005.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – V

24ME302T					Dynamics of Machines					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the effect of static and dynamic forces on the behaviour of a body/system.
2. To comprehend the function, motions and force distribution in elements like gears, brakes etc.
3. To develop an ability to analyse the motions in various types of gear trains.
4. To determine the unbalance in a system and subsequently balance it.

UNIT I: STATIC AND DYNAMIC FORCE ANALYSIS 10 Hrs.

Static Force Analysis: Static equilibrium, equilibrium for two force and three force members, torque, force convention, free body diagrams, superposition, virtual work. **Dynamic Force Analysis:** D 'Alembert's principle, dynamic analysis of four link, slider crank, velocity and acceleration of automobile components, turning moment, dynamically equivalent system, turning moment diagrams, fluctuation of energy, flywheels.

UNIT II: GEAR AND GEAR TRAINS 10 Hrs.

Gears: Laws of gearing, gears terminology, tooth form, standard interchangeable tooth profile, minimum number of teeth on pinion in contact with a gear, interference and undercutting, bevel, helical and spiral gears. **Gear Trains:** Simple, compound, reverted and epicyclic gear trains, analytical and tabular methods, torques in epicyclic train

UNIT III: BALANCING 10 Hrs.

Balancing: Balancing of rotating masses in single and multiple planes. **Balancing of Reciprocating Masses:** Primary and secondary balancing of reciprocating masses. Unbalanced forces and couples examination of "V", multi cylinder inline engines for primary and secondary balancing.

UNIT IV: VIBRATION 10 Hrs.

Brakes and Dynamometers: Introduction, general description and study of operating principle. **Vibration**: Types of vibrations, free longitudinal and transverse vibrations, whirling speeds, damped vibrations, logarithmic decrement, forced vibrations, free torsional vibrations of single, two and three rotor system.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Recall force analysis basics, gear terminology, and principles.
CO2 : Understand how force analysis, gear systems including gear trains within the context of kinematics.
CO3 : Apply force analysis to solve engineering problems and design gear systems.
CO4 : Analyze mechanical systems to solve vibration issues, assessing balancing techniques.
CO5 : Evaluate the effectiveness of balancing methods, gear train designs, and related components.
CO6 : Analyze various types of vibrations to optimize machinery performance.

TEXT/REFERENCE BOOKS

1. S. S. Ratan "**Theory of Machines"**, Tata Mc Graw-Hill publications, New Delhi.
2. Ghosh Amitabha, "**Theory of Mechanisms and Machines"**, East West Press.
3. Rao J.S. and Dukkipati R.V, "**Mechanisms and Machines Theory"**, Wiley Eastern Ltd.
4. Shigley J.E and Uicker J.J, **"Theory of Mechanisms and Machines**", Oxford University Press.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – V

24ME302P					Dynamics of Machines Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To analyze the behavior of bodies undergoing vibrations, both theoretically as well as practically.
2. To statically and dynamically balance an unbalanced rotating system.
3. To calculate gyroscopic torques in a gyroscope apparatus.
4. To compare the behavior of various configurations of governors.

LIST OF EXPERIMENTS

1. To study Undamped free vibrations (longitudinal) of a spring mass system
2. To study Undamped free vibrations (torsional) of a single rotor system
3. To determine the natural frequency of a two rotor system
4. To determine the Gyroscopic couple and its effect on a rotating disc
5. To demonstrate the effect of static and dynamic unbalance in a system.
6. To completely balance a system of rotating masses.
7. To find the damping coefficient of a system undergoing torsional oscillations
8. To plot the characteristics of Forced Damped Vibrations for the given system
9. To demonstrate whirling of shafts
10. To determine the characteristics of governors
11. To determine the jump speed of a Cam-follower system
12. To determine the radius of gyration of a body using Bi-filar and Tri-filar Suspension.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : **Analyse** the behaviour of bodies undergoing vibrations, both theoretically as well as practically
CO2 : **Apply** the principles of force and couple balance to statically and dynamically balance an unbalanced rotating system
CO3 : **Compute** the damping coefficient of system subjected to transverse and torsional vibrations.
CO4 : **Compare and assess** the dynamic behaviour of various mechanisms
CO5 : **Understand** the principles of gyroscope and governors
CO6 : **Illustrate and apply** a method to compute moment of inertia of rigid bodies

TEXT/REFERENCE BOOKS

1. Dynamics of Machines Lab Manual.
2. SS Rattan, **"Theory of machines",** Tata McGraw-Hill Education, New Delhi.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – V

24ME303T					Manufacturing Process-I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To provide the basics and advances in manufacturing processes.
2. To provide the fundamentals and working principles of casting, welding, and metal working processes
3. To provide the basics of defects, causes and remedies for different manufacturing processes.
4. To provide overview of novel manufacturing techniques for processing materials such as ceramics, plastics.

UNIT I: CASTING 10 Hrs.

Introduction to manufacturing-classification-challenges-selection. Introduction to casting, foundries, types of castings-patterns-allowances-moulding sand and ingredients-gating system-cores-chaplets-crucibles. Making of-Patterns-Cores-Casting design. Solidification of casting. Casting of metals-plastics. Casting Types-Sand Casting-Permanent-Investment-Die-Centrifugal-Continuous-CO2 Casting-Evaporative pattern. Casting defects, prediction and remedies,

UNIT II: METAL WORKING PROCESSES 10 Hrs.

Classification and concepts of metal working processes. **Forging**-Principles-Classifications-Tools-Dies-Defects. **Rolling**- Fundamentals-Theory-Tools-Types-Defects.**Extrusion**-Classifications-Tools-Dies-Operations-Defects. **Drawing**-Wires-Bars-Tubes-Forces. **Sheet metal forming-**Bending- Deep drawing-Roll forming- Stamping-Spinning-Peen forming. Defects in forging, causes and remedies.

UNIT III: WELDING 10 Hrs.

Introduction-Welding-Soldering-Brazing. Classification of welding-fluxes. Gas welding-ARC- MIG-TIG-Resistance- Defects-Causes-Remedies. Destructive and NDT of welds.

UNIT IV: OTHER MANUFACTURING PROCESSES 10 Hrs.

Processing of ceramics: Ceramic powder preparation, synthesis of ceramic powders, fabrication of ceramic products from powders via sintering, Processing of Plastics: thermoplastics and thermosets, Processing of Plastics: Extrusion. Injection moulding. Thermoforming. Compression moulding. Transfer moulding. General Behavior of polymer melts. Additive Manufacturing Overview.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Define the fundamentals of manufacturing processes and their classifications.
CO2 : Understand the working principles of various casting processes.
CO3 : Demonstrate the forging processes and its types
CO4 : Classify various types welding processes and their significance
CO5 : Create a map for defects in different manufacturing process along with their remedies and causes.
CO6 : Explore different process for manufacturing of ceramics and plastics.

TEXT/REFERENCE BOOKS

1. Serope Kalpakjian, "**Manufacturing engineering and Technology**" Wesley Publishing Co.
2. Lindberg R.A, "**Processes and Materials of Manufacture**", Prentice Hall of India (P) Ltd.
3. P.N.Rao, "**Manufacturing & Technology: Foundry Forming and Welding**" Tata McGraw Hill Publications.
4. Chee Kai Chua, Kah Fai Leong, Chu Sing Lim, "**Rapid prototyping: Principles and applications**" World scientific publications.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – V

24ME303P					Manufacturing Process-I Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To analyse and understand various manufacturing techniques
2. To understand and analyse types of defects in welding, casting and metal forming processes
3. To understand moulding process and its different types

LIST OF EXPERIMENTS

1. To study the safety aspects of welding, casting and metal forming operations
2. To study the Shielded Metal Arc Welding Process
3. To study the Gas welding and Gas cutting processes
4. To study Gas Tungsten Arc welding process
5. To Study Resistance Spot Welding process and its types.
6. To understand the use of various welding gauges
7. To study Soldering and Brazing process
8. To study the Wire-Arc Additive Manufacturing Process
9. To study Compression moulding process for polymers.
10. Demonstration of sand-casting operations & manufacturing of various cast products
11. To study the Friction welding and Friction stir welding process.
12. To study the Gas Metal Arc Welding Process

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Understand various Manufacturing processes
CO2 : Analyze the effect of process parameters on different quality parameters
CO3 : Examine Quality of the manufactured product
CO4 : Produce sand cast mould and cast a component
CO5 : Evaluate Additive manufacturing process
CO6 : Understand Solid state welding processes

TEXT/REFERENCE BOOKS

1. P. N. Rao, **"Manufacturing & Technology: Foundry Forming and Welding"**, Tata McGraw Hill Publications.
2. Serope Kalpakjian & Steuen. R. Sechmid, **"Manufacturing Technology"**, Pearson Education Asia
3. Taylor H.F Flemings M.C & Wulff J., "**Foundry Engineering"**, Wiley Eastern Limited

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VI

24ME335T					Mechanical Vibrations					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To learn theory of vibrations and characterize longitudinal, transverse and torsional vibration.
2. To formulate the equation of motion for single and multi-degree of freedom systems.
3. To formulate initial and boundary conditions for continuous system.
4. To design, analyse and interpret the significance of vibration isolators.

UNIT I: INTRODUCTION 11 Hrs.

Review of Single Degree of Undamped, Damped and Forced Vibration. Two Degree of Freedom System: Mode Shapes, Eigen Values and Eigen Vectors, Static and Dynamic Coupling, Semi-Definite System, Double Pendulum, Lagrange's Methods etc.

UNIT II: MULTI DEGREE OF FREEDOM SYSTEM 11 HRS.

Fourier Transform: Integral transform, Fourier integral theorem, Fourier sine and cosine integrals, Fourier transforms, Fourier sine and cosine transforms, Properties of Fourier transform, Convolution, Parseval's identity, Relationship between Fourier and Laplace transform

UNIT III: CONTINUOUS SYSTEMS 9 HRS.

Formulation of Initial Conditions and Boundary Conditions, Derivation of Longitudinal, Transverse and Torsional Vibrations of Shafts.

UNIT IV: VIBRATION CONTROL AND MEASUREMENT 9 HRS.

Vibration Control and Measurement: Vibration Isolators, Vibration Isolation with Rigid and Flexible Foundations, Active Vibration Control, Use of Vibration Absorbers, Vibration Pickups, Vibration Exciters, Signal Analysis, Dynamic Testing of Machines.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Recall the basic concept of vibration and able to differentiate between damped and undamped vibrations.
CO2 : Analyze and understand single and two degree of freedom system.
CO3 : Formulate equation of motions of multi degree freedom system.
CO4 : Compare various methods and interpret the results.
CO5 : Construct equations of motion for continuous system.
CO6 : Identify and illustrate the practical applications of vibration absorbers, isolators and exciters.

TEXT/REFERENCE BOOKS

1. S.S. Rao, **"Mechanical Vibrations"**, Pearson Education.
2. W.T. Thomas, **"Theory of Vibration with Applications"**, Pearson.
3. L. Meirovitch, **"Fundamentals of Vibrations"**, Waveland Pr.
4. S.G. Kelly, **"Schaum's Outline of Mechanical Vibrations"**, McGraw-Hill.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VI

24ME336T					Additive Manufacturing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To provide fundamentals of additive manufacturing (AM) with recent development and applications
2. To study role of CAD models and CAM programming in AM with Reverse engineering.
3. To provide knowledge of different AM processes for various materials based on ASTM standards.
4. To develop experimental based learning with case study related to AM processes.

UNIT I: INTRODUCTION TO ADDITIVE MANUFACTURING **10 Hrs.**

Overview – History – Need- Classification of AM processes- fundamental engineering aspects. Applications of AM: AM applications in various Industries. Industry 4.0 and Digital and Smart manufacturing.

UNIT II: CAD FOR AM **10 Hrs.**

CAD model preparation – Part orientation and support generation – Model slicing –Tool path generation (preparatory (G) and miscellaneous (M) code generation) – Softwares for AM Technology. magics, mimics, STL file generation, part building errors.

UNIT III: AM PROCESSESS **14 Hrs.**

ASTM Classifications of AM processes, Fused deposition modelling (FDM)- Principle, process, advantages and applications Stereolithography (SLA)-Binder Jetting-Material jetting-Powder bed fusion AM processes involving sintering and melting- Principle, process, advantages and applications-Directed energy deposition-Sheet lamination: Principle, process, advantages and applications

UNIT IV: MATERIALS AND POST PROCESSING **8 Hrs.**

Different materials used in AM- polymers, metals, multiple materials, multifunctional and graded materials. Tooling and Manufacturing: Classification of RT Routes, RP of Patterns, Indirect RT: Indirect method for Soft and Bridge Tooling, Indirect method, Direct RT: Direct RT method for Soft and Bridge Tooling, Direct method for Production Tooling

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Understand fundamentals of Additive manufacturing (AM) with classification of AM process.
CO2 : Apply various designing and slicing techniques that enable AM and create programming for tool path.
CO3 : Understand fundamentals of polymer material based AM processes.
CO4 : Analyze the characteristics of Powder based AM process.
CO5 : Explain different materials used for building three dimensional AM components.
CO6 : Examine the various post processing techniques used in AM.

TEXT/REFERENCE BOOKS

1. Ian Gibson, David W. Rosen and Brent Stucker, "**Additive manufacturing technologies: rapid prototyping to direct digital manufacturing**", Springer.
2. C.K. Chua, K.F. Leong and C.S. Lim, "**Rapid prototyping: Principles and applications**", 3rd Edition, World Scientific.
3. Gebhardt A., **"Rapid prototyping"**, Hanser Gardener Publications.
4. Andreas Gebhardt, "**Understanding additive manufacturing: rapid prototyping, rapid tooling, Rapid manufacturing**", Hanser Publishers.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VI

24ME337T					Production and Operations Management					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To study significance on management of production operations.
2. To study the importance of forecasting and various techniques of forecasting
3. To develop skills of Inventory management, material requirement planning and project management
4. To evaluate various waiting line models, analysis of various queues and measuring queue performance

UNIT 1 FORECASTING AND INVENTORY **10 Hrs.**

Operations Management: Introduction, Operations Management and Strategy, Tools for Implementation of Operations Forecasting: Introduction to Operations Management, operations strategy. Forecasting, time series methods of forecasting, causal methods of forecasting, measures of error, qualitative forecasting. Inventory management, inventory costs, and the basic EOQ model.

UNIT 2 MATERIAL REQUIREMENTS AND PLANNING **10 Hrs.**

Material Requirements Planning (MRP), components of MRP, MRP logic, lot sizing in MRP systems (LFL, EOQ, POQ, LTC, LUC, etc.), introduction to ERP systems. Operations scheduling, loading, sequencing methods. Introduction to project management, Gantt charts, CPM, Activity on arrow /Activity on node networks, concept of slack, the critical path, probabilistic time estimates, project crashing. Introduction to manufacturing planning and control, brief about planning, routing, scheduling, loading, and dispatching

UNIT 3 SERVICE PROCESSES **10 Hrs.**

Waiting line models, various types of queues, measures of queue performance, management of waiting lines. Introduction to facility planning, the facility location problem, factors influencing facility location, facility location models, process layouts, layout methods, computerized algorithms for facility layout, product layouts, fixed position layouts, cellular layouts, layout of service facilities.

UNIT 4 QUALITY MANAGEMENT **10 Hrs.**

Introduction to quality management, cost of quality, quality management systems, concepts of TQM, quality tools, process capability, concept of six sigma, quality tools, control charts. Lean manufacturing, JIT, the Toyota Production System, waste elimination, push vs. pull systems, use of kanban.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Define the fundamentals of operations managements.
CO2 : Apply the principles of forecasting and inventory management
CO3 : Estimate cost and quantity of orders by materials requirements and planning techniques
CO4 : Analyse operations by using operations scheduling, Gantt charts and critical path methods.
CO5 : Evaluate various waiting line models, analysis of various queues and measuring queue performance
CO6 : Understand the concepts of quality management, six sigma and lean manufacturing.

TEXT/REFERENCE BOOKS

1. Chase, R. B., Ravi Shankar, Jacobs, F. R. and Aquilano, N. J., "**Operations & Supply Management"**, Tata McGraw Hill publishing company.
2. Buffa, E. S. and Sarin, R., "**Modern, Production and Operations Management**, John Wiley & Sons.
3. Martand Telsang, **Industrial engineering and production management**", PHI Learning
4. N. G. Nair, "**Production and operations management"**, Tata McGraw Hill publishing company.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VI

24ME338T					Heat Exchanger Design					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart the knowledge of construction, working and application of various heat exchangers
2. To perform the thermal and hydraulic design of various heat exchangers
3. To estimate the effect of geometric and operating parameters on the performance of heat exchangers

UNIT I: ADVANCED FUNDAMENTALS OF HEAT EXCHANGER DESIGN **10 Hrs.**

Classification of heat exchanger, selection of heat exchanger, review of LMTD & e-NTU method, multi-pass and cross flow heat exchanger, fouling, cleanliness factor, over surface design, techniques to control fouling, additives, rating and sizing problems, enhancement of heat transfer, performance evaluation of heat transfer enhancement technique. Real-world case studies.

UNIT II: SHELL AND TUBE HEAT EXCHANGER DESIGN **11 Hrs.**

Basic components of various STHE, TEMA standard, Classification as per TEMA standard, Thermal Design Theory for shell and tube heat exchanger, as per Kern and Bell-Delaware method, hydraulic design of shell and tube heat exchanger as per Kern method, Bell-Delaware method for Shell and tube heat exchanger design, introduction to HTRI software for STHE design

UNIT III: COMPACT HEAT EXCHANGER DESIGN **11 Hrs.**

Thermal design of plate-fin heat exchanger, fin and tube heat exchanger and plate heat exchanger, Estimation of pressure drop and hydraulic design of plate-fin, fin and tube, and plate heat exchange. Effect of geometric parameters and operating parameters on performance of heat exchanger. Design of double pipe heat exchangers. Selection of materials and innovative designs suitable for high-efficiency applications in aerospace, automotive, and renewable energy sectors, incorporating computational tools for design and analysis.

UNIT IV: REGENERATIVE HEAT EXCHANGER DESIGN **8 Hrs.**

Assumptions for Regenerator Heat Transfer Analysis, Λ-Π method for regenerator design, balance and symmetric regenerator design, unbalanced and unsymmetrical regenerator design, Influence of Matrix Material, Size, and Arrangement, Influence of longitudinal and transverse heat conduction. Applicability of phase change materials (PCMs) and additive manufacturing in regenerative heat exchangers, focusing on energy efficiency and innovation.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Identify and describe various heat exchangers, detailing their types, construction, components, operation, and applications
CO2 : Conduct thermal design for shell and tube heat exchangers, applying relevant methodologies and principles.
CO3 : Analyze the hydraulic design of shell and tube heat exchangers using diverse design approaches.
CO4 : Design plate-fin and fin-tube heat exchangers, assessing both their thermal and hydraulic performance.
CO5 : Implement design strategies for plate and double pipe heat exchangers, evaluating their operational efficiency.
CO6 : Execute regenerative heat exchanger design projects, assessing their effectiveness and performance.

TEXT/REFERENCE BOOKS

1. R.K.Shah, P. Sekulic, **"Fundamentals of Heat Exchanger Design"**, John Willey
2. Sadik Kakac, Hongtan Liu, **"Heat exchanger-selection, rating and thermal design**", CRC press
3. A.P. Frass, **"Heat exchanger design"**, Willey
4. Eric M. Smith, **"Advances in thermal design of heat exchangers"**, Willey.
5. VK Patel, VJ Savsani, MA Twahid, **"Thermal system design optimization"**, Springer Nature

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VI

24ME304T					Refrigeration and Air-conditioning					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	-	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart the knowledge of construction, working and analysis of various refrigeration and air-conditioning system
2. To evaluate the performance of various refrigeration system and identify its application
3. To estimate the cooling/heating load and design the appropriate air-conditioning system

UNIT 1 VAPOUR COMPRESSION REFRIGERATION SYSTEM 14 Hrs.

Vapour Compression Refrigeration: Working principle and essential components of the plant, simple vapour compression refrigeration cycle - COP, Representation of cycle on T-S and P-h charts - Effects of various parameters on system performance - cycle analysis - Actual cycle, multistage compression system, and their analysis, multi-evaporator system and their analysis, cascade system. Industrial refrigeration system.Refrigerants: Desirable properties of refrigeration's; classification of refrigerants; ozone depletion global warming, secondary refrigerants, future industrial refrigerants, recent development.

UNIT 2 NON-CONVENTIONAL REFRIGERATION SYSTEMS 10 Hrs.

Air refrigeration: Introduction to Refrigeration; Necessity and applications; Bell-Coleman cycle, open and dense air systems, simple, boot strap, regenerative, and reduced air refrigeration system, comparison of various air refrigeration systems. Vapour Absorption Refrigeration: working principles; description and working of NH3- H20 system and LiBr- H20 system; three fluid absorption system and its salient features; Steam jet refrigeration system - working principle, basic components.

UNIT 3 PSYCHOMETRIC PROPERTIES AND PROCESS 11 Hrs

Psychometric – Composition of air and its effect on human comfort; psychometric terms – specific humidity, relative humidity percentage humidity and absolute humidity; temperatures – dry bulb, wet bulb and dew point; Psychometric processes: different types of psychometric processes sensible heating and cooling process, Latent heating and cooling process, heating with humidification, cooling with dehumidification, adiabatic cooling; air washer process; contact and bypass factor; apparatus dew pint; condition line; sensible heat factor; Requirement of human comfort.

UNIT 4 COOLING/HEATING LOAD CALCULATION, AIR CONDITIONING SYSTEMS & COMPONENTS DESIGN 10 Hrs

Cooling/Heating load calculation for various industrial & commercial applications; Selection of air-conditioning system, requirements of industrial air-conditioning system; Summer, winter and year-round air-conditioning system; Different method of duct design such as equal pressure drop, velocity reduction and static regain method

TOTAL HOURS: 45 HRS

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Understand the construction and working of various refrigeration & air-conditioning systems and list its applications.
CO2 : Analysed the various configuration of vapour compression refrigeration system and evaluate its performance.
CO3 : Investigate the performance of different conventional and nonconventional refrigeration systems
CO4 : Develop generalized psychometrics of moist air and apply to air-conditioning processes
CO5 : Design thermal comfort conditions with proper psychometric processes and evaluate its impact on human comfort, productivity, and health
CO6 : Estimate the cooling/heating load for different application and design the associate sub systems

TEXT/REFERENCE BOOKS

1. C. P. Arora, **Refrigeration and Air Conditioning"**, Tata McGraw Hill
2. R.J. Dossat, "**Principal of refrigeration**, John Willey
3. Manohar Prasad, "**Refrigeration and Air-conditioning"**, New age publishers
4. W.F. Stoker, "**Refrigeration and Air-conditioning"**, McGraw-Hill

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VI

24ME304P					Refrigeration and Air-conditioning Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	-	-	-	25	25	50

COURSE OBJECTIVES

1. Provide the knowledge of construction, working and operation of various refrigeration and air-conditioning equipments
2. To measure the performance parameter and evaluate the system performance of various refrigeration and air-conditioning equipments
3. To Identify the effect of operating parameters on the system performance

LIST OF EXPERIMENTS

1. Performance test on vapor compression refrigeration system to measure the COP of the system
2. Performance test on VCR system with continuous flow condition and measure the COP of the system
3. Performance comparison of the water-cooled and air-cooled condenser of VCR system
4. Performance test on the heat pump system
5. Performance test on CASCADE refrigeration system
6. Performance test on NH3-H2O vapor absorption refrigeration system
7. Performance test on three fluid vapor absorption refrigeration system
8. Performance test to obtain various psychrometric processes
9. Performance test on the air-conditioning system and measure the cooling capacity and COP of the system
10. Perform the cooling load calculation for the given space

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Understand the function of different components of refrigeration and air-conditioning systems with its construction and working.
CO2 : Evaluate the performance of compression-based refrigeration systems
CO3 : Analysed the effect of operating parameters on the performance of refrigeration and air-conditioning systems.
CO4 : Evaluate the performance of non-conventional refrigeration system
CO5 : Understand the different psychrometric terms and analyse the various psychrometric process
CO6 : Evaluate the performance of the air-conditioning system

TEXT/REFERENCE BOOKS

1. C. P. Arora, **Refrigeration and Air Conditioning"**, Tata McGraw Hill
2. W.F. Stoker, "**Refrigeration and Air-conditioning"**, McGraw-Hill

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VI

24ME305T					Machine Design - I					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To gain familiarity with the concepts of design procedure under different types of loads.
2. To be able to design a pressure vessel as per industrial requirements.
3. To obtain the knowledge of designing power transmission systems.
4. To attain capability of designing various components of an Engine.

UNIT I: FAILURE RESULTING FROM STATIC AND VARIABLE LOAD 10 Hrs.

Design based on deflection and stiffness: Tension, compression and torsion based design, deflection in members, statistically indeterminate design problems, design of compression members, design for eccentric loading, design for shock and impact loading. **Failure resulting from static load:** Stress concentration, theories of failure for ductile and brittle material, contact stress **Failure resulting from variable load:** strain –life relationship, stress-life relationship, endurance limit, fatigue strength, notch sensitivity, torsional fatigue, fluctuating stress characterization, Goodman's line, Soderberg's line, Modified Goodman's line, surface fatigue strength, Design factor in fatigue.

UNIT II: DESIGN OF PRESSURE VESSELS 10 Hrs.

Types and applications of pressure vessels, Design of thin and thick cylindrical and spherical shells, Compounding of cylinders, Design of interference joints – press / shrink fitted assemblies, Design of cylinder covers, Cover plates.

UNIT III: DESIGN OF POWER TRANSMISSION SYSTEMS 10 Hrs.

Introduction and applications of power transmission systems. Types of power transmission devices, advantages and disadvantages, components of belt drive, mechanism of belt drive, Belt Materials, Types of belts and pulleys and their selection, Stresses in belts, Transmission efficiencies, Design/selection of flat belt drive, design/selection of V-belt drive, Design of Chain drives and wire ropes.

UNIT IV: DESIGN OF ENGINE PARTS 10 Hrs.

Components of I.C. engine, materials for engine components, working conditions, Forces and stresses acting on various engine components, Design of cylinder and cylinder liner, Design of piston, Design of Connecting Rod, Design of crank shafts, Design of crank pins.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Recall fundamentals of failure of mechanical components related to static loading.
CO2 : Evaluate the life of component under variable loading.
CO3 : Solve the problem of cylinder for different thickness.
CO4 : Analyze the various stresses in pressure vessels.
CO5 : Compare different transmission devices such as belt and chain drives.
CO6 : Design the engine components such as cylinders, piston, connecting rod and crank shaft.

TEXT/REFERENCE BOOKS

1. V. Bhandari, **"Machine Design"**, Tata-McGraw Hill Publishers.
2. R. S. khurmi and J. K. Gupta, **"Machine Design"**, S Chand Publication
3. C. Sharma and K. Purohit, **"Design of Machine Elements"**, PHI Publishers.
4. J. Shigley, C. Mischke, R. Budynas, **"Mechanical Engineering Design"**, Tata-McGraw Hill Publishers.
5. R. Juvinall, K. Marshek, **"Fundamental of Machine Component Design"**, John Wiley and Sons Publishers.
6. R. Norton, **"Machine Design: An Integrated Approach"**, Pearson Education Publishers.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VI

24ME305P					Machine Design -I Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To define mechanical problem and learn mathematical formulation.
2. To learn Computational coding and CAD modelling.
3. To perform analysis and interpret the results.

LIST OF EXPERIMENTS

1. To study the basic of Geometric Dimensioning and Tolerancing (GD&T) in Machine Design.
2. To study design based on fatigue loads (variable loads).
3. To design a cylinder shells subjected to internal pressure (pressure vessel).
4. To design a spherical shells subjected to internal pressure (pressure vessel).
5. To design a Flat belts and pulleys drive system.
6. To design a V belts and pulleys drive system.
7. To design an IC engine cylinder subjected to internal stresses.
8. To design a connecting rod.
9. To design a crank shaft and crank pin.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Learn to utilize component catalogues and standard machine components effectively.
CO2 : Classify different types of analysis that can be performed on mechanical components.
CO3 : Prepare problem and Solve mathematical equations for simple interdisciplinary problem.
CO4 : Analyse the dimension of components using the analytical tools.
CO5 : Compare the results obtain using analytical and numerical modelling.
CO6 : Design and Develop Computational coding, CAD model and perform analysis for a mechanical components.

TEXT/REFERENCE BOOKS

1. Gene R. Cogorno, **"Geometric Dimensioning and Tolerancing for Mechanical Design"**, Tata-McGraw Hill Publishers.
2. V. Bhandari, **"Machine Design"**, Tata-McGraw Hill Publishers.
3. Rudra Pratap, **"Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers"**, Oxford University Press.
4. Steven C. Chapra, **"Applied Numerical Methods with MATLAB for Engineers and Scientists"**, Tata McGraw-Hill Education.
5. Mary K. Thompson & John M. Thompson, **"ANSYS Mechanical APDL for Finite Element Analysis"** Butterworth-Heinemann.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VI

24ME306T					Manufacturing Process- II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To provide fundamentals of machining machine tools.
2. To study single point cutting tool with importance of different tool angles.
3. To provide knowledge of machining techniques with numerical and experimental understanding.
4. To understand gear indexing mechanisms and methods of gear manufacturing.

UNIT I: INTRODUCTION TO MACHINING AND TOOL GEOMETRIES 12 Hrs.

Need of machining – classification of machining. Introduction to machine tools and power drives. **Single point cutting tool:** Tool geometry– concept of rake and clearance angles –different systems of tool geometry –mechanism of chip formation- Merchant's circle analysis- essential properties and types of cutting fluids, machinability – tool life and tool failure.

UNIT II: LATHE, SHAPING, SLOTTING, AND PLANNING MACHINES 12Hrs.

Lathe: Lathe: Principle of working. Classification and specification of lathe machines – lathe accessories and attachments – various lathe operations - numerical and experimental study-effect of process parameters. **Shaping, slotting, and planning machines:** Kinematic systems – principle of working – classifications, specification and operations performed - machining time calculation.

UNIT III: MILLING MACHINES, GEAR INDEXING AND MANUFACTURING METHODS 08 Hrs.

Kinematic system – principle of working – classifications – specifications – operations performed – accessories – milling cutter – classifications of cutters. Introduction to gear indexing – methods of indexing – calculations of gear indexing methods– manufacturing methods of gears.

UNIT IV: DRILLING, BORING AND GRINDING MACHINES 08 Hrs.

Drilling and Boring machines: Kinematic system – principle of working – classifications – specifications – operations performed – machining time calculations. Classifications of grinding machines – specifications grinding wheels – mechanism of grinding – different bonds and abrasives–truing and dressing.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Study the fundamentals of machining and machine tools used in manufacturing.
CO2 : Analyze single point cutting tool geometry with role of different tool angels.
CO3 : Apply different principles of lathe machine with machining characteristic in manufacturing.
CO4 : Analyze the shaping, slotting and planning operations with machining time calculations.
CO5 : Understand fundaments of milling machines and evaluation of gear indexing methods.
CO6 : Explain drilling, boring, and grinding processes with different classifications.

TEXT/REFERENCE BOOKS

1. A. B. Chattopadhyay, **"Machining And Machine Tools"**, John Wiley & Sons Publisher.
2. Geoffrey Boothroyd, **"Fundamentals Of Metal Machining And Machine Tools"**, Crc Press.
3. R.K. Jain And S.C. Gupta, "Production Technology", Khanna Publishers.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VI

24ME306P					Manufacturing Process- II Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To understand the working principle and operations of conventional machining techniques such as lathe, milling, drilling, grinding, shaper and grinding machines.
2. To prepare a job by using lathe, milling, drilling, grinding, shaper and grinding machines. Different electronic circuits and their practical applications.
3. To understand the working principle and operations of non-conventional machining techniques.
4. To prepare a job by using of non-conventional machining techniques such as edm, wedm and ecm processes.

LIST OF EXPERIMENTS

1 To study the safety aspects of conventional and non-conventional machining operations.
2 To study the lathe machine components and different machining operations performed by lathe.
3 To prepare a job of required geometry by using lathe machine operations
4 To prepare a job of required geometry by using milling machine operations
5 To prepare a job of required geometry by using drilling machine operations
6 To prepare a job of required geometry by using shaper machine operations
7 To prepare a job of required feature by using grinding machine operations
8 To study the impact of various factors of edm process on performance measures through experimental trials.
9 To study the impact of various factors of wire-edm process on performance measures through experimental trials.
10 To perform electrochemical machining (ecm) machining operations.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Define fundamentals principles of metal cutting to practical applications using lathe machine operations
CO2 : Apply principles of metal cutting through milling and shaping machining processes.
CO3 : Analyze the effect of process parameters through drilling machine operations.
CO4 : Determine the effect of process parameters for grinding operations.
CO5 : Examine the effect of process parameters using ecm machining process.
CO6 : Evaluate the performance of edm, and wedm process

TEXT/REFERENCE BOOKS

1. Sharma PC, **"A Textbook Of Production Engineering",** S. Chand Publishing.
2. H.M.T., "**Production Technology**", Tata Mcgraw-Hill Education.
3. R.K. Jain And S.C. Gupta**, "Production Technology"**

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VI

24ME307T					Robotics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand demonstrate the ability to design, analyse, and implement robotic systems.
2. To evaluate the kinematics and dynamics of robot manipulators.
3. To learn the basic of mapping, velocity, acceleration of robot manipulators.
4. To study the industrial robots from the view of Industry 4.0.

UNIT I: INTRODUCTION TO ROBOTICS 10 Hrs.

Introduction to Robotics, Laws of robotics, Robot anatomy, Links joints, DOF, Arm and wrist configuration, End effector, Cylindrical, Polar & Articulated configurations, Classification of Robotic manipulators, Co-ordinate frames, Mapping and Transformation – Rotation of vectors, Translation of vectors, Composite transformation also using software, Transformation matrix, Rotation matrix, Euler Angle representation, Fixed Angle representation.

UNIT II: KINEMATICS OF ROBOT 10 Hrs.

Description of Links and Joints, Frame assignments to the manipulators, Denavit-Hartenberg Notation, D-H Parameters using software, Kinematic relation between adjacent links, Manipulator Transformation Matrix, Forward Kinematics. Inverse Kinematics, Solvability of inverse kinematic model.

UNIT III: DIFFERENTIAL MOTION, TRAJECTORY PLANNING & CONTROL 10 Hrs.

Velocity propagation along links – linear and angular velocity analysis, manipulator Jacobian, Jacobian singularity, Jacobian in force analysis. Manipulator trajectory and analysis, Joint vs Cartesian space approach, motion planning, Trajectory planning. Open and closed loop control, Proportional, Integral & Derivative (PID) Control, Force and torque controls of manipulators.

UNIT IV: DYNAMICS OF ROBOT 10 Hrs.

Introduction to Dynamic modelling of manipulator, Lagrangian mechanics of manipulator dynamics, 2-DOF manipulator dynamic modelling, Lagrange-Euler formulation, Inverse dynamics, Software based dynamic modelling.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Comprehend the basics of robot manipulators.
CO2 : Understand the fundamentals of matrix transformation and rotation matrices.
CO3 : Assess the manipulator kinematic relationships using Denavit-Hartenberg parameters.
CO4 : Estimation of the differential motion - velocity analysis of robot manipulators.
CO5 : Evaluate the path and trajectory of robot manipulator.
CO6 : Formulate a dynamical model for robot manipulator.

TEXT/REFERENCE BOOKS

1. R K Mittal and I J Nagrath, **"Robotics and Control"**, TMH Edu. Pvt. Ltd..
2. Robert J. Schiling, **"Fundamentals of Robotics Analysis and control"**, PHI publishers.
3. John J. Craig, **"Introduction to Robotics: Mechanics and Control**", 3rd Edition, Pearson.
4. Siciliano, Bruno, Lorenzo Sciavicco, **"Robotics-Modelling, Planning and Control"**, Springer.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VI

24ME307P					Robotics Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To comprehend the elementary terminology of robotic systems.
2. To accomplish the kinematic and dynamic modelling of several robotic manipulators.
3. To study the fundamental of programming language for different robots.

LIST OF EXPERIMENTS

1. Comprehend configurations and degree of freedoms of Robots using software.
2. Study the Forward Kinematical model of a manipulator using software.
3. Study the Inverse kinematical model of a manipulator using software.
4. Formulate the Dynamical model of Robotic system using software.
5. Interfacing of Input-Output devices using Open-source developmental board - Arduino.
6. Interfacing of Input-Output devices using Open-source developmental board - Raspberry Pi.
7. Programming of Computer Vision using software.
8. Proportional-Integral-derivative (PID) control of an inverted pendulum system.
9. Learn the procedure of manipulators using teach pendent.
10. Build a Robotic system - group wise student mini projects and Case studies.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Recognize the elementary terms of robotic manipulators.
CO2 : Understand the forward and inverse kinematical model of a robot.
CO3 : Develop robot programs for interfacing Arduino and Raspberry Pi.
CO4 : Formulate a computer program of robot vision.
CO5 : Analyse and understand the working of industrial robot manipulators.
CO6 : Design state-of-the-art robots as case studies.

TEXT/REFERENCE BOOKS

1. R K Mittal and I J Nagrath, **"Robotics and Control"**, TMH Edu. Pvt. Ltd..
2. Robert J. Schiling, **"Fundamentals of Robotics Analysis and control"**, PHI publishers.
3. John J. Craig, **"Introduction to Robotics: Mechanics and Control"**, 3rd Edition, Pearson.
4. Siciliano, Bruno, Lorenzo Sciavicco, **"Robotics-Modelling, Planning and Control"**, Springer.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VII

24ME431T					EXERGY ANALYSIS OF THERMAL SYSTEM					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart detailed study of energy and exergy analysis of various thermal systems
2. To study the exergy economics and Life cycle assessment

UNIT I: EXERGY FUNDAMENTALS: THERMODYNAMICS AND LAWS IN THERMAL SYSTEMS 09 Hrs.

Basic Concepts Of Thermodynamics, Thermodynamic Properties, Introduction Of Steady State And Steady Flow Properties; Application Of The First Law Of Thermodynamics For Closed / Open Systems; Application Of The Second Law Of Thermodynamics For Closed / Open Systems

UNIT II: EXERGY ANALYSIS AND THERMODYNAMIC EFFICIENCY IN THERMAL SYSTEMS 14 Hrs.

Exergy, Environment, Dead State, Limited Dead State, Definition Of Exergy Related To Kinetic And Potential Energy, Reversible Work And Irreversibility, Explanation Of The Second Law Efficiency, Thermo Mechanical Exergy, Exergy Transfer, Exergy Of A Mass, Exergy Transfer By Work And Heat; Determination Of Flow Exergy For Closed / Open Systems, Establishing Basic Exergy Equations; The Decrease Of Exergy Principle And Exergy Destruction

UNIT III: EXERGY ANALYSIS OF THERMAL SYSTEMS 09 Hrs.

Exergy Applications For Close And Open Systems, For Continuous Flow Systems Such As Turbine, Pump, Compressor, Nozzle, Heat Exchanger, Mixer, Energy Storage Systems Etc. Exergy Balance And Second Law Efficiency.

UNIT IV: THERMO-ECONOMIC APPLICATIONS OF EXERGY 10 Hrs.

Linkages Between Exergy, Economics, The Environment And Sustainability, Life Cycle Assessment: Stages Of Life Cycle Assessment, Exergetic Life Cycle Assessment, Levelized Cost Of Energy, Capital Recovery Factor, Case Studies Of Exergy Costing In Different Thermal Components

TOTAL HOURS: 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : **Recall** the concepts of energy, entropy and exergy
CO2 : **Apply** the first law of thermodynamics for closed / open systems.
CO3 : **Apply** the second law of thermodynamics for closed / open systems.
CO4 : **Defining** exergy analysis for open and closed systems in Engineering Thermal Systems
CO5 : **Establishing** exergy equations for each system to determine the optimum working conditions
CO6 : **Develop** the methodology for increasing the energy efficiency of thermal plants through exergy-economic analysis

TEXT/REFERENCE BOOKS

1. T. J. Kotas, **"The Exergy Method of Thermal Plant** Analysis", Elsevier
2. Ibrahim Dincer and Marc A. Roshan, **"Exergy analysis of Heating, Refrigerating and Air-conditioning",** Elsevier
3. Adrian Bejan, George Tsatsaronis, Michael J. Moran, **"Thermal Design and Optimization",** John Wiley & Sons
4. Michael J. Moran, **"Availability Analysis: A Guide to Efficient Energy Use",** Amer Society of Mechanical
5. Cengel, Y. A. (Year). **"Thermodynamics: An Engineering Approach".** McGraw-Hill

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B. Tech. Mechanical Engineering
Semester – VII

24ME432T					Machine Design - II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart knowledge on design to various force transmission elements like gears and bearings.
2. To provide the knowledge of various Industrial material handling devices.
3. To appreciate the knowledge of design of an industrial gear box.

UNIT I: DESIGN OF GEAR DRIVES 12 HRS.

Gear terminology, Kinematics of gear drive, Standard system of gear tooth, Gear materials, Design of Spur, Helical and Bevel gears.

UNIT II: DESIGN OF BEARINGS 12 HRS.

Materials and selection of bearings, Working conditions for the bearings, Hydrodynamic lubrication theory for journal bearings, Design factors, Design procedure, Design of bearings, Ball and roller bearings, Load and life rating

UNIT III: DESIGN OF GEAR BOX 6 HRS.

Geometric progression- standard step ratio, sliding mesh gear box, constant mesh gear box, synchromesh gearbox, multi speed gear box.

UNIT IV: DESIGN OF MATERIAL HANDLING EQUIPMENT 10 HRS.

Introduction of material handling equipment, Concept of material handling system design, design of ropes, Hooks.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Design bearings that are used in various engineering and commercial applications.
CO2 : Design gears that are used in various engineering and commercial applications.
CO3 : Identify the concept of materials handling systems in industries.
CO4 : Design various components namely rope and crane hook for their safe use.
CO5 : Design gear box after understanding the concepts of various types of gear drives.
CO6 : Evaluate the various design and failure criterion as per the industry standards.

TEXT/REFERENCE BOOKS

1. MC. Sharma and K. Purohit, **"Design of Machine Elements"**, PHI Publishers.
2. U. Jindal, **"Machine Design"**, Pearson Publishers.
3. J. Shigley, C. Mischke, R. Budynas, **"Mechanical Engineering Design"**, Tata-McGraw Hill.
4. R. Norton, **"Machine Design: An Integrated Approach"**, Pearson Education Publishers.
5. V. B. Bhandari, **"Machine Design"**, Tata-McGraw Hill Publishers.

Pandit Deendayal Energy University, School of Technology

B. Tech. Mechanical Engineering

Semester – VII

24ME433T					Micro and Nano Manufacturing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the requirements for micro/nano manufacturing
2. To introduce various mechanical micro machining techniques
3. To provide basics of various micro/nano finishing processes
4. To introduce micro/nano fabrication methods and metrology

UNIT 1 — 10 Hrs.

Introduction to Precision Engineering, Micro-electromechanical systems – micro instrumentation, micro mechatronics merits and applications. Introduction to Bulk micromachining, Surface micromachining - LIGA and SLIGA. Introduction to Micro and Nano Fabrication: basics, Photolithography and Bulk micromachining, Flowchart, basic chip making processes - – principles and applications – Examples (Field Effect Transistor). Nanofabrication using soft lithography and various approaches of soft lithography.

UNIT 2 — 10 Hrs.

Introduction to mechanical micromachining, Micro drilling, Micro turning, Micro milling and Micro grinding – process, tools and applications. Introduction to Non-conventional micro-nano manufacturing. Process, principle and applications – Micro EBM – Process principle, description and applications, Electron Beam Micro-welding – description and applications, Laser Micro welding – description and applications, Abrasive Jet Micro Machining, WAJMM, Micro EDM, Micro WEDM, Micro ECM, Micro LBM - Process principle, description and applications.

UNIT 3 — 10 Hrs.

Introduction to Micro and Nano Finishing Processes - Chemical Mechanical Polishing (CMP) – Schematic diagram, principle and applications, Magnetorheological Finishing (MRF) processes, Magnetorheological abrasive flow finishing processes (MRAFF), Force analysis of MRAFF process, Magnetorheological Jet finishing processes. Working principle and polishing performance of MR Jet Machine. Elastic Emission Machining (EEM) – machine description, applications. Ion Beam Machining (IBM) – principle, mechanism of material removal, applications.

UNIT 4 — 10 Hrs.

Introduction to Nanotechnology – Nanomaterials Classification, Carbon Nano-tubes – properties and structures, Molecular Logic Gates and Nano level Biosensors – applications. Introduction to micro and nano measurements (metrology), defining the scale, uncertainty. Optical Microscopy – description, applications and limitations. Scanning Electron Microscopy and FIB – description, principle and applications. Scanning Probe Microscopy.

Max. 40 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : **Illustrate** various mechanical micro machining methods
CO2 : **Compare** macro mechanical machining and micro mechanical machining methods
CO3 : **Understand** various micro and nano fabrication techniques
CO4 : **Judge** application of micro and nano fabrication and finishing methods
CO5 : **Identify** applications of micro and nano fabrication and finishing methods
CO6 : **Compare** different micro and nano measurement methods

TEXT/REFERENCE BOOKS

1. V.K. Jain, **"Micro-manufacturing Processes",** CRC Press, 2012
2. Nitaigour Premchand Mahalik, **"Micro-manufacturing and Nanotechnology",** 2006
3. Mark. J. Jackson, **"Micro-fabrication and Nano-manufacturing – Pulsed water drop micromachining",** CRC Press, 2006
4. Mark. J. Jackson, **"Micro and Nano-manufacturing",** Springer, 2006.
5. Lucille A. Giannuzzi, Fred A. Stevie, **"Introduction to Focused Ion Beams Instrumentation",** Theory, Techniques and Practice, Springer 2005

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B. Tech. Mechanical Engineering
Semester – VII

24ME434T					Cryogenics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	-	-	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart the knowledge of production and maintaining low temperature and its application
2. To explain various cryogenic liquification system and obtain its comparative performance
3. To explain the various cry refrigerator and evaluate its performance

UNIT 1: CRYOGENICS LIQUIFICATION SYSTEMS: **11 Hrs.**

Introduction to Cryogenic engineering, properties of cryogenic fluids like Oxygen, Nitrogen, Argon, Neon, Florin, Helium, Hydrogen, Safety in handling of cryogens, Properties of material at cryogenic temperature- mechanical, thermal, electrical, Super conductivity, formation of superconductivity, super conducting material behaviour, application of cryogenic systems in space, medical, industries, biological, Super conductive devices such as bearings, motors, cryotrons, magnets, D.C. transformers, space simulation,

UNIT 2: CRYOGENICS LIQUIFICATION SYSTEMS **12 Hrs.**

Introduction, thermodynamically ideal systems and its performance assessment, J-T effect and analysis, inversion curve and its importance, liquefaction systems for oxygen, nitrogen, air, hydrogen, helium etc., assessment of its performance parameters, parametric analysis of the system and its effect of performance parameter, comparison of all such systems based on the performance parameters.

UNIT 3: CRYOCOOLERS AND CRYOREFRIGERATOR **12 Hrs.**

Thermodynamically ideal refrigeration cycles, simple and precooled J-T refrigerator, expander-based refrigeration system, Cry coolers: Sterling refrigerator, regenerator and its effect on the performance of sterling refrigerator, Parametric study (Schmidt's Analysis), Walker's optimization charts, Design methodology of a Stirling cryocooler. single and double volume G-M refrigerator, performance comparison between sterling and G-M refrigerator, pulse tube refrigerators, adiabatic magnetization and demagnetization, magnetic refrigerator, dilution refrigerator Thermodynamically.

UNIT 4: CRYOGENIC INSULATION AND MEASUREMENT **10 Hrs.**

Cryogenic insulation – expanded foams, gas filled & fibrous insulation, vacuum insulation, evacuated powder & fibrous insulation, opacified powder insulation, multilayer insulation, comparison of performance of various insulations. Dewar vessel for storage of cryogenic liquid. Cryogenic temperature, pressure, and Flow measurement

LECTURE: 45 HRS

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Recall and list the properties of cryogenic fluids and the application of cryogenics.
CO2 : Identify the behaviour of material properties at low temperature and its application.
CO3 : Understand the construction and working of various cryogenic liquification systems
CO4 : Understand the construction and working of various cryorefrigerator
CO5 : Compare and analyse the performance of various cryogenic liquification and refrigeration system.
CO6 : Analysed the various cryogenics insulations and evaluate its performance.

TEXT/REFERENCE BOOKS

1. RF Barron, "**Cryogenic systems**", Oxford University Press
2. Klaus D. Timmerhaus, Thomas M Flynn, "**Cryogenic process engineering**", Springer
3. S. S. Thipse, "**Cryogenics: A Text Book**", Alpha Science Intl Ltd
4. Graham Walker, "**Cryocooler, Part I &II**", Springer
5. M. Mukhopadhyay, "**Fundamentals of Cryogenic Engineering**", PHI

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VII

24ME435T					Computer Aided Design					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the mathematical modelling of geometric entities.
2. To apply basic knowledge of a programming software in generating algorithms for basic CAD geometric entities.
3. To apply the concepts modelling of Curves.
4. To introduce the fundamental concepts of Finite Element Analysis.

UNIT I: CAD FUNDAMENTALS AND GRAPHICS **8 Hrs.**

Introduction to CAD its benefits, CAD programming, DDA and Bresenham's Algorithm of line, mid point circle algorithm and ellipse generation algorithm.

UNIT II: GEOMETRIC TRANSFORMATIONS **9 Hrs.**

2D and 3D geometric transformations: Translation, Scaling, Rotation, Reflection, Homogeneous transformations, Projections, Orthographic and Affine transformations.

UNIT III: CURVES AND SURFACES **12 Hrs.**

Parametric representation curves: Hermit splines, Bezier curves, B-splines, NURBS, constructive solid geometry, Introduction to Surfaces, Introduction to Reverse Engineering, Introduction to Virtual prototyping, Case Studies

UNIT IV: FINITE ELEMENT METHOD **11 Hrs.**

Introduction, FEM procedure, Discretization of the Domain, Interpolation Models, Higher Order and Isoparametric Elements, Derivation of Element Matrices, Assembly of Element Matrices, Derivation of System Equations, Numerical Solution, Basic Equations and Solution Procedure, Analysis of Trusses, Beams.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Defining the fundamental concepts related to CAD and FEM
CO2 : Interpreting the geometrical concepts on CAD entities
CO3 : Examining 2D and 3D modelling of CAD objects
CO4 : Calculating various transformations and geometrical entities
CO5 : Evaluating geometric curves and entities for given conditions
CO6 : Solving the transformations and finite element models

TEXT/REFERENCE BOOKS

1. David F Rogers and J. Adams "**Mathematical elements for computer graphic**" 2nd Ed, TMH, New Delhi.
2. Ibrahim Zeid, "**CAD/CAM Theory & Practice**", 2nd Edition, Tata Mc Graw Hill, New Delhi
3. S. S. Rao, "**The Finite Element Method in Engineering**", 5th Edition, Elsevier/Butterworth Heinemann, 2011
4. Donald Hearn, "**Computer Graphics**", 2nd Edition, Prentice-Hall, New Jersey, U.S
5. David Salomon, "**Curves and Surfaces for Computer Graphics**", Springer, New York

Pandit Deendayal Energy University, School of Technology

B. Tech. Mechanical Engineering

Semester – VII

24ME436T					Welding for Metal Joining, Surfacing and Additive Manufacturing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To Understand various basic and advanced welding processes and its applications
2. To learn importance of welding position, edge preparation and testing of welded joints
3. To study welding metallurgy of ferrous and non-ferrous materials
4. To analyse various cutting, cladding, hard facing and additive manufacture operations
5. To review automation and robotics systems for welding operations

UNIT 1 BASIC OF ARC WELDING PROCESSES 10 Hrs.

Importance and classification of metal joining processes. Physic of arc, power source characteristics. Metal transfer, force acting on the arc, different mode of metal transfer, heat & fluid flow in welding. SMAW, SAW, GTAW, GMAW, Basics, application, advantages and disadvantages, pulsed and synergic welding. Effect of welding parameters on welding quality.

UNIT 2 RESISTANCE, BEAM AND SOLID STATE WELDING PROCESSES 10 Hrs.

Resistance, Beam and solid state welding processes; Types of processes, Fundamental principles of operation, process characteristics, parameters and applications. Heat generation, equipment details, advantages and disadvantages. Electro slag and electro gas welding. Metallography of weld.

UNIT 3 ADVANCED WELDING AND CUTTING PROCESSES 10 Hrs.

New Development in Fusion welding processes; Activated Flux TIG process, Metal Core Arc Welding, Flux Core Arc Welding. Narrow Gap Welding processes, Hybrid Welding processes; Underwater welding & repair, cladding and surfacing. Weldability of ferrous and non-ferrous systems. Testing of welds and welding defects and significance as per various ASME/ASTM standards. Cutting Processes-Gas Cutting, Plasma cutting, Water jet cutting, Laser cutting; welding symbols and welding positions.

UNIT 4 IMPORTANCE OF CLADDING, HARD FACING , AUTOMATION AND ADDITIVE MANUFACTURING IN WELDING 10 Hrs.

Various cladding and hard facing processes, various types of automation and robotics system applicable in advanced welding processes. Importance of health and safety in various welding processes. Welding processes for additive manufacturing includes wire and arc additive manufacturing, cold metal transfer and friction stir welding for additive manufacturing and other solid state additive manufacturing. Weld 4.0, Welding simulators.

Total Hours. 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 - Define the Various heat sources for metal joining processes.
CO2 - Explain the science behind the welding Arc, Beam, Metal transfer and Heat & Fluid flow.
CO3 - Demonstrate the various advanced welding process, applications, defects, weldability and testing.
CO4 - Analyse the various cutting, cladding methods and hard facing operations.
CO5 - Evaluate the concept of automation, robotics, Weld 4.0 and virtual welding
CO6 – Create integration of welding processes with additive manufacturing

TEXT/REFERENCE BOOKS

1. Nasir Ahmed,"**New Development in Advance Welding"**, Wood head publishing Limited, England
2. John Norrish, "**Advance Welding Processes- Technologies and Process Control"** Wood head publishing Limited, England.
3. Welding Hand **Bo**ok, "**Welding Science and Technology"**, Vol. 1, American Welding Society
4. ASM Handbook, "**Welding, Brazing and Soldering"**, Vol. 6,ASM international
5. ASM Handbook, "**Welding fundamental and Processes"** , Vol. 6A, ASM international
6. J Vora, V J Badheka, "**Advances in Welding Technologies for Process Development"**, CRC Press.
7. ASM Handbook, "**Additive Manufacturing processes",** Vol. 24, ASM international

Pandit Deendayal Energy University, School of Technology

B. Tech. Mechanical Engineering

Semester – VII

24ME437T					Automobile Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To comprehend the function of various components of a modern-day automobile.
2. To understand the significance of automotive parameters on the performance of the automobile.
3. To outline the current standard norms and modern technologies in the domain of automobile engineering.

UNIT I: INTRODUCTION **07 Hrs.**

Introduction to Automobile and its Performance: Automobile parts, assembly of vehicle, power required for acceleration, stability of a vehicle on a slope, dynamics of a vehicle running on banked track, stability of a vehicle taking a turn. Chassis, Frame & Body: Types, Two-wheeler Chassis, comparison, Comparison of front and rear mounting of engine, aerodynamic considerations in body profiling, Ergonomic considerations, defects in frames and body.

UNIT II: TRANSMISSION SYSTEMS **12 Hrs.**

Clutch: Constructional features and working of different types of clutch (like single plate, multi plate, cone, semi– centrifugal, fully, centrifugal, wet etc.) used in automobiles, calculation of surface area and number of driving and driven plates, fluid coupling. Gear Box: Functions of gearbox, need of gear box, gears & gear ratios, principle of gearing, types of gear boxes, manual gearboxes. Automatic Transmission: Basic devices used in automatic transmission, principle of epicyclic gearing, torque converter, free wheel clutch, over speed drive and its working, semi, fully automatic transmission, continuously variable transmission (CVT), Adaptive 4-wheel Drive System. Propeller Shaft: Propeller shafts and their types, fluid drive and fluid flywheel, universal joints, hotch-kiss drive, torque tube drive. Differential: Principle of the differential, locking differential, limited slip differential Final Drive and Rear Axle: Final drives and its types, hypoid type final drive, rear axle, rear axle drives, rear axle shaft supporting, rear axle casing, axle breather, oil retention

UNIT III: AUTOMOTIVE SUB-ASSEMBLIES **11 Hrs.**

Front Axle: Types, construction, components and their functions. Suspension System: Principle, type of suspension system, conventional and independent front and rear axle, spring, rubber and air suspensions, automatic, hydro suspension system, shock absorbers. Semi-Active and Fully Active Suspension System. Steering System: Steering layout, types of steering gears, steering linkages, steering mechanism, steering geometry, measurement and adjustment of various steering system layouts, steering ratio, under steering and over steering, power assisted steering, wheel alignment. Brakes: Principle, braking distance, braking efficiency, weight transfer, wheel skidding, principle and working of various types of brakes, anti–lock brake systems (ABS). Battery: Construction, Types of batteries, working, methods of rating, faults, charging methods. Lighting system: Wiring system, head lights, indicating lights. Accessories and Safety systems like air bags, safety belts

UNIT IV: REGULATION AND MODERN VEHICLES **10 Hrs.**

Regulation and Standardization of Vehicles: Motor vehicle act, registration of motor vehicles, driving license, control of traffic, insurance against third party, traffic signs, central motor vehicle rules, vehicle safety standards and regulations, vehicle Pollution Norms. Modern Vehicles: Construction and operational features of four wheelers available in Indian market, Vehicle Management Systems, ESP, Hill Assist, ACC, EBD, Lane Assist, Smart Features. Introduction to electric vehicles & hybrid vehicles. Connected Cars and IOT, ADAS and Autonomous Vehicles.

TOTAL HOURS: 10 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Analyse the performance characteristics of an Automobile and the factors affecting it.
CO2 : Analyse the transmission system of an Automobile.
CO3 : Explain the working of suspension and steering systems in an Automobile.
CO4 : Compare the relative working and performance of various auxiliaries and sub-systems of an Automobile.
CO5 : Summarize the function of electrical and safety systems in an Automobile.
CO6 : Identify the standard norms and modern technologies in the domain of Automobile Engineering.

TEXT/REFERENCE BOOKS

1. Kirpal Singh, "**Automobile Engineering Vol-I & II"**, Standard Pub. & Distributer.
2. W. Crouse, "**Automotive Mechanics"**, Tata McGraw Hill.
3. S. K. Gupta, "**A Textbook of Automobile Engineering"**, S. Chand Pub.
4. K. K. Jain and R. B. Asthana, "**Automobile Engineering",** McGraw Hill Pub.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VII

24ME438T					Computer Aided Manufacturing					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand detail of CNC machines
2. To implement concept of manual part programming
3. To provide fundamentals of flexible manufacturing system and robotics
4. To understand group technology and cellular manufacturing

UNIT I INTRODUCTION TO CNC MACHINES 10 Hrs.

Introduction to CAM, Nature & type of manufacturing system, NC, CNC and DNC systems, Elements of CNC machine - Slideways, motion transmission elements, Automatic tool changers and multiple pallet systems, feedback devices - encoders and transducers, sensors, actuators, Spindle drives and axes drives, Tooling for CNC machines-Tool preset and qualified tools, work and tool holding devices.

UNIT II: CNC PART PROGRAMMING 10 Hrs.

Axis identification and coordinate systems, Programming formats. Manual part programming for a turning center- Do loop, Sub routines and canned CNC lathe cycles. Manual part programming for CNC milling center - Do loop, Subroutines and Canned milling cycles. CNC part programming using APT language.

UNIT III: FLEXIBLE MANUFACTURING SYSTEM 10 Hrs.

Introduction of FMS, Types of FMS, Manufacturing Cells, JIT & GT applied to FMS, FMC, Tool Management, industrial robotics and material Handling, AS/RS, AGVS , RGV, Flexible Fixturing, Flexible Assembly Systems, FMS scheduling, sequencing, FMS lay out and essentials

UNIT IV: GROUP TECHNOLOGY AND CELLULAR MANUFACTURING 10 Hrs.

Introduction, part families, part classification and coding, machining cells, production flow analysis, Cellular Manufacturing, Computer Aided Production management- Introduction, PPC fundamentals, Problems with traditional PPC, use of computer in PPC such as CAPP, MRPI, MRPII, CAGC etc.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to:

CO1 : Understand CNC machine structures and system drives
CO2 : Analyze basics and advancement in NC and CNC for automatic manufacturing
CO3 : Create manual and APT part programs for complex profiles for Lath and milling machine
CO4 : Understand role of FMS, JIT, and Robotics in material movement in manufacturing
CO5 : Apply the concepts of group technology and cellular manufacturing in automation
CO6 : Understand computer aided production management in industries

TEXT/REFERENCE BOOKS

1. Chang, Tien-Chien, and Richard A. Wysk. "**Computer-aided manufacturing**", Prentice Hall PTR
2. Groover, Mikell P. "**Automation, production systems, and computer-integrated manufacturing"** Pearson Education India,
3. Sinha, Sanjay Kumar. "**CNC programming using FANUC custom macro"** McGraw Hill Professional.
4. Luggen, William W. "**Flexible manufacturing cells and systems**" Prentice Hall.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VII

24ME439T					Non-Destructive testing and failure analysis					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To introduce and familiarize the different Non-destructive testing techniques and its importance in manufacturing.
2. To understand basic working principle and its allied aspects for different widely used NDT techniques.
3. To enable the students for doing Failure analysis of a component and make them aware about different tools used.
4. To make student aware about advanced tools pertaining to Industry 4.0 in NDT.

UNIT 1 FAILURE ANALYSIS 10 Hrs.

Failure analysis – methodology; approaches, tools and techniques of failure analysis; modes of failure; failure data retrieval; procedural steps for Investigation of a failure for failure analysis. **Techniques for Failure identification:** Optical Microscopy, X-RAY Diffraction, Electron microscopy

UNIT 2 INTRODUCTION TO NDT 10Hrs.

Introduction to Non-Destructive Testing (NDT), its relevance, importance and key features. Classification of NDT techniques and its various applications. Selection of NDT techniques and their importance in the field of reliability analysis as well as remaining life assessment (RLA). Brief introduction to 16 methods of NDT and brief introduction to 6 widely used NDT techniques. **Visual examination:** Fundamentals of defects, root causes of defects, tools and techniques for visual observation. Acceptance standards and application. Liquid penetrant testing – procedure; penetrant testing materials, penetrant testing method – sensitivity; application and limitations.

UNIT 3 MAGNETIC PARTICLE TESTING 10 Hrs.

MPT: Definition and principle; magnetizing technique, procedure, equipment sensitivity and limitation; Application & Acceptance Standards **RADIOGRAPHY:** Basic principle, electromagnetic radiation in film, radiographic imaging, inspection techniques, applications, limitations, real time radiography, safety in Industrial radiography. Application & Acceptance Standards

UNIT 4 ADVANCED TECHNIQUES 10 Hrs.

Ultrasonic Techniques: Ultrasonic transducers, inspection methods, technique for normal beam inspection, flaw characterization technique, ultrasonic flaw detection equipment modes of display, immersion testing, advantage, limitations; Application & Acceptance Standards **Eddy current testing:** Principle, instrument techniques, sensitivity application, limitation; ultrasonic testing – basic properties of sound beam, Application & Acceptance Standards **Acoustic emission testing:** Principles of AET and techniques, its application, Acceptance standards. Use of automation, AI and Industry 4.0 in testing techniques and its case studies

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Understand the basic concept of Failure analysis and apply it for remaining life assessment.
CO2 : Evaluate the basis of NDT and principles of visual testing.
CO3 : Explain the various methods of NDT such as, magnetic particle testing and liquid penetrant testing.
CO4 : Demonstrate the NDT method of RT and UT and its application on real life manufacturing scenario.
CO5 : Evaluate the advanced NDT technique such as AET and ECT for manufacturing applications.
CO6 : Compose the industry standards of NDT and use of industry 4.0 tools for Non-destructive testing.

TEXT/REFERENCE BOOKS

1. Baldev Raj, Jayakumar T., Thavasimuthu M., 'Practical Non-Destructive, 2002
2. Testing', Narosa Publishing, 1997.
3. Das A.K., 'Metallurgy of Failure Analysis', TMH, 1992.
4. Hull., 'Non-Destructive Testing', ELBS Edition, 1991
5. Halmshaw R., - 'Non-Destructive Testing', Edward Arnold, 1990

Pandit Deendayal Energy University, School of Technology

B. Tech. Mechanical Engineering

Semester – VII

24ME440T					Material and Procurement Management					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	0	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the concept of material management and its application.
2. To introduce the Capacity Management and Planning and understand its application.
3. To study the Demand Management and Forecasting along with their applications.
4. To study applications of Economic-Order Quantity and Period-Order Quantity.

UNIT I: INTRODUCTION TO MATERIAL MANAGEMENT 10 Hrs.

Introduction, Sales and Operations Planning, Manufacturing Resource Planning, Enterprise Resource Planning, Making the Production Plan, Master Scheduling, Developing a Master Production Schedule , Production Planning, Master Scheduling, Material Requirements Planning, Bill of Material, Material Requirements Planning Process, Using the Material Requirements Plan.

UNIT II: CAPACITY MANAGEMENTAND PURCHASING 10 Hrs.

Capacity Management and Planning, Capacity Requirements Planning (CRP), Capacity Available, Capacity Required (Load), Scheduling Orders, Making the Plan, Production Activity Control, Data Requirements, Order Preparation, Load Levelling, Scheduling Bottlenecks, Theory of Constraints and Drum-Buffer-Rope, Implementation, Control, Production Reporting. Purchasing: Establishing Specifications, Functional Specification Description, Selecting Suppliers, Price Determination, Impact of Material Requirements Planning on Purchasing , Expansion of Purchasing in to Supply Chain, Management, Some Organizational Implications of Supply Chain, Management.

UNIT III: FORECASTING 10 Hrs.

Demand Management, Demand Forecasting, Characteristics of Demand, Principles of Forecasting, Collection and Preparation of Data, Forecasting Techniques, Some Important Intrinsic Techniques, Seasonality, Tracking the Forecast. Inventory Fundamentals, Aggregate Inventory Management, Item Inventory Management, Inventory and the Flow of Material, Supply and Demand Patterns, Functions of Inventories, Objectives of Inventory Management, Inventory Costs, Financial Statements and Inventory, ABC Inventory Control

UNIT IV: ORDER QUANTITIES 10 Hrs.

Economic-Order Quantity (EOQ), Variations of the EOQ Model, Quantity Discounts, Order Quantities for Families of Product When Costs Are Not Known, Period-Order Quantity (POQ), Independent Demand Ordering Systems, Order Point System, Determining Safety Stock, Determining Service Levels, Different Forecast and Lead-Time Intervals, Determining When the Order Point Is Reached, Periodic Review System, Distribution Inventory

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Identify the role of supply chain management in balancing the conflicting objectives of marketing, finance and production
CO2 : Integrate the sales, production planning and master production schedule to develop an overall plan.
CO3 : Apply various purchasing method and inventory controlling techniques into practice.
CO4 : Analyse the impact of material requirements planning and capacity management on purchasing.
CO5 : Evaluate various facility alternatives and their capacity decisions.
CO6 : Develop a balanced line of production that support organizations strategic goals.

TEXT/REFERENCE BOOKS

1. J. R. Tony Arnold, Stephen N. Chapman, Lloyad M.Clive, **"Introduction to Material Management"**, PHI Learning.
2. Datta, A.K., **"Material Management Procedure: Text and Cases"**, PHI Learning.
3. Dobbler, B., **"Purchasing and Supply Management"**, Tata McGraw Hill.
4. Gopalakrisnana, P. and Sundaraesan M., **"Material Management: An Integral Approach"**, PHI Learning.
5. Varma, M.M., **"Material Management"**, Sultan Chand and Sons.
6. Menon, K. S., **"Purchasing and Inventory Control"**, Wheeler Publishers

Pandit Deendayal Energy University, School of Technology

B. Tech. Mechanical Engineering

Semester – VII

24ME440T					Material and Procurement Management					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	0	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the concept of material management and its application.
2. To introduce the Capacity Management and Planning and understand its application.
3. To study the Demand Management and Forecasting along with their applications.
4. To study applications of Economic-Order Quantity and Period-Order Quantity.

UNIT I: INTRODUCTION TO MATERIAL MANAGEMENT 10 Hrs.

Introduction, Sales and Operations Planning, Manufacturing Resource Planning, Enterprise Resource Planning, Making the Production Plan, Master Scheduling, Developing a Master Production Schedule , Production Planning, Master Scheduling, Material Requirements Planning, Bill of Material, Material Requirements Planning Process, Using the Material Requirements Plan.

UNIT II: CAPACITY MANAGEMENTAND PURCHASING 10 Hrs.

Capacity Management and Planning, Capacity Requirements Planning (CRP), Capacity Available, Capacity Required (Load), Scheduling Orders, Making the Plan, Production Activity Control, Data Requirements, Order Preparation, Load Levelling, Scheduling Bottlenecks, Theory of Constraints and Drum-Buffer-Rope, Implementation, Control, Production Reporting. Purchasing: Establishing Specifications, Functional Specification Description, Selecting Suppliers, Price Determination, Impact of Material Requirements Planning on Purchasing , Expansion of Purchasing in to Supply Chain, Management, Some Organizational Implications of Supply Chain, Management.

UNIT III: FORECASTING 10 Hrs.

Demand Management, Demand Forecasting, Characteristics of Demand, Principles of Forecasting, Collection and Preparation of Data, Forecasting Techniques, Some Important Intrinsic Techniques, Seasonality, Tracking the Forecast. Inventory Fundamentals, Aggregate Inventory Management, Item Inventory Management, Inventory and the Flow of Material, Supply and Demand Patterns, Functions of Inventories, Objectives of Inventory Management, Inventory Costs, Financial Statements and Inventory, ABC Inventory Control

UNIT IV: ORDER QUANTITIES 10 Hrs.

Economic-Order Quantity (EOQ), Variations of the EOQ Model, Quantity Discounts, Order Quantities for Families of Product When Costs Are Not Known, Period-Order Quantity (POQ), Independent Demand Ordering Systems, Order Point System, Determining Safety Stock, Determining Service Levels, Different Forecast and Lead-Time Intervals, Determining When the Order Point Is Reached, Periodic Review System, Distribution Inventory

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 : Identify the role of supply chain management in balancing the conflicting objectives of marketing, finance and production
CO2 : Integrate the sales, production planning and master production schedule to develop an overall plan.
CO3 : Apply various purchasing method and inventory controlling techniques into practice.
CO4 : Analyse the impact of material requirements planning and capacity management on purchasing.
CO5 : Evaluate various facility alternatives and their capacity decisions.
CO6 : Develop a balanced line of production that support organizations strategic goals.

TEXT/REFERENCE BOOKS

1. J. R. Tony Arnold, Stephen N. Chapman, Lloyad M.Clive, **"Introduction to Material Management"**, PHI Learning.
2. Datta, A.K., **"Material Management Procedure: Text and Cases"**, PHI Learning.
3. Dobbler, B., **"Purchasing and Supply Management"**, Tata McGraw Hill.
4. Gopalakrisnana, P. and Sundaraesan M., **"Material Management: An Integral Approach"**, PHI Learning.
5. Varma, M.M., **"Material Management"**, Sultan Chand and Sons.
6. Menon, K. S., **"Purchasing and Inventory Control"**, Wheeler Publishers

Pandit Deendayal Energy University, School of Technology

B. Tech. Mechanical Engineering

Semester – VII

24ME401T					Optimization Techniques					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart the knowledge of unconstraint optimization techniques
2. To learn constraints optimization techniques
3. To understand classical and non-traditional optimization techniques

UNIT I: PROBLEM FORMULATION AND GRAPHICAL SOLUTIONS 10Hrs.

Introduction, need of optimization, objective function, constraints, design variables, feasible and infeasible solutions, classification of optimization problems, applications. Graphical Method: different cases, Feasible and infeasible solutions, redundant constraints, unbound solutions, unique solution.

UNIT II: LINEAR PROGRAMING PROBLEM AND SOLUTIONS 12 Hrs.

Linear Programming, Problem formulation, simplex method, Big-M method for LPP, transportation and assignment problems, Duality in Linear Programming

UNIT III: SINGLE VARIABLE PROBLEM AND SOLUTIONS 12 Hrs.

Unconstrained optimization techniques, elimination methods, interpolation methods, direct and indirect search methods

UNIT IV: 4 MULTI VARIABLE PROBLEM AND SOLUTIONS 11 Hrs.

Classical optimization techniques, single variable, multivariable optimization techniques, random search methods, methods of feasible directions, Genetic Algorithm, Simulated Annealing, Teaching-learning-based optimization

TOTAL HOURS: 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1	:	Understand basic concepts of mathematics to formulate an optimization problem and solve it graphically.
CO2	:	Use LP techniques to obtain the solution of the simplex and dual simplex problem.
CO3	:	Evaluate various assignment problem
CO4	:	Evaluate various transportation problem
CO5	:	Implement direct and indirect search method for single variable optimization problem
CO6	:	Apply search method for multi-variable optimization problem

TEXT/REFERENCE BOOKS

1. S S Rao, "**Engineering Optimization**", New Age International
2. K Deb, "**Optimization for Engineering Design: Algorithms & Examples**", Prentice-Hall of India
3. C Pearce, E Hunt , "**Optimization: Structure and Applications**", Springer
4. Ravindran, G. Reklaitis, K. M. Ragsdell, "**Engineering Optimization: Methods and Applications**", Wiley
5. F Hillier, G Lieberman, "**Introduction to Operation Research**", Mc Graw Hill
6. H Taha, **Operation Research** –, Pearson Education.
7. A Verma, "**Operation Research**", S.K. Kataria and Sons.
8. V Kapoor, "**Operation Research**", Sultan Chand & Sons

Pandit Deendayal Energy University, School of Technology

B. Tech. Mechanical Engineering

Semester – VII

24ME402T					Project Management					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs./Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the importance of project Management in manufacturing and service sectors
2. To define project requirements and identify stakeholders
3. To create project plan and schedule for monitoring project deliverables.
4. To deliver successful projects that support organizations strategic goals.

UNIT I: INTRODUCTION TO PROJECT MANAGEMENT 10Hrs.

Justifying Project Management, Projects – Definitions, The Project Management Triangle – Scope, Time and Cost, What is Project Management, Projects & Operations, The Project Life Cycle, Project Stakeholders, Project Management Process, Groups, Project Management Knowledge Areas, Project Initiation: The Project Charter, The Project Scope Document, Work Breakdown
Structures, Project Contracts – Scope, Delivery, Costs and Risks.

UNIT II: PROJECT PLANNING AND SCHEDULING 10 Hrs.

Project Network Representations, Activity Parameter, Estimation – Time, Cost and Resources, Project Time Schedule, Gantt Charts, CPM and PERT, Activity and Project Crashing, Resources Scheduling

UNIT III: PROJECT EXECUTION MANAGEMENT 10 Hrs.

Quality Specifications, Quality Control Tools, Resources Procurement and Allocation, Systems and Processes, Communications and Documentation, Managing Teams, Resources Demobilization, Project Simulation and Risk Assessment, Use of IT tools.

UNIT IV: PROJECT MONITORING & CONTROL PROCESS 10 Hrs.

Monitoring Process (on a regular basis)-Monitoring and controlling activities, Key Results from monitoring process; Techniques to evaluate project performance- Earned Value Analysis, The Critical Ratio, Review Meetings; Project Crashing and Time-Cost Trade-Off**;** Project Closure and Review**:** Performance Evaluation – Scope, Time and Cost, Performance of
Teams, Lessons Learnt, Project Closure Report. Integrated Examples/Cases.

TOTAL HOURS: 40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1: Identify the project requirements and stakeholders.

CO2: Understand the importance of project Management in manufacturing and service sectors.

CO3: Apply the methods, activities and risks involved in projects.

CO4: Create project plan and schedule for monitoring project deliverables.

CO5: Develop necessary skills to manage stakeholders by IT tools.

CO6: Deliver successful projects that support organizations strategic goals.

TEXT/REFERENCE BOOKS

1. Mantel Jr., Samuel J., Jack R. Meredith, Scott M. Shafer, Margaret M. Sutton with M. R. Gopalan, "**Project Management Core Text Book**", John Wiley & Sons.
2. Meredith, Jack R., and Samuel J. Mantel, Jr., **"Project Management: A Managerial Approach**", John Wiley & Sons.
3. Pinto, Jeffrey K. **"Project Management: Achieving Competitive Advantage and MS Project**", Pearson Publishing.
4. Maylor Harvey, **"Project Management**", Pearson Publishing.

Pandit Deendayal Energy University, School of Technology
B. Tech. Mechanical Engineering
Semester – VII

24ME403P					Computational Engineering Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	4	2	04	-	-	-	25	25	50

COURSE OBJECTIVES

1. Learn computational Software for numerical calculations.
2. Understand the basic commands of the computational software.
3. Apply the software programming to solve real life problems.

Module-1 Introduction to Numerical Methods and computational applications

a. Introduction to the Numerical methods, Discretization of domain and equations, errors.
b. Introduction to computational software: Matrices and Basic Graph plotting, Data Files and Text Strings, Basic Programming and User defined functions and function files

Module-2 Numerical Methods for Mechanical Engineering problems

a. Mathematical modelling of an Engineering System and numerical Solution to ODE
b. Mathematical modelling of an Engineering System and numerical Solution to PDE
c. Solution of Simultaneous Algebraic Equations and numerical tools for Eigen value problem.
d. Solution of Algebraic and Transcendental Equations
e. Numerical Method for Interpolations and Regression analysis
f. Numerical method for Differentiation and Integration
g. Demonstration of advanced packages or open-ware toolkit based using the software

Module-3 Case-Studies and mini-projects from Mechanical engineering to demonstrate the acquired numerical skills

a. Case Study 1
b. Case Study 2

Max hours: 52

COURSE OUTCOMES

On completion of the course, student will be able to

CO-1: **Understand** the features of the software program.
CO-2: **Apply** basic operations of the computational software and **plot** and **analyse** results.
CO-3: **Solve** the ODE using numerical methods and software tools.
CO-4: **Solve** the PDE using numerical methods and software tools.
CO-5: **Understand and apply** different numerical methods and **develop** programs based on respective numerical methods.
CO-6: **Apply** the software programming to real applications/Engineering case-studies.

TEXT/REFERENCE BOOKS

1. Chapra, Steven, Applied Numerical Methods with MATLAB for Engineers and Scientists. McGraw Hill, 2011.
2. B. S. Grewal, Numerical Methods in Engineering & Science with Programs in C, C++ & MATLAB. Khanna Publishers 10th edition, 2012.
3. Xu, Sheng. An Introduction to Scientific Computing with MATLAB® and Python Tutorials. CRC Press, 2022.