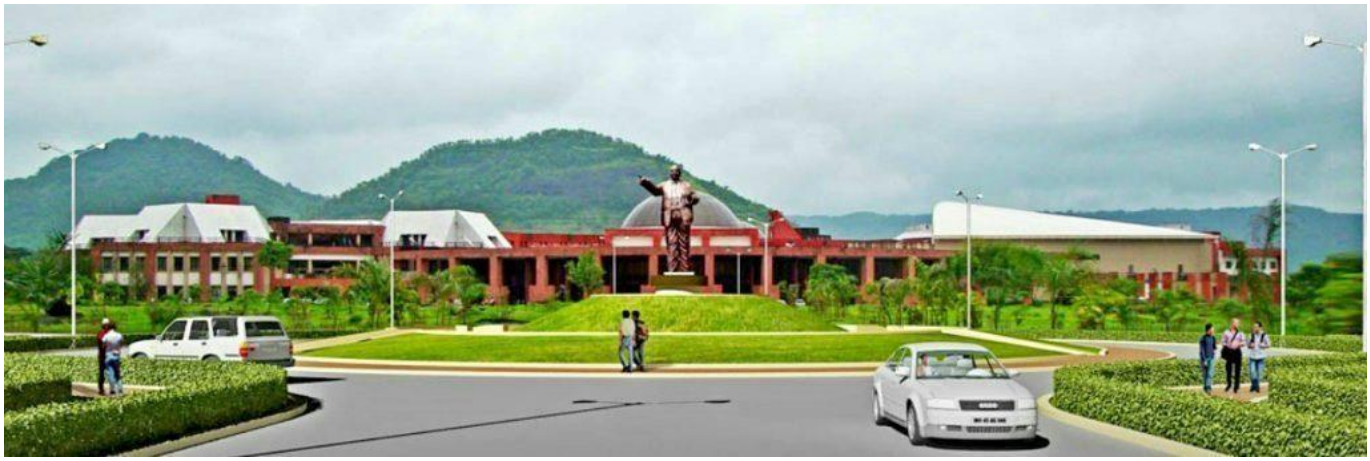
Dr. Babasaheb Ambedkar Technological University

(Established as a University of Technology in the State of Maharashtra)
(under Maharashtra Act No. XXIX of 2014)
P.O.: Lonere, Dist.: Raigad,
Pin 402 103, Maharashtra.
Telephone and Fax. : 02140 - 275142
www.dbatu.ac.in

Course Structure and Contents
for
M. Tech in Mechanical Engineering
(For Affiliated Institutes)

Syllabus as per the guidelines of National Education Policy 2020
To be implemented from Academic Year 2024-25.



Vision

The vision of the Department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission

Imparting quality education, looking after holistic development of students and conducting need based research and extension activities.

Programme Educational Objectives (PEOs)

No.	PEO
PEO1	To train the students with in-depth and advanced knowledge to become professional and capable of identifying, analyzing and solving complex problems in the areas of mechanical engineering.
PEO2	To enable post graduates to carry out innovative and independent research work, disseminate the knowledge in Academia/Industry/Research Organizations to develop systems and processes in the related field.
PEO3	To prepare the students to exhibit a high level of professionalism, integrity, effective communication skills and environmental and social responsibility.
PEO4	To provide an academic environment that gives adequate opportunity to the students to cultivate life-long independent learning abilities for their successful professional careers.

Programme Outcomes (POs)

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

No.	PO
PO1	Acquire, demonstrate and apply advanced knowledge in the area of mechanical engineering.
PO2	Identify problems in the field of mechanical engineering, formulate them and solve by using advanced techniques.
PO3	Conduct independent research and generate new knowledge for the benefit of community, society Industry and country.
PO4	Apply various numerical methods, advanced software and engineering tools to model, analyze and solve mechanical engineering problems.
PO5	Work effectively in interdisciplinary teams for solving real life problems in the related field.
PO6	Apply engineering and scientific principles for the effective management of mechanical systems.

PO7	Effectively communicate through technical reports, presentations and scientific publications with the engineering community as well as society at large.
PO8	Demonstrate traits of management in handling engineering projects, related finance, and coordinate with workforce towards achieving goals.
PO9	Demonstrate high level of professional and intellectual integrity, ethics of research and scholarly standards.
PO10	Examine critically the outcomes of one's actions and make corrective measures subsequently.
PO11	Demonstrate the ability to work in team in the laboratory in achieving multidisciplinary tasks required for the project.
PO12	Engage in life-long reflective and independent learning with high level of enthusiasm and commitment.

Abbreviations

PEO: Program Educational Objectives
PO: Program Outcomes
CO: Course Outcomes
L: No. of Lecture hours (per week)
T: No. of Tutorial hours (per week)
P: No. of Practical hours (per week)
C: Total number of credits
PCC: Professional Core Course
OEC: Open Elective Course
PEC: Professional Elective Course
AC: Audit Course
AEC: Ability Enhancement Course
VEC: Vocational Education Course
IKS: Indian Knowledge Society
MDM: Multidisciplinary Minor

Master of Technology in
Mechanical Engineering
Syllabus with effect from AY 2024-25

Semester-I

Course Code	Type/ Category of Course	Name of the Course	Hours/Week			Credit	Examination Scheme				
							Theory		CA	PR/OR	Total
			L	T	P		ESE	MSE			
24AF2612PC101	PCC	Thermodynamics and Heat Power Cycles	3	1	-	4	60	20	20	-	100
24AF2612PC102	PCC	Machining and Forming Processes	3	1	-	4	60	20	20	-	100
24AF2612PC103	PCC	Mechanical Vibrations	3	1	-	4	60	20	20	-	100
24AF2612PE104A	PEC	Advanced Machine Design	3	-	-	3	60	20	20	-	100
24AF2612PE104B		Utilization of Solar Energy									
24AF2612PE104C		Advanced I.C. Engines									
24AF2612PE105A	PEC	Manufacturing Planning and Control	3	-	-	3	60	20	20	-	100
24AF2612PE105B		Hydraulic, Pneumatic and Fluidic Control									
24AF2612PE105C		Wind Energy									
24AF2956PE105C		Finite Element Analysis									
24AF2612EL106	ELC	Seminar	-	-	2	1			50	50	100
24AF2630AU108	Audit Course	Stress Management	-	-	2	-	-	20	20	-	40
		Total	**15**	**03**	**04**	**19**	**300**	**120**	**170**	**50**	**640**

Semester-II

Course Code	Type/ Category of Course	Name of the Course	Hours/Week			Credit	Examination Scheme				
							Theory		CA	PR/OR	Total
			L	T	P		ESE	MSE			
24AF2612PC201	PCC	Advanced Fluid Mechanics	3	1	-	4	60	20	20	-	100
24AF2612PC202	PCC	Mechanical Design Analysis	3	1	-	4	60	20	20	-	100
24AF2612PE203A	PEC	CAD- CAE	3	-	-	3	60	20	20	-	100
24AF2612PE203B		Computational Fluid Dynamics									
24AF2612PE203C		Design of Heat Exchangers									
24AF2612PE203D		Alternative Fuels for I.C. Engines									
24AF2956PE203A		Process Control Automation									
24AF2612PCL204	PCC	PG Lab	-	-	2	1	-	-	60	40	100
24AF2612OE205A	PEC	New Labor Codes of India	3	-	-	3	60	20	20	-	100
24AF2612OE205B		Urban Utilities Planning: Water Supply, Sanitation and Drainage									
24AF2612OE205C		Environment and Development									
24AF2630OE205B		Entrepreneurship									
24AF2608ML206	MLC	Research Methodology	3	-	-	3	60	20	20	-	100
24AF2612EL207	ELC	Mini-Project	-	-	2	1			25	25	50
24AF2612IK208A	AEC/VEC/IKS	Indian Knowledge System (IKS): Concepts and Applications in Engineering	2	-	-	2		20	20		40
24AF2612IK208B		Indian Knowledge System (IKS): Humanities and Social Sciences									
24AF2612AU209	Audit Course	Disaster Management	-	-	2	-	-	20	20	-	40
		Total	**17**	**02**	**06**	**21**	**300**	**140**	**225**	**65**	**730**

Semester-III

Course Code	Type/ Category of Course	Name of the Course	Hours/Week			Credit	Examination Scheme				
							Theory		CA	PR/OR	Total
			L	T	P		ESE	MSE			
24AF2612PC301	PCC	Additive Manufacturing	3	1	-	4	60	20	20	-	100
24AF2630MD302A	MDM	Design Of Mechatronic Systems	3	-	-	3	60	20	20	-	100
24AF2630MD302B		Ethical Hacking									
24AF2630MD302C		Sustainable Power Generation Systems									
24AF2612MD302A		Components And Applications of Internet of Things									
24AF2612MD302B		Linear Algebra									
24AF2612MD302C		Artificial Intelligence and Machine Learning									
24AF2612OE303A	OEC	Business To Business Marketing (B2B)	3	-	-	3	60	20	20	-	100
24AF2612OE303B		Organizational Behavior									
24AF2630OE303B		Principles Of Economics									
24AF2956PC303		Intellectual Property Rights									
24AF2612OE303C		Introduction to Public Administration									
24AF2612EL304	ELC	Project I	-	-	4	10			50	50	100
		Total	**09**	**01**	**04**	**20**	**180**	**60**	**110**	**50**	**400**

Semester-IV

Course Code	Type of Course	Name of the Course	Hours/Week			Credit	Examination Scheme				
							Theory				
			L	T	P		ESE	MSE	CA	PR/OR	Total
24AF2612EL401	ELC	Project II	-	-	4	20	-	-	100	100	200

Credit Distribution				
SEM I	**SEM II**	**SEM III**	**SEM IV**	**Total**
19	**21**	**20**	**20**	**80**

Semester- I

24AF2612PC101	Thermodynamics and Heat Power Cycles	PCC	3-1-0	Credits:4
Exam Scheme				
Mid-Term Exam 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Pre-Requisites: Thermodynamics

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

CO1	Explain basic thermodynamic concepts and laws.
CO2	Describe the concepts entropy and exergy and their use in analyses of thermal energy systems.
CO3	Analyze power plants, refrigeration plants and thermal/chemical installations.
CO4	Evaluate means for minimizing energy losses in selected processes.
CO5	Use advanced thermodynamics on a research case.

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1		2		1						
CO2	2	1										
CO3	1	2		1						1		
CO4	2	2	1	1		2						
CO5												

Course Contents

Unit 1: Review of Thermodynamic Laws and Corollaries (08 Hours)

Transient flow analysis, Second law of thermodynamics, Entropy, Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation. Evaluation of thermodynamic properties of working substance

Unit II: P.V.T Surface (08 Hours)

Equation of state. Real gas behavior, Vander Waals equation, Generalization compressibility factor. Energy properties of real gases. Vapor pressure, Clausius-Clapeyron equation. Throttling, Joule Thompson coefficient. Non-reactive mixtures of perfect gasses. Governing laws, Evaluation of properties, Psychometric mixture properties and psychrometric chart, Air conditioning processes, cooling towers. Real gas mixture.

Unit III: Combustion (08 Hours)

Combustion Reactions, Enthalpy of formation. Entropy of formation, Reference levels of tables. Energy of formation, Heat reaction, Adiabatic flame temperature generated product, Enthalpies, Equilibrium. Chemical equilibrium of ideal gases, Effect of non-reacting gasses equilibrium in

multiple reactions, The Vent Hoff's equation. The chemical potential and phase equilibrium. The Gibbs phase rule.

Unit IV: Power Cycles (08 Hours)

Review binary vapor cycle, cogeneration, and combined cycles, Second law analysis of cycles. Refrigeration cycles, Thermodynamics of irreversible processes. Introduction, Phenomenological laws, Onsager Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermoelectric circuits.

Unit V: Direct Energy Conversion Introduction (08 Hours)

Fuel cells, Thermoelectric energy, Thermionic power generation, Thermodynamic devices magneto hydrodynamic generations, Photovoltaic cells.

Textbooks:

1. Basic and Applied Thermodynamics by P. K. Nag, TMH 2. Engineering Thermodynamics by Rogers & Mayhew, Pearson 3. Thermodynamics by Holman, McGraw Hill.

References Books:

1. Thermal Engineering by Rathore, TMH
2. Applied Thermodynamics by R.K. Rajput, Laxmi Publications
3. Thermal Engineering by Soman, PHI
4. Engineering Thermodynamics by P. L. Dhar, Elsevier
5. Thermodynamics by Sonntag & Van Wylen, John Wiley & Sons
6. Thermodynamics for Engineers by Doolittle-Messe, John Wiley & Sons
7. Irreversible Thermodynamics by HR DeGroff.
8. Thermodynamics & Heat Power by Granet & Bluestein, CRC Press
9. Engineering Thermodynamics by Chattopadhyaya.

24AF2612PC102	Machining and Forming Processes	PCC	3-1-0	Credits:4
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Understand the machining theory and cutting forces in machining
CO2	Explain the advanced forming processes and effect of parameters like strain rate, working temperature and composition on forming processes
CO3	Understand the mechanics of grinding and grinding economics
CO4	Explain different advanced machining and forming processes
CO5	Develop the manual part programming and generate tool paths for a given profile

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit 1: (08 Hours)

Advanced machining theory & practices -Material removal mechanism Parametric analysis, mechanisms of chip formation, shear angle relations, and theoretical determination of cutting forces in orthogonal cutting; analysis of turning, drilling, and milling operations

Unit II: (08 Hours)

Advanced forming processes – Theory of Plastic deformation, Strain hardening, Effect of Temperature, Composition and Strain rates on metal forming, Recovery, Recrystallization and Grain Growth, Characteristics and applications of Hot working and Cold working.

Process principle and details of electro-magnetic forming, explosive forming, electro-hydraulic forming, stretch forming, contour roll forming, Blow Molding, Thermoforming, Rotational Molding, Compression Molding, Transfer Molding

Unit III: (08 Hours)

Mechanics of grinding, design considerations for grinding, finishing operations, economics of abrasive machining and finishing operations; dynamometry; thermal aspects of machining; tool wear; economics of machining; processing of polymers, ceramics, and composites; Cutting tool materials and cutting fluids.

Unit IV: (08 Hours)

Advanced machining processes - Details of USM, AJM, ECM, EDM, LBM, and EBM, their advantages, limitations and applications, Micromachining of MEMS Devices, Solid free form fabrication of devices, Nanoscale manufacturing, Additive manufacturing Processes, VP, self-replicating Machines, Direct manufacturing and rapid tooling.

Unit V: (08 Hours)

CNC Machines, Operating principle, encoders, servo motors, CNC Part Programming Fundamentals- G and M Codes-Interpolation Systems-Methods of CNC Part Programming-APT Language-Motion Commands-CNC Part Programming Using CAD/CAM-Computer Automated Part Programming, Machining centers, Machine Tool structures, Vibrations and chatter in machining operations, High speed machining, Hard Machining, Ultra precision machining and machining economics.

Reference Books:

1. Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering & Technology, Pearson, Prentice Hall
2. Astashev V K Babitsky, Ultrasonic Processes and Machines, Springer 2010
3. George E Dieter, Mechanical Metallurgy, McGraw-Hill

24AF2612PC103	Mechanical Vibrations	PCC	3-1-0	Credits:4
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Pre-Requisites: Mathematics, Theory of Machines.

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

CO1	Derive the equation of motion by creating the mathematical model of Free and Forced vibration systems.
CO2	Apply the knowledge of numerical techniques for the analysis of Multi degree freedom system.
CO3	Analyze the methods for solving the problems of continuous, random, and non-linear vibrations.
CO4	Understand the vibration control and measurements methods.

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2								2
CO2	3	2	3	3	1							3
CO3	1	3	3	3								2
CO4	1	1		3	3							1

Course Contents

Unit I: Single and Two degrees of freedom system (08 Hours)

Introduction to free, forced, transient and damped vibrations, terminology, and applications. Discrete systems – single degree and two-degree systems, response to free forced motions (steady state and transient) applications to vibration isolation and absorption.

Unit II: Several Degrees of Freedom (08 Hours)

Multi Degree Freedom System: Free Vibration equation of motion. Influence Coefficient i) Stiffness Coeff. (ii) Flexibility Coefficient. Generalized coordinates, and Coordinate couplings. Lagrange's Equations, Matrix Method, Eigen Values and Eigen Vector problems.

Multi Degree System Numerical Methods: Techniques of analysis i) Dunkerley Method ii) Rayleigh Method iii) Rayleigh-Ritz Method iv) Holzer Method v) Matrix Iteration Method vi) Transfer Matrix Method.

Unit III: Continuous and Torsional Vibration (08 Hours)

Vibrations of String, Bars, Shafts and beams, free and forced vibration of continuous systems. Beams with attached masses rotor dynamics and FEM applications.

Unit IV: Non-linear and Random Vibration (08 Hours)

Non-linear vibrations: Jump phenomenon and stability. Applications including self-excited and parameter excited vibrations.

Random vibrations: Stationary and non-stationary, ergodic systems, response of single degree systems to random excitation.

Unit V: Vibration Control and Measurement (08 Hours)

Vibration Control: Balancing of rotating machine, control of natural frequency, Introduction of damping, vibration isolation & vibration absorbers.

Vibration Measurement: FFT analyzer, Vibration exciters, Time domain & Frequency domain analysis of signals. Experimental modal analysis, Machine Conditioning and Monitoring, Fault diagnosis.

Textbooks:

1. Theory of Vibrations with Applications: W. T. Thomson, Pearson Publications.
2. Mechanical Vibrations: G K Groover.

Reference Books:

1. Mechanical Vibrations Theory and Application: S. Graham Kelly.
2. Mechanical Vibrations: S. S. Rao Pearson Publications.
3. Mechanical Vibrations: V. P. Singh.

24AF2612PE104A	Advanced Machine Design	Program Elective-I	3-0-0	Credits:3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	To analyze variance, factorial design and regression and understand reliability theory, design and analysis of reliability.
CO2	Students will have the ability to analyze behavior of mechanical elements under fatigue and creep
CO3	To study optimization and its methods.
CO4	To study composite materials and its characteristics.
CO5	To design mechanical components for various materials and process.

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		1			1						2
CO2	1											3
CO3	1		1			1						2
CO4		1			1							1
CO5	1		1			2						

Course Contents

Unit I: Review of fundamental concepts (08 Hours)

Load analysis - 2D and 3D static load analysis; Case studies of static load analysis - Bicycle hand brake lever, Bicycle with pedal arm, Plier-wrench; Understanding of static failure for ductile and brittle materials; Comparison of experimental data with failure theories; Significance of the theories of failure; Importance of factor of safety in design; Design case studies - Bracket, Bicycle hand brake lever, Bicycle with pedal arm, Plier-wrench.

Unit II: Fatigue and Creep (08 Hours)

Introduction, Fatigue strength, factors affecting fatigue behavior, Influence of super imposed static stress, Cumulative fatigue damage, fatigue under complex stresses, Fatigue strength after over stresses, True stress and true strength, mechanism of creep of material at high temperature, Exponential creep law, hyperbolic sine creep law, stress relaxation, bending etc.

Unit III: Optimization (08 Hours)

Introduction, multivariable search methods, linear & geometric programming, structural and shape optimization, and simplex method

Unit IV: Composite materials (08 Hours)

Composite materials and structures, classical lamination theory, elastic stress analysis of composite material, Fatigue strength improvement techniques, stresses, stress concentration around cutouts in composite laminates, stability of composite laminate plates and shells, Hybrid materials, applications.

Unit V: Design for Materials and Process of Mechanical components (08 Hours)

Design for brittle fracture, Design for fatigue failure, Design for different machining process, assembly & safety etc.

Textbooks/References Books:

1. J.F.Blackburn, G.Rechthof, J.L. Shearer, Fluid Power Control, MIT.
2. B.W.Anderson,The Analysis and Design of Pneumatic Systems, Wiley.
3. K.Foster, G.Parker, Fluidic Components and Circuits, Wiley.
4. A.B.Goodwin, Fluid Power Systems, Macmillan.
5. Machine design an integrated approach, Robert L Norton, Pearson Education, Second edition, 2009.
6. Mechanical Engineering Design, Richard G. Budynas, J Keith Nisbett, Shigley's McGraw Hill, Ninth edition, 2011.
7. Mechanical Behavior of materials, Marc Meyers and Krishan Chawla, Cambridge University Press, 2nd Edition, 2009.
8. Mechanical properties of engineered materials, Wolé Soboyejo, Marcel Dekker, Inc.,2002.

24AF2612PE104B	Utilization of Solar Energy	Program Elective-I	3-0-0	Credits:3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Acquire knowledge on solar radiation principles with respect to solar energy estimation.
CO2	Get familiarized with various collecting techniques of solar energy and its storage.
CO3	Learn the solar photovoltaic technology principles and different types of solar cells for energy conversion and different photovoltaic applications.
CO4	Understand the working principles of several solar appliances like Solar cookers, Solar hot water systems, Solar dryers, Solar Distillation, Solar greenhouses.
CO5	Summarize the basic economics of the solar energy collection system.

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit I: Solar Radiation (08 Hours)

History of solar energy utilization – Solar radiation and modeling – Empirical equations for predicting the availability of solar radiation – Measurement of global, direct, and diffuse radiation – Radiation computations on inclined surfaces – Angstrom's turbidity – Solar chart – Standard radiation scale.

Unit II: Solar Radiation Measurement And Estimation (08 Hours)

Measurement of solar radiation – Solar energy measuring instruments – Pyranometer – Pyrheliometer – Sunshine recorder – Estimation of average solar radiation – Ratio of beam and total radiation on tilted surface of that on horizontal surface.

Unit III: Solar Thermal Systems (08 Hours)

Principle of conversion of solar radiation into heat, Collectors used for solar thermal conversion: Flat plate collectors and Concentrating collectors, Thermal Analysis of Flat- plate Collector and Useful Heat Gained by the fluid – fin efficiency – collector efficiency factor – Heat Removal Factor – Focusing collectors – Types and applications of focusing collectors. Solar Thermal Power Plant,

Solar cookers, Solar hot water systems, Solar dryers, Solar Distillation, Solar greenhouses. Thermal storage systems.

Unit IV: Solar Photovoltaic Systems (08 Hours)

Conversion of Solar energy into Electricity – Photovoltaic Effect, Solar photovoltaic cell and its working principle, Different types of Solar cells, Series and parallel connections, Photovoltaic applications: Battery chargers, domestic lighting, street lighting and water pumping.

Unit V: Solar Economics (08 Hours)

Application of economic methods to analyze the feasibility of solar systems to decide project / policy alternatives – Net energy analysis – and cost requirements for active and passive heating and cooling – for electric power generation – and for industrial process-heating.

References Books:

1. Solar Energy Utilization, G. D. Rai, Khanna Publishers
2. Solar Energy- Fundamentals, design, modeling & applications, G.N. Tiwari, Narosa Pub., 2005.
3. Solar Energy-Principles of thermal energy collection & storage, S.P. Sukhatme, Tata McGraw Hill Publishers, 1999.
4. Solar Photovoltaics- Fundamentals, technologies and applications, Chetan Singh Solanki, PHI Learning Pvt. Ltd.,
5. Science and Technology of Photovoltaics, P. Jayarama Reddy, BS Publications, 2004.
6. H P Garg, M Dayal, G Furlan, Physics and Technology of Solar Energy- Volume I: Solar Thermal Applications, Springer, 2007.
7. John Canivan, Solar Thermal Energy, Sunny Future Press – 2003.
8. Charles Christopher Newton – Concentrated Solar Thermal Energy- Published by VDMVerlag, 2008.
9. Principles of solar engineering – D.Y. Goswami, F. Kreith and J.F
10. Fundamentals of solar energy conversion – Edward E. Anderson, 1st Ed.
11. Duffie, J.A., and Beckman, W.A. Solar Energy Thermal Process, John Wiley and Sons, NewYork, Jui Sheng Hsieh, Solar Energy Engineering, Prentice-Hall, 2007.
12. M. Stix, The Sun, An Introduction, Second Edition, Springer 2002.
13. Nelson, The Physics of Solar Cells. Imperial College Press, 2003.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Solar Energy Engineering and Technology	By Prof. Pankaj Kalita	IIT Guwahati	https://onlinecourses.nptel.ac.in/no 20_ph14/preview
Solar Energy Technology	By Prof. V.V. Satyamurty	IIT Kharagpur	https://archive.nptel.ac.in/courses/1 2/105/112105051/

24AF2612PE104C	Advanced I.C. Engines	Program Elective-I	3-0-0	Credits:3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Describe and compare different types, Constructional details, Cycles of operation and operative systems of I. C. Engines.
CO2	Compare the Design, Performance and Fuel quality Factors affecting to avoid the detonation/ knocking in SI and CI engines.
CO3	Evaluate the Performance Parameters of I.C. Engines and analyze the Performance maps.
CO4	Understand the importance of BHARAT STAGE Emission Norms and technologies associated for meeting the same.
CO5	Understand the research trend in alternative fuels, Fuel cell, Hybrid and Electric vehicles and analyze engine heat transfer.

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										
CO2			1	1		1		2				
CO3				1	1		1	2				
CO4												
CO5												

Course Contents

Unit I: (08 Hours)

Introduction- Historical Review, Engine Types, Design and Operating Parameters. Thermo-chemistry of Fuel, Air mixtures, Engine Cycle Analysis, Ideal Models of Engine Cycles, Real Engine cycles, differences, and Factors responsible for deviation, Computer Modeling

Unit II: (08 Hours)

Gas Exchange Processes: Volumetric Efficiency, Flow through ports, altitude compensation, Supercharging and Turbo charging.

Charge Motion: Mean velocity and turbulent characteristics, various types of combustion chambers in SI and CI engines, Swirl, Squish, Pre-chamber Engine flows.

Unit III: (08 Hours)

Engine Combustion in S.I. Engines: Combustion and Speed, cyclic Variations Ignition, Abnormal combustion Fuel factors, MPFI, SI engine testing.

Combustion in CI engines: Essential Features, Types off Cycle, Fuel Spray Behavior, Ignition Delay, Mixing Formation and control, Common rail fuel injection system.

Unit IV: (08 Hours)

Pollutant Formation and Control: Nature and extent of problems, Nitrogen Oxides, Carbon monoxide, unburnt Hydrocarbon and particulate, Emissions Measurement, Exhaust Gas Treatment, Catalytic converter, SCR, Particulate Traps.

Modern Trends in IC Engines: Lean Burning and Adiabatic concepts, Rotary Engines, Modification in I.C engines to suit Bi fuels, HCCI and GDI concepts.

Unit V: (08 Hours)

Engine Heat Transfer: Importance of heat transfer, heat transfer and engine energy balance, Convective heat transfer, radiation heat transfer, Engine operating characteristics, Fuel supply systems for S.I. and C.I engines to use gaseous fuels like LPG, CNG and Hydrogen.

Textbooks/References Books:

1. I.C. Engines / V. Ganesan /TMH
2. I.C. Engines Fundamentals/Heywood/TMH
3. I.C. Engines /RK Rajput/ Laxmi Publications
4. Computer Simulation of C.I. Engine Process/ V. Ganesan/University Press
5. Fundamentals of IC Engines/HN Gupta/PHI/2nd edition
6. I.C. Engines/Fergusson/Wiley
7. The I.C. Engine in theory and Practice Volume I / Taylor / MIT Press

24AF2612PE105A	Manufacturing Planning and Control	Program Elective-II	3-0-0	Credits:3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Apply the systems concept for the design of production and service systems.
CO2	Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques.
CO3	Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources.
CO4	Understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand circumstances.
CO5	Understand the lot sizing and production scheduling
CO6	Study about quality planning, cost planning and control.

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										
CO2			1	1		1		2				
CO3				1	1		1	2				
CO4												
CO5												

Course Contents

Unit I: **(**08 Hours)

Overview of manufacturing systems and various issues of interest: assembly line, repetitive batch manufacturing.

Unit II: (08 Hours)

Cellular manufacturing, Flexible Manufacturing System (FMS), Just In Time (JIT) Manufacturing System, Computer Integrated Manufacturing (CIM), preplanning: forecasting, economic analysis, aggregate planning, capacity planning, inventory planning. (08 Hours)

Unit III: (08 Hours)

Decision making in design of manufacturing systems: Group Technology (GT), line balancing, plant layout.

Unit IV: (08 Hours)

Operations planning: MRP, MRP II, hierarchical planning systems, JIT systems. (08 Hours)

Unit V: (08 Hours)

FMS Operation and control: lot sizing decisions, production scheduling, line of balance. Quality planning and control, cost planning and control, Simulation analysis of manufacturing systems, Case studies (08 Hours)

Textbooks/References Books:

1. D.D.Bedworth and J.E Bailey, Integrated Production Control, System-management, Analysis and Design, John Wiley, 1983.
2. E.A.Elsayed and T.O.Boucher , Analysis and Control of Production Systems, Prentice Hall, 1985.
3. J. R.King ,Production Planning and Control, Pergamon Press, Oxford, 1975.
4. P.F.Bestwick and K.Lockyer, Quantitative Production Management, Pitman Publications, 1982.
5. A.C.Hax and D.Candea, Production and Inventory Management, Prentice-Hall, 1984
6. M.G.Korgaokar, JIT Manufacturing, Macmillan, 1992.

24AF2612PE105B	Hydraulic, Pneumatic and Fluidic Control	Program Elective-II	3-0-0	Credits:3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Understand the type of control system and their utility
CO2	Describe the hydraulic power generation.
CO3	Design pneumatic and hydraulic circuits for a given application
CO4	Discuss steady state operating forces, transient forces and valve instability
CO5	Design of pure fluid digital elements, Lumped and distributed parameter fluid systems

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	2											
CO3	2	2		3	1	1						
CO4	2				3	2	3			2		1
CO5	2	2		2	3							

Course Contents

Unit I: (08 Hours)

Introduction to control system, types of control system and their utility.

Unit II: (08 Hours)

Hydraulic power generation and transmission, valve control pressure flow relationship and constructions.

Unit III: (08 Hours)

Steady state operating forces, transient forces, and valve instability.

Unit IV: (08 Hours)

Circuit design, pneumatic valves, hydraulic and pneumatic drives, introduction to fluidic devices and sensors, Design of Hydraulic & pneumatic circuit for given application.

Unit V: (08 Hours)

Lumped and distributed parameter fluid systems, fluid mechanics of jets, wall attachment and vortex devices. Pure fluidic analog amplifiers, analog signal control techniques, design of pure fluid digital elements.

Texts / References:

1. J.F.Blackburn, G.Rechthof, J.L. Shearer, Fluid Power Control, MIT.
2. B.W.Anderson,The Analysis and Design of Pneumatic Systems, Wiley.
3. K.Foster, G.Parker, Fluidic Components and Circuits, Wiley.
4. A.B.Goodwin, Fluid Power Systems, Macmillan.

24AF2612PE105C	Wind Energy	Program Elective-II	3-0-0	Credits:3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Outcomes: At the end of the course, student should be able to:

CO1	Identify and describe history of wind energy and its scope in future.
CO2	survey and analyze through a literature review world distribution of wind, Weibull
	statistic, variation in wind energy etc.,
CO3	Conduct an experiment to use various wind energy measurement indicators, anemometers, and apply it to analyze and check data obtained from surveys.
CO4	Demonstrate and calculate performance parameters wind energy turbine.
CO5	Illustrate various electrical systems used in wind energy power plant.
CO6	Examine and justify economics of wind system.

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	2								
CO2	1		2		1	1					1	
CO3	2	1	1									
CO4	1			2	1	1						
CO5	1	1										
CO6	1	1			1			1				

Course Contents

Unit I: (08 Hours)

Introduction: Historical uses of wind, History of wind electric generations.

Unit II: (08 Hours)

Wind Characteristics: Metrology of wind, World distribution of wind, Atmospheric stability, Wind speed variation with height, Wind speed statistics, Weibull statistics, Weibull parameters, Rayleigh and normal distribution.

Wind Measurements: Biological indicators, Rotational anemometers, other anemometers, Wind direction.

Unit III: (08 Hours)

Wind Turbine Power, Energy and Torque: Power output from an ideal turbine, Aerodynamics, Power output from practical turbines, Transmission and generation efficiency, Energy production and capacity factor, Torque at constant speeds, Drive train oscillations, Turbine shaft power and torque at variable speeds.

Unit IV: (08 Hours)

Wind Turbine Connected to the Electrical Network: Methods of generating synchronous power, AC circuits, the synchronous generator, per unit calculations, the induction machine, Motor starting, Capacity credit features of electrical network.

Wind turbines with Asynchronous Electric Generators: Asynchronous systems, DC shunt generator with battery load, Per unit calculation, Self excitation of the induction generators, Single phase operation the induction generator, Field modulated generators, Roesel generator.

Unit V: (08 Hours)

Asynchronous Load: Piston water pumps, Centrifugal pumps, Paddle wheel heaters, Batteries, Hydrogen economy, and Electrolysis cells.

Economics of Wind Systems: Capital costs, Economic concepts, Revenues requirements, Value of wind generated electricity, Latest Technologies in wind energy, Ongoing research work in wind energy, Comparison between wind tubine and under water wind turbine technologies, Major application of wind energy, Offshore wind energy technologies growth, workforce growth and support,

Text/Reference Books:

1. Garg L Johnson: "Wind Energy Systems" Prentice Hall. Inc, New Jersey – 1985
2. Desire Le Gouriers: "Wind Power Plants: Theory and Design" Pergamon Press – 1982

24AF2956PE105C	Finite Element Analysis	Program Elective-II	3-0-0	Credits:3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Understand the basics principle of FE method
CO2	Identify mathematical model for solution of common problems
CO3	Solve structural, thermal problem using FE in 1D Case
CO4	Derive element stiffness matrix by different methods
CO5	Understand the formulation for 2D and 3D case

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										
CO2	3	3	1		1							1
CO3	2	2	1	2	2				2			1
CO4	3								2			
CO5	3	2										

Course Contents

Unit I: (08 Hours)

1-D Problems: Introduction to structural analysis and FEM, Introduction to approximate solutions and FEM, summary of linear elastic mechanics.

Unit II: (08 Hours)

1-D Problems: Principles of linear elastic mechanics, principles of virtual displacements and minimum potential energy, Rayleigh Ritz method, exact v/s approximate solution, beam elements.

Unit III: (08 Hours)

2-D Problems: Plane stress and plane strain conditions, triangular elements, constant strain triangle, linear strain triangle, Boundary conditions, body forces and stress recovery, quadrilateral elements.

Unit IV: (08 Hours)

2-D Problems: Lagrange and Serendipity shape functions, isoperimetric formulation, numerical integration, modeling with isoperimetric elements, requirements for convergence, patch test, nonconforming elements, reduced integration.

Unit V: (08 Hours)

3-D Problems: Axisymmetric solids, governing equations, axisymmetric elements and their applications, mixed formulations, bending of flat plates (Kirchhoff Theory), continuity requirements

and boundary conditions.

3-D Problems: Discrete Kirchhoff's elements, thick plate elements, plate bending applications, shells as assemblage of flat plates, finite element formulation for dynamic problems, mass properties, introduction to elastic stability for frames and plates.

Texts / References:

1. R. D. Cook, Concepts and Applications of Finite Element Analysis; John Wiley and Sons, second edition, 1981.
2. C.S. Krishnamurti, Finite element method; Tata Mc-Graw Hill Publication.
3. K.J. Bathe, Finite Element Method and Procedures; Prentice Hall, 1996.
4. Tirupathi, R., and Chandrupatla, Finite Elements in Engineering; PHI Publication, New Delhi.
5. Bruce Irons and Soharab Ahmed, Techniques of Finite Elements; John Wiley and Sons, New York.
6. O.P., Goptha, Finite and Boundary Element Methods in Engineering; Oxford and IBH.
7. Singiresu S. Rao, The Finite Element Method in Engineering, Butterworth-Heinemann

24AF2612EL106	Seminar	ELC	0-0-2	Credit: 1
Exam Scheme				
Continuous Assessment 50 Marks		(OR/PR) 50 Marks		Total 100 Marks

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

CO1	Identify the topic for seminar from the recent areas and technologies in thermal and fluids engineering or related areas.
CO2	Carry out detailed comprehensive survey of the literature related to the topic selected. Use information available from various sources like research papers, patents, websites, discussion with experts on the topic etc.
CO3	Comprehend the information, organize it and write technical report. Give presentations on the topic to the group of students.
CO4	Identify and report latest developments and unresolved issues in the selected topic/area.
CO5	Analyze the impact of the technologies on the environment. Identify green technologies related to selected topic.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2		1		3	2		1		2
CO2			2		2		2		2			
CO3			1		1			2		2	1	
CO4					3	1	2		2	1		3
CO5					1	1				1		2

Course Contents:

The seminar shall consist of the preparation of the report by the candidate on the topic mutually decided by himself and the supervisor. The topic should be a problem in the field of Mechanical Engineering and should have sufficient research orientation. The recent development in the field of the chosen topic needs to be understood by the candidate. The report must be presented in front of the examiners committee and other faculty members and students of the department. The committee should be set by the PG coordinator and Head, Mechanical Engineering for evaluation of the seminar.

24AF2630AU108	Stress Management	Audit Course	0-0-2	Credits:--
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam --	Total 40 Marks	

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

CO1	Recognize the signs and sources of stress, understanding its effects on mental and physical well-being.
CO2	Master a variety of yoga techniques, including postures, breathing, and meditation, to effectively manage stress
CO3	Acquire relaxation strategies that promote calmness, reduce anxiety, and enhance overall mental clarity.
CO4	Incorporate healthy habits inspired by yoga principles to foster better sleep, nutrition, and self-care routines.
CO5	Develop practical skills to navigate and cope with stress, enhancing emotional balance and promoting a more harmonious life.

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1		2		1						
CO2	2	1										
CO3	1	2		1						1		
CO4	2	2	1	1		2						
CO5												

Course Contents

Unit 1: (08 Hours)

Introduction to Yoga for Stress Management – 1, Introduction to Yoga for Stress Management - 2 Stress according to Western perspective, Stress Eastern Perspective, Developmental process: Western and Eastern Perspective Stress Hazards and Yoga.

UNIT II (08 Hours)

Meeting the challenges of Stress –1 Meeting the challenges of Stress - 2 Introduction to Stress Physiology Stress, Appetite and Dietary management- Modern and Yogic perspective Sleep and Stress: understanding the relationship for effective management of stress

UNIT III (08 Hours)

Stress Assessment methods- a valuable tool toward stress management Role of Yoga in prevention and management of stress related disorders – a summary of research evidence Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 1 Concept of stress and its

management - perspectives from Patanjali Yoga Sutra - Part 2 Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 3

UNIT IV (08 Hours)

Concept of stress and its management - perspectives from Bhagavad Gita - Part 1 Concept of stress and its management - perspectives from Bhagavad Gita - Part 2 Concept of stress and its management - perspectives from Bhagavad Gita - Part 3

UNIT V (08 Hours)

Asana practices – 1 Tadasana, Ardhakati Chakrasana, Ardha Chakrasana, Trikonasana, Vrikshasana Asana practices – 2 Vakrasana, Janu Sirshasana, Ushtrasana, Sashankasana, Asana practices – 3 Ardhamatseyndrasana, Paschimottanasana, Poorvottanasana, Gomukhasana Asana practices – 4 Makarasana, Bhujangasana, Salambha Shalabahasana, Dhanurasana Asana practices – 5 Setu Bandhasana, Sarvangasana, Matsyasana, Deep Relaxation Technique (DRT)

Textbooks/References Books:

1. H R Nagendra and R Nagarathna. Yoga for Promotion of Positive Health. Swami Vivekananda Yoga Prakashana. 2011.
2. Contrada, R., & Baum, A. (Eds.). The handbook of stress science: Biology, psychology, and health. Springer Publishing Company. 2010
3. Al'Absi, M. (Ed.). Stress and addiction: Biological and psychological mechanisms. Elsevier. 2011.
4. Van den Bergh, O. Principles, and practice of stress management. Guilford Publications. 2021.
5. Swami Muktibodhananda, Hatha Yoga Pradipika, Bihar School of Yoga, 1998
6. Swami Satyananda Saraswati, Four Chapters on Freedom, Bihar School of Yoga, 1975
7. Swami Tapasyananda, Srimad Bhagavad Gita, Sri Ramakrishna Math, 2012

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Yoga for Stress Management	Dr H RNagendra, Dr Mithila M V, Dr Rajesh Nair	Swami Vivekananda Yoga Anusandhana Samsthana	https://onlinecourses.swayam2.ac.in/aic23_ge10/preview#:~:text=In%20this%20course%20we%20intend,meeting%20the%20 challenges%20of%20stress

Semester- II

24AF2612PC201	Advanced Fluid Mechanics	PCC	3-1-0	Credits: 4
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Explain concepts of fluid kinematics and fluid dynamics
CO2	Explain Boundary layer theory and derive Navier Stokes equation for viscous fluid
CO3	Analyze steady state and transient heat conduction problems of real-life Thermal systems
CO4	Analyze the analytical and numerical solutions for heat transfer problem.
CO5	Analyze extended surface heat transfer problems and problems of phase change heat transfer like boiling and condensation

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	2	1		3								
CO3	3	2	1									
CO4	3	2	1									
CO5	3	2	1									

Course Contents

Unit I: (08 Hours)

Brief recapitulation of some preliminary concepts of Fluid Mechanics: Concept of continuum, Fluid Kinematics, Dynamics of Inviscid Flows and Reynolds Transport Theorem

Unit II: (08 Hours)

Dynamics of viscous flows - Derivation of Navier-Stokes equation Some exact solutions of Navier-Stokes Equation-Steady Flows, Boundary Layer theory Introduction to CFD (Computational Fluid Dynamics), Governing Equations of CFD and applications.

Unit III: (08 Hours)

Brief introduction to different modes of heat transfer: conduction: general heat conduction equation-initial and boundary conditions.

Finite difference methods for conduction: id & 2d steady state and simple transient heat conduction problems-implicit and explicit methods.

Unit IV: (08 Hours)

Transient heat conduction: lumped system analysis, Heisler charts, semi-infinite solid, use of shape factors in conduction, 2d transient heat conduction, product solutions.

Unit V: (08 Hours)

Convection and Boiling: Flow over a flat plate: Application of empirical relations to variation geometries for laminar and turbulent flows. hydrodynamic & thermal entry lengths; use of empirical correlations. Approximate analysis on laminar free convective heat transfer, combined free and forced convection. Boiling curve, correlations, assumptions & correlations of film condensation for different geometries

Texts / References:

1. F.M.White ,K.Muralidhar and Bishwas, Advance Engineering fluid mechanics, Alpha science International limited
2. Fox and McDonald, Introduction to Fluid Mechanics, J.H. Wiley and Sons
3. Fluid Mechanics and Fluid Machines by S K Som and G Biswas, TMH
4. Fluid Dynamics by William F. Hughes & John A. Brighton, TMH.
5. YunusA.Cengal, Heat and Mass Transfer – A practical Approach, 3rd edition, Tata McGraw - Hill, 2007.
6. S. P.Sukhatme, A Textbook on Heat Transfer
7. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co., 1985
8. Heat Transfer by P.K.Nag, TMH

24AF2612PC202	Mechanical Design Analysis	PCC	3-1-0	Credits: 4
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

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

CO1	Understand theory of fatigue failure of materials under different conditions and analyze behavior of mechanical elements under fatigue and creep
CO2	Analyze variance, factorial design and regression and understand reliability theory, design and analysis of reliability.
CO3	Describe various optimization techniques and its application.
CO4	Understand various composite materials and its characteristics.
CO5	Design mechanical components for various materials and process

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	2								
CO2	1	1	2	2								
CO3	1	2	1		1							
CO4	3		1		1							
CO5	1			2								

Course Contents

Unit I: (08 Hours)

Introduction: Failure Analysis, Limit design, Fundamentals of fracture mechanics. Fatigue designing for finite life, contact stresses and surface failures, oil films and their effects

Unit II: (08 Hours)

Impact: Energy methods, longitudinal stress waves in elastic media impact on beams, torsional impact on shafts and longitudinal impacts on helical springs.

Unit III: (08 Hours)

Thermal properties and stresses: Effect of short term and long term properties of materials on design, creep and stress relaxation. Elementary analysis of thermal stresses, thermal fatigue.

Optimum design: Basis concepts, introduction to various techniques of optimization, optimum design of simple mechanical components.

Unit IV: (08 Hours)

Design with composite materials: Polymers and F.R.P. as materials form Mechanical components. Reliability based design: Definition normal exponential and Weibull distributions system reliability. Reliability based on strength.

Unit V: (08 Hours)

Analysis and design of power transmission systems and elements such as: Spur, helical, bevel and worm gear drives, speed reducers and gearboxes, epicyclic gear drives, selection of ball and roller bearings.

Textbooks / references books:

1. H. Burr & John B.Cheatham, "Mechanical Analysis and Design", Prentice Hall of India (1997).
2. Kenneth Edwards & Robert B. Makee, “Fundamentals of Mechanical Component Design",McGraw Hill International ed. 1991.
3. Joseph Edward Shigley & Charles R. Mischke, "Mechanical Engineering Design", Mc. Graw Hill (1989).
4. M. F. Spotts" Mechanical Design Analysis", Prentice Hall.
5. Aaron D. Deutschmanetal," Machine Design" Collier Macmillan Publishers International edition.

24AF2612PE203A	Computer Aided Design (CAD) and Computer Aided Engineering (CAE)	PE II	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Know the different approaches of Design and CAD CAE in the Product Design
CO2	Understand the concepts of Wireframe and Surface Modeling
CO3	Learn various Solid and Assembly Modeling techniques used
CO4	Understand Meshing, Elements and Applications of FEA (CAAE) in Heat Transfer & Fluid Mechanics 1D &2D problems
CO5	Analyze Accuracy of the CAE results

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2						1			1		
CO2	2				1							
CO3	2				1							
CO4	3	2	2	2	1							
CO5	3			1	3					1		

Course Contents

Unit I: Design and CAD, CAE: (08 Hours)

Importance of design, design process, embodiment design, parametric design, Industrial design, Human factors in design, Sustainability in design, Design for X (DFX), Computer Assisted Design, Introduction to CAD and CAE, Applications of CAD and CAE, Hardware and Softwares in CAD and CAE

Unit II: Wireframe and Surface Modeling: (08 Hours)

Wire Frame Modeling, Curves and surfaces: Curve representation, parametric representation of analytic and synthetic curves; Surface models, Surface representations, parametric representation of analytic and synthetic surfaces.

Unit III: Solid and Assembly Modeling: (08 Hours)

Solid Modeling: Boundary representation, CSG, sweep representations, Octree representations, primitive instancing, cell decomposition, spatial occupancy enumeration, FBM, PM, Feature recognition, Design by features, Tolerance modeling.

Assembly modeling: Representation, mating conditions, representation schemes, generation of assembling sequences.

Unit IV: Meshing, ID & 2D FEA (CAE) (08 Hours)

Meshing: Mesh topology, Data structures, Introduction to Mesh generation algorithms, Surface meshes, Element types and quality criteria, Aspect Ratio, Node Numbering.

Applications in Heat Transfer & Fluid Mechanics: One dimensional heat transfer element, Application to one-dimensional heat transfer problems, Scalar variable problems in 2-Dimensions, Applications to heat transfer in 2-Dimension, Application to problems in fluid mechanics in 2-Dimension.

Unit V: Accuracy & Validation of FEA (CAE) (08 Hours)

Validation and accuracy of FEA results, Computational accuracy: strain energy norm, residuals, Reaction forces and moments; convergence test, Average and unaverage stress difference

Correlation with actual testing: strain gauging-stress comparison; natural frequency comparison; Dynamic response comparison, temperature and pressure distribution comparison

Texts / References:

1. Ibrahim Zeid and R Sivasubramanian, CAD/CAM: Theory and Practice, McGraw-Hill
2. Ibrahim Zeid, Mastering CAD / CAM, McGraw-Hill
3. Gerald Farin, Curves and Surfaces for CAGD: A Practical Guide, Elsevier India, 5th Edition, 2013 Micheal E. Mortenson, Geometric Modeling, Industrial Press
4. David Rogers and J.A. Adams, Mathematical Elements for Computer Graphics, McGraw Hill
5. Singiresu S. Rao, The Finite Element Method in Engineering, Butterworth-Heinemann
6. Tirupathi, R., and Chandrupatla, Finite Elements in Engineering; PHI Publication
7. Bruce Irons and Soharab Ahmed, Techniques of Finite Elements; John Wiley and Sons

24AF2612PE203B	Computational Fluid Dynamics	PE III	3-0-0	Credits: 3
Examination Scheme				
Mid Semester Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

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

CO1	Develop an understanding for major theories, approaches and methodologies used in CFD.
CO2	Evaluate solution of aerodynamic flows, appraise & compare various CFD software, which Simplify flow problems and solve them exactly.
CO3	Design and setup flow problem properly within CFD context, performing solid using CAD package and producing grids via meshing tool.
CO4	Interpret both flow physics and mathematical properties of governing Navier-Stokes equation and define proper boundary conditions for solution.
CO5	Apply CFD software to model relevant engineering flow problems, analyze results and compare with the available data and discuss the findings.

Mapping of course outcomes with program outcomes

POs → Cos↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	-	-	-	-	-	-	-	-
CO2	1	-	2	3	1	1	-	-	-	-	-	-
CO3	2	1	1	2	1	-	1	-	-	-	-	-
CO4	1	-	-	1	1	1	-	-	-	-	-	-
CO5	-	-	2	2	2	1	-	-	-	2	-	1

Course Contents

UNIT I: Introduction to CFD (08 Hours)

Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations.

UNIT II: Governing Equations (08 Hours)

Review of Navier-Stokes Equation and simplified forms, Solution Methodology: FDM and FVM with special emphasis on FVM, Stability, Convergence and Accuracy.

UNIT III: Finite Volume Method (08 Hours)

Domain discretization, types of mesh and quality of mesh, SIMPLE, pressure velocity coupling, Checkerboard pressure field and staggered grid approach.

UNIT IV: Geometry Modeling and Grid Generation (08 Hours)

Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and

selection criteria, Mesh quality, Key parameters, and their importance.

UNIT V: Methodology of CFDHT (08 Hours)

Objectives and importance of CFDHT, CFDHT for Diffusion Equation, Convection Equation and Convection-Diffusion Equation. Semi-Explicit and Semi-Implicit Algorithms for Staggered Grid System and Non-Staggered Grid System of N-S Equations for Incompressible Flows.

Reference Books:

1. John D. Anderson. JR. "Computational Fluid Dynamics the Basics with Applications" McGraw-Hill International Editions, 2017.
2. H. K. Versteeg, W. Malalasekera, "An Introduction to computational fluid dynamics", Pearson Education, 2008.
3. J. H. Ferziger and M. Peric, Computational Methods for Fluid Dynamics, Springer, 4th edition 2020.
4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
5. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, CRC Press, Indian Edition, 2017.
6. An Introduction to Computational Fluid Mechanics, Chuen-Yen Chow, Wiley Publication, 2011.

24AF2612PE203C	Design of Heat Exchangers	PE III	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Demonstrate the heat exchanger design methodology, and design considerations
CO2	Analyze performance of Heat exchanger by applying basic design methods.
CO3	Design double pipe, shell and tube, tube fin, plate type and plate-fin heat exchanger.
CO4	Model and illustrate heat exchanger based on I-law and irreversibility.
CO5	Demonstrate Fouling & Selection criteria of Heat Exchanger

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1							1			
CO2	1	1										
CO3			2						2			
CO4	1											
CO5	2	1							1			

Course Contents

Unit I: (08 Hours)

Introduction: Classification, overview of heat exchanger design methodology, Design specifications, thermos-hydraulic design, and other considerations.

Unit II: (08 Hours)

Basic design Methods of Heat Exchanger: LMTD method, ε-NTU method, P-NTU method, ψ-P method and P1- P2 method.

Unit III: (08 Hours)

Heat exchanger design procedures: Design of double pipe, shell and tube, tube fin, plate type and plate-fin heat exchanger.

Unit IV: (08 Hours)

Thermodynamic modeling and analysis: modeling of heat exchanger based on I-law and Irreversibility.

Unit V: (08 Hours)

Fouling of Heat Exchangers: Effect of fouling, Process of Fouling, Prediction of fouling, Operation of heat exchanger under fouling, Control of fouling and cleaning of heat exchanger.

Selection of heat exchangers: selection criteria, general selection guidelines of shell and tube heat exchanger, plate type heat exchanger.

Texts / References:

1. R. K. Shah and Deusan P. Sekulic, *Fundamentals of heat exchanger design*, 2003, John Willeyand Sons.
2. S. Kakac, Heat *Exchangers – Thermal Hydraulic Fundamentals and Design*, Hemisphere, Mc Graw-Hill.
3. D. Q. Kern and A. D. Kraus; *Extended Surface Heat transfer*, McGraw-Hill.
4. W. M. Kays and A. C. London, *Compact Heat Exchangers*, McGraw-Hill.

24AF2612PE203D	Alternative Fuels for I.C. Engines	PE III	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Demonstrate Structure of petroleum, Refining process, Products of refining process, Selec suitable fuels for use in SI engines. Understand various performances rating in SI engines.
CO2	Illustrate properties of petroleum products and classify them on their characteristic.
CO3	Describe and analyze Need for alternative fuels such as Ethanol, Methanol, LPG, CNG Hydrogen and their manufacturing procedure.
CO4	calculate and estimate performance and emission characteristics of alternative fuels
CO5	Analyze environmental effects of combustion of various fuels, suggest modification in thei usage.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2		1										
CO3	1	1		1	1							
CO4			1	1								
CO5	1	1			1	1						

Course Contents

Unit I: (08 Hours)

Fuels: Introduction, Structure of petroleum, Refining process, Products of refining process, Fuels for spark ignition, Knock rating of SI engine fuels, Octane number requirement, Diesel fuels and Numericals.

Unit II: (08 Hours)

Properties of petroleum products: Specific gravity, Density, Molecular weight, Vapour pressure, Viscosity, Flash point, Fire point, Cloud point, Pour point, Freezing point, Smoke point & Char value, Aniline point, Octane Number, Performance Number, Cetane Number, Emulsification, Oxidation Stability, Acid Value/Number, Distillation Range, and Sulphur content.

Unit III: (08 Hours)

Alternative fuels for I.C. engines: Need for alternative fuels such as Ethanol, Methanol, LPG, CNG, Hydrogen, Biogas and Producer gas and their methods of manufacturing**.**

Unit IV: (08 Hours)

Single Fuel Engines: Properties of alternative fuels, use of alternative fuels in SI engines, Engine modifications required, Performance and emission characteristics of alternative fuels in SI mode of operation v/s gasoline operation.

Availability: Suitability & Prospects of these gaseous fuels in Indian context. Environmental pollution with conventional and alternate fuels, Pollution control methods and packages.

Unit V: (08 Hours)

Dual fuel Engine: Need and advantages, the working principle, Combustion in dual fuel engines, Factors affecting combustion in dual fuel engine, Use of alcohols, LPG, CNG, Hydrogen, Biogas and Producer gas in CI engines in dual fuel mode. Engine modifications required. Performance and emission characteristics of alternative fuels (mentioned above) in Dual Fuel mode of operation v/s Diesel operation.

Biodiesels: What are biodiesels, Need of biodiesels, Properties of biodiesels V/s petrol diesel, Performance and emission characteristics of biodiesels v/s Petro diesel operation.

Texts / Reference Books:

1. R.P Sharma & M.L.Mathur: "A Course in Internal Combustion Engines", D.Rai & Sons.
2. O.P. Gupta: "Elements of Fuels, Furnaces & Refractories", Khanna Publishers, 2000.
3. Domkundwar V.M.: "Internal Combustion Engines", I Edition, Dhanpat Rai & Co., 1999
4. John B. Heywood: "Internal Combustion Engines Fundamentals", McGraw Hill International Edition,
5. Osamu Hirao & Richard Pefley: "Present and Future Automotive Fuels", Wiley Interscience Publication. NY. 1988.

24AF2956PE203A	Process Control Automation	PE III	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Pre-Requisites: None

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

CO1	Student will able to explain Process Modeling
CO2	Student will able to design PID controller for given application
CO3	Student will able to solve problems related to frequency response analysis
CO4	Student will able to simulate control system for given application
CO5	Student will able to use tools and techniques for advances process control
CO6	Students will be able to discuss issue related to plant control

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	2									1		
CO3	2	1										
CO4	2	1										
CO5	2	1								1		
CO6	2											

Course Contents

Unit I: Process Modeling (08 Hours)

Introduction to Process control and process instrumentation-Hierarchies in process control systems-Theoretical models-Transfer function-State space models-Time series models- Development of empirical models from process data-chemical reactor modeling-. Analysis using softwares.

Unit II: Feedback &Feedforward Control (08 Hours)

Feedback controllers-PID design, tuning, trouble shooting, Cascade control, Selective control loop, Ratio control.

Unit III: Frequency Response (08 Hours)

Control system design based on Frequency response Analysis, Direct digital design, Feed- forward and ratio control. State feedback control. LQR problem, Pole placement.

Unit IV: Software Simulations of control system (08 Hours)

Simulation using softwares, Control system instrumentation, Control valves, Codes and standards, Preparation of P& I Diagrams.

Unit V: Advanced process control (08 Hours)

Multi-loop and multivariable control, Process Interactions, Singular value analysis, tuning of multi loop PID control systems, decoupling control, strategies for reducing control loop interactions, Real-time optimization.

Unit VI: Plant Control (08 Hours)

Model predictive control-Batch Process control-Plant-wide control & monitoring- Plant wide control design- Instrumentation for process monitoring-Statistical process control- Introduction to Fuzzy Logic in Process Control-Introduction to OPC.

Introduction to environmental issues and sustainable development relating to process industries. Comparison of performance different types of control with examples on softwares

References

1. Seborg, D.E., T.F. Edgar, and D.A. Mellichamp, Process Dynamics and Control, John Wiley , 2004
2. Johnson D Curtis, Instrumentation Technology, (7th Edition) Prentice Hall India, 2002.
3. Bob Connel, Process Instrumentation Applications Manual, McGrawHill, 1996.
4. Edgar, T.F. & D.M. Himmelblau, Optimization of Chemical Processes, McGrawHill Book Co, 1988. Macari Emir Joe and Michael F Saunders, Environmental Quality Innovative Technologies

24AF2612PCL204	PG Lab	PCC	0-0-2	Credit: 1
Exam Scheme				
Continuous Assessment: 60 Marks		PR/ OR: 40 Marks		Total: 100 Marks

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

CO1	Study performance of various mechanical devices, analysis software
CO2	Draw and analyze performance curves of these machines/systems, analysis by using various software
CO3	Analyze the results obtained from the tests.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		1			2					2	
CO2	1			1								
CO3	2					1						

Experiments on the following set-ups (Any Eight):

1. CAD modeling of any two machine components using Catia / Pro-E / Solid edge / any suitable modeling software
2. FEM analysis of any two machine members by using reputed commercial software for stress distribution
3. Stress concentration and report writing on results of analysis. Using Ansys/Nastran/ Hyper mesh / LS-DYNA / any suitable analysis software.Heat Transfer EnhancementComputerized Single Cylinder Diesel Engine using Alternative Fuel
4. Air Conditioning Test-rig
5. Centrifugal/Gear Pump at Variable speed
6. Unsteady State Heat Transfer
7. Blower Test-rig

24AF2612OE205A	New Labor Codes of India	OE-I	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Analyze the evolution, history, and current government policies of labour laws in India, including key reports and international conventions that shape these laws.
CO2	evaluate the role, formation, management, and recognition of trade unions, along with their constitutional and international frameworks.
CO3	demonstrate the ability to identify and resolve industrial disputes, understanding the concepts of strikes, lock-outs, layoffs, retrenchment, and closures, as well as the procedures for disciplinary actions.
CO4	apply the provisions and implementation strategies of the Code on Wages 2019 and the Code on Social Security 2020, including minimum wages, payment of wages, equal remuneration, employee compensation, benefits, and various social security schemes.
CO5	implement knowledge about the Occupational Safety, Health and Working Conditions Code, 2020, including health and safety regulations, working conditions, and special provisions for different types of workers, ensuring compliance with these standards in various industrial settings.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

UNIT 1: History of Labour Laws and Trade Unions (08 Hours)

Government Policies Regarding Labour, History of Labour Laws in the Country, History of Previous Social Legislations in India, National Labour Commission and its Reports.

Trade Unions, Evolution of Trade Unions in India, Constitutional Freedom to Form Associations and Unions, International Labour Organization on Trade Unions, Trade Union – Definition,

Registration, Cancellation, Management of Funds, Recognition, Immunities

UNIT 2: Industrial Disputes, Employment Contracts and The Code on Wages (08 Hours)

Industrial Dispute – Introduction, Definitions, Resolution of Industrial Disputes, Concept of Workmen, Contract of service, Contract for service, Strike, Lock-out

Lay-off, Retrenchment, Closure of Undertakings, Industrial Employment (Standing Orders), Disciplinary Action and Procedures

The Code on Wages 2019 – An Introduction, Minimum Wages, Floor Wages, Central and State Advisory Board, Payment of Wages, Deductions & Recovery, Fines, Equal Remuneration, Bonus

UNIT 3: Legal Frameworks for Wage Equality and Protection (08 Hours)

C131: Minimum Wage Fixing Convention, 1970, C026: Minimum Wage – Fixing Machinery Convention, 1928; C099: Minimum Wage Fixing Machinery (Agriculture) Convention, 1951, C095: Protection of Wages Convention, 1949, C100: Equal Remuneration Convention, 1951: International Instruments on Equality of Pay, C173: Protection of Workers' Claims (Employer's Insolvency) Convention, 1992; C111: Discrimination (Employment and Occupation) Convention, 1992

UNIT 4: Employee Compensation and Benefits and Social Security (08 Hours)

Code on Social Security, 2020 – Introduction, Definitions under Social Security Code, 2020, Social Security Organizations (SSO), Employee's Compensation and Benefits, The Concept of arising out of and in the course of employment

Employees State Insurance, Different Benefits under the ESI Scheme, Employee's Provident Fund, Gratuity, Maternity Benefit

Social Security in the case of Building and other Construction Workers, Social Security for Unorganized sector and Platform workers, Bonded Labour System Abolition and Regulation, Child Labour Prohibition, Plantation Labour

UNIT 5: Health, Safety, and Working Conditions in the Workplace, Regulatory Framework for Factories: (08 Hours)

Occupational Safety, Health and Working Conditions Code, 2020 – Introduction, Definitions, Occupational Safety and Health, Health Safety and Working Conditions, Welfare Provisions, Regulation of Working H ours and the Concept of Decent Work, Duties of Employer and Employees, Special Provisions relating to Employment of Women, Hours of Works, Annual Leave with Wages, Maintenance of Registers. The Meaning of Factory, Manufacturing Process, Approval and Licensing of Factories, Role of Inspector-cum-facilitator and Other Authorities, Social Security Fund, Offences and Penalties, Contract Labour and Proposed ILO Convention, Inter-State Migrant Workers

Mines Workers, Beedi and Cigar Workers (Kerala & West Bengal Legislations), Audio-Visual workers, Cine-workers and Dock workers, The Effective Abolition of Child Labour (ILO: C029, C105, C138 & C182), The Governance Convention of ILO Labour Standards

Textbooks:

1. Taxmann's New Labour & Industrial Laws, 2022 Edition
2. Taxmann's Labour Laws, 2023 Edition
3. Avtar Singh & Prof (Dr) Harpreet Kaur, Introduction to Labour and Industrial Laws, 2022

24AF2612OE205B	Urban Utilities Planning: Water Supply, Sanitation and Drainage	OE-I	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Students should be able to demonstrate a clear understanding of the fundamental concepts related to water supply, sanitation, and drainage systems in urban settings.
CO2	Students should be capable of applying design principles to develop efficient and sustainable water supply, sanitation, and drainage systems that meet the needs of urban populations while considering factors such as population growth, climate change, and land use.
CO3	Students should be able to outline strategies for the effective management, operation, and maintenance of water supply, sanitation, and drainage infrastructure to ensure long-term sustainability and functionality.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

UNIT I (09 Hours)

Urban Utilities

Urban utilities planning: Introduction, Urban Water Supply, Collection of water.

UNIT II (09 Hours)

Water Storage & Distribution

Pumping and storage, Water supply Distribution system and Plans, Water Quality, testing, treatment, and cost.

UNIT III (09 Hours)

Sanitation

Sanitation and Drainage Fundamentals, Water carriage system, Sewer design,

UNIT IV (09 Hours)

Sewage treatment

Sewer appurtenances and master plans, Sewage treatment, drainage, and recharge

Textbooks / References:

1. Water Supply Engineering, S. K. Garg (18th ed.), Khanna Publishers.
2. Water Supply and Sanitary Engineering, G. S. Birdie & J. S. Birdie (8th ed.), Dhanpat Rai Publishing Company, New Delhi.
3. Stormwater drainage manual Planning, Design and Management, Drainage services department, Government of the Hong Kong Special Administrative Region.

NPTEL platform:

NPTEL Course	**Name of Instructor**	**Host Institute**	**Link**
Urban Utilities Planning: Water Supply, Sanitation and Drainage	Prof. Debapratim Pandit	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc23_ar08/preview

24AF2612OE205C	Environment and Development	OE-I	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

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

CO1	Demonstrate a deep understanding of the complex interrelationships between environmental factors and socioeconomic development, including how they influence and shape each other.
CO2	Identify and critically analyze key environmental challenges resulting from development activities, and evaluate their impacts on ecosystems, natural resources, and human well-being.
CO3	
CO4	

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

Course Contents

UNIT I (07 Hours)

Environmental movement

An overview of development, economic growth, and the imperative of sustainable development. Foundational concepts in ecosystem ecology, Environmentalism and the Environmental Movement, and the unique dynamics of environmentalism within the global south.

UNIT II (06 Hours)

Social ecology

Approaches to environment: Ecofeminism, Feminist political ecology, Marxism and ecology, Debates on environmental ethics including Deep ecology, Gandhi and ecology, and social ecology.

UNIT III (07 Hours)

Impact of Religion on environment

Religion, environment, and conservation: Explores the historical roots of the ecological crisis, biodiversity conservation ethics in Buddhism and Hinduism, and the role of Christianity in addressing the ecological crisis.

UNIT IV (06 Hours)

Natural Resources & development

Management of natural resources, Private vs. common property comparison in forests, forestry, and conservation, Development impacts: conservation-induced displacement, national rehabilitation and resettlement policy, environmental influence assessments, Land takeover and purchase.

UNIT V (06 Hours)

Gender & Development, Climate change

Development theory and gendered development perspectives, Gender in the context of environment and sustainable development. Environmental issues and climate change: Policy framework and interventions for climate change, focusing on the Eastern Himalayas region.

UNIT VI (08 Hours)

Belief and local knowledge of environment

Belief systems and biodiversity conservation: Examining ecological knowledge's role in sustainability, with a focus on traditional religion and nature conservation in Northeast India. Additionally, discussing the significance of indigenous knowledge in the environment-development discourse, supported by relevant case studies.

Textbooks / References:

1. Arnold, David, and Guha, Ramchandra, (eds.), 1997. Nature, Culture and Imperialism, New Delhi: Oxford University Press.
2. Baviskar, Amita. 1997. In the Belly of the River: Tribal Conflicts over Development in the Narmada Valley, OUP, Delhi.
3. Barnhill, David Landis & Roger S. Gottlieb. (eds.) 2001. Deep Ecology and World Religions: New Essays on Sacred Grounds. State Univ. of New York Press, Albany.
4. Bicker, Alan, Paul Sillitoe and Johan Pottier. 2004. Development and Local Knowledge: New Approaches to Issues in Natural Resources Management, Conservation and Agriculture. Routledge, London & New York.
5. Esteva, G. 1997. _Development‘ in W. Sachs, ed., The Development Dictionary, Orient Longman, pp. 8-34.
6. Gadgil, Madhav and Guha, Ramchandra. 1995. Ecology and Equity: The use and Abuse of Nature in Contemporary India, New Delhi: Oxford University.
7. Gottlieb, Roger S. 2004. This Sacred Earth: Religion, Nature, Environment. Routledge, New York, and London.
8. Merchant, Carolyn. 1994. Ecology: Key Concepts in Critical Theory, Humanities Press, New Jersey.
9. Ramakrishnan, P.S. 1992. Shifting Agriculture and Sustainable Development: An Interdisciplinary Study from North-Eastern India, Man and the Biosphere Series, Volume 10, UNESCO.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Environment and Development	Prof. Ngamjahao Kipgen	IIT Guwahati	https://onlinecourses.nptel.ac.in/noc21_hs83/preview

24AF2630OE205B	Entrepreneurship	OE-I	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Students will be able to generate innovative business ideas by identifying market gaps, customer needs, and emerging trends.
CO2	Students will be capable of developing comprehensive business plans that encompass market research, financial projections, and strategic goals.
CO3	Students will gain skills in budgeting, financial forecasting, and managing financial resources for their entrepreneurial ventures.
CO4	Students will be able to identify and manage potential risks associated with entrepreneurship, including financial, operational, and market risks.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

Course Contents

UNIT I (08 Hours)

Entrepreneurial Journey, Entrepreneurial Discovery, Ideation and Prototyping, Role of entrepreneurship in economic development, Types of business models for technology ventures

UNIT II (08 Hours)

Testing, Validation and Commercialization, Disruption as a Success Driver

UNIT III (08 Hours)

Technological Innovation and Entrepreneurship – 1, Technological Innovation and Entrepreneurship – 2, Raising Financial Resources. International expansion and globalization

UNIT IV (08 Hours)

Education and Entrepreneurship, Beyond Founders and Founder-Families, India as a Start-up Nation Marketing and sales strategies for startups

UNIT V (08 Hours)

National Entrepreneurial Culture, Entrepreneurial Thermodynamics, Entrepreneurship and

Employment, Start-up Case Studies

Textbooks / References:

1. Zero to One: Notes on Startups, or How the Build the Future by Peter Thiel.
2. The Lean Startup: How Today‘s Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries.
3. India as Global Start-up Hub: Mission with Passion by C B Rao.
4. Elon Musk: Tesla, SpaceX, and the Quest for a Fantastic Future by Ashlee Vance.
5. Steve Jobs by Walter Isaacson.
6. Innovation and Entrepreneurship: Practice and Principles by Peter F Drucker.
7. The Innovator‘s Solution: Creating and Sustaining Successful Growth by Clayton M Christensen.
8. "The Lean Startup" by Eric Ries

24AF2608ML206	Research Methodology	MLC	3-0-0	Credits: 3
Examination Schedule				
Mid-Sem Examination 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Explain the need and significance of research
CO2	Explain the need for the research design
CO3	Explain the role of hypothesis testing in research work
CO4	Explain the significance of data collection
CO5	Explain the need of interpretation

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit 1: Research Methodology (08 Hours)

Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, an illustration.

Unit 2: Reviewing the literature (08 Hours)

Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

Unit 3 (08 Hours)

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Techniques, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

Unit 4: Testing of Hypotheses (08 Hours)

Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi-Square Tests.

Unit 5: Interpretation and Report Writing (08 Hours)

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

References:

1. Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International, 4th Edition, 2018.
2. Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), Ranjit Kumar, SAGE Publications, 3rd Edition, 2011.
3. Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.
4. Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

24AF2612EL207	Mini-Project	ELC	0-0-2	Credit: 1
Exam Scheme				
Continuous Assessment 25 Marks		End-Sem Evaluation (PR/OR) 25 Marks		Total 50 Marks

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

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference Proceedings.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		2	2	1	1	2	2	1	2
CO2	1	1	2	2			2	2	1	2	1	2
CO3	2	2		3					2	2		1
CO4				2				2	2	3		1
CO5		1		2	2			2	2	3		1

Objectives:

To train students in identification, analysis, finding solutions and execution of live Mechanical Engineering and Managerial problems. It is also aimed to enhance the capabilities of the students.

Individual students are required to choose a topic of their interest. The subject content of the mini project shall be from emerging / thrust areas, topics of current relevance having research aspects or shall be based on industrial visits. Students can also choose live problems from Mechanical Engineering as their mini project. At the end of the semester, the students should submit a report duly authenticated by the respective guide, to the head of the department.
Mini Project will have internal marks 25 and Semester-end examination marks 25.

Internal marks will be awarded by respective guides as per the stipulations given below. Attendance, regularity of student (10 marks)
Individual evaluation through viva voce / test (15 marks) Total (25 marks)

Semester end examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, before the committee. Students individually will present their work before the committee. The committee will evaluate the students individually and

marks shall be awarded as follows.

Report = 10 marks
Concept/knowledge in the topic = 05 marks Presentation = 10 marks
Total marks = 25 marks

24AF2612IK208A	Indian Knowledge System (IKS): Concepts and Applications in Engineering	3-0-0	Credits: 3
Exam Scheme			
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	--	Total 40 Marks

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

CO1	To familiarize learners with major sequential development in Indian science, engineering, and technology.
CO2	To review & strengthen the ancient discovery and research in physics, chemistry, maths, metallurgy, astronomy, architecture, textile, transport, agriculture, and Ayurveda etc.
CO3	To help students to trace, identify and develop the ancient knowledge systems to make meaningful contribution to development of science today.
CO4	To help to understand the apparently rational, verifiable, and universal solution from ancient Indian knowledge system for the scientific, technological, and holistic development of physical, mental, and spiritual wellbeing.

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit 1: Indian Traditional Knowledge; Science and Practices (08 Hours)

Introduction to the Science and way of doing science and research in India, Ancient Science in Intra & Inter Culture Dialogue & coevolution. Traditional agricultural practices, Traditional water-harvesting practices, Traditional Livestock and veterinary Sciences Traditional Houses & villages, Traditional Forecasting, Traditional Ayurveda & plant-based medicine, Traditional writing Technology

Unit 2: Ancient Indian Science (Physics, Chemistry, Mathematics) (08 Hours)

Physics in India: Vaisheshika darshana Atomic theory & law of motion, theory of panchmahabhuta, Brihath Shathaka (divisions of the time, unit of distance), bhaskaracharya (theory of gravity, surya siddhanta & siddhanta shiromani), Lilavati (gurutvakashan Shakti). Chemistry in India Vatsyayana, Nagarjuna,Khanda, Al-Biruni, Vagbhaṭa –building of the ras-shala (laboratory), working arrangements of ras-shala, material and equipment, Yaśodhara Bhaṭṭa- process of distillation, apparatus, sarana samskara, saranataila Mathematics in India: Baudhayana's Sulba Sutras, Aryabhaṭa, Bhaskaracharya-I, Severus Sebokht, Syria, Brahmagupta, Bhaskaracharya-II, Jyeṣṭhadeva

Unit 3: Ancient Indian Science (metallurgy, Astronomy, Architecture) (08 Hours)

Metallurgy in India: Survarṇa(gold) and its different types, prosperities, Rajata(silver), Tamra(copper), Loha(iron), Vanga(tin), Naga / sisa(lead), Pittala(brass) Astronomy in India Vedang Jyotish, aryabhatta siddhanta, Mahabhaskriya, Laghubhaskariya, vateshwar siddhanta, Sisyadhivrddhida, Grahashyay, Goladhyaya, Kadanakutuhala (Aryabhaṭa, Varahamihira, Brahmagupta, Vaṭesvara, Bhaskara, Paramesvara, NilakaṇṭhaSomayaji, Jyeṣṭhadeva, ŚankaraVarman) Architecture in India: Nagara (northern style), Vesara (mixed style), and Dravida (southern style), Indian vernacular architecture, Temple style, cave architecture, rock cut architecture, kalinga architecture, chandels architecture, rajput architecture, jain architecture, sikh architecture, Maratha architecture Indo-Islamic architectural, Indo-Saracenic revival architecture, Greco Buddhist style.

Unit 4: Ancient Indian Science (Textile, Agriculture, Transport) (08 Hours)

Textile Technology in India: Cotton (natural cellulose fiber), silk, wool (natural protein fibers), bast and leaf fibers, mridhudhautadhupitambaram (meaning a practice of fumigating the fabric with incense smoke before use as a part of the finishing process), sitadhautavasanayugala (bleached white–a finishing process); suchhastah,

sutradhara (needle and thread – tools for stitching). dyeing, washing spinning and weaving technology, Agriculture in India: krishi suktas, Krishiparashara, Brihatsamhita, Types of crops, Manures, Types of land- devamatruka, nadimatruka, use of animals in warfare, animal husbandry, Animals for medicines. Ancient transport in India

Unit 5: Ancient Indian Science (Ayurveda & Yoga) (08 Hours)

Ayurveda for Life, Health and Well-being: Introduction to Ayurveda: understanding Human body and Pancha maha bhuta, the communication between body & mind, health

Reference books:

1. Textbook on IKS by Prof. B Mahadevan, IIM Bengaluru.
2. Kapur K and Singh A.K (Eds) 2005). Indian Knowledge Systems, Vol. 1. Indian Institute of Advanced Study, Shimla. Tatvabodh of sankaracharya, Central chinmay mission trust, Bombay, 1995.
3. Nair, Shantha N. Echoes of Ancient Indian Wisdom. New Delhi: Hindology Books, 2008.
4. SK Das, The education system of Ancient hindus, Gyan publication house, India
5. R P Kulkarni, Glimpese of Indian Engineering and Technology (Ancient & Medieval period, Munshiram Manoharlal Publishers Pvt. Ltd. 2018
6. AK Pathak, Science and Technology in India, Anshika prakashan pratapgarh, 2016
7. PB Sharma, S. Narain, Doctors Scientists and Engineers of Ancient India, Kalpaz Publications 2017
8. NVP, Unithiri, Indian Scientific Traditions (Professor K.N. Neelakantan Elayath Felicitation Volume), publication division unieristy of Calicut, 2006
9. Anonyms, History of Science in India- Volume-I Part-I (Physics, Mathematics and Statistics), the national academy of science, India & the ramkrishna mission institute of culture, 2014

24AF2612IK208B	Indian Knowledge System (IKS): Humanities and Social Sciences	3-0-0	Credits: 3
Exam Scheme			
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	--	Total 40 Marks

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

CO1	Gain a comprehensive understanding of the philosophical, scientific, and technological aspects of Indian Knowledge Systems and their historical development.
CO2	Understand the philosophical underpinnings of IKS, including concepts like dharma, karma, and holistic thinking, and explore their relevance to engineering.
CO3	Understand Vedic mathematical principles and computational methods, and their potential relevance in solving modern engineering problems
CO4	Investigate the connections between yoga, meditation, and stress management, and their potential impact on mental well-being in engineering contexts.
CO5	Reflect on the ethical, cultural, and social dimensions of integrating IKS concepts into engineering practices and applications.

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	1											
CO3	1											
CO4						1						
CO5	2	1		1		2						

Course Contents

UNIT I (07 Hours)

Indian Knowledge System – An Introduction & Vedic Corpus

What is IKS? Why do we need IKS? Organization of IKS, Historicity of IKS, Some salient aspects of IKS, Introduction to Vedas, A synopsis of the four Vedas, Sub-classification of Vedas, Messages in Vedas, Introduction to Vedāṅgas, Prologue on Śikṣā and Vyākaraṇa, Basics of Nirukta and Chandas, Introduction to Kalpa and Jyotiṣa, Vedic Life: A Distinctive Features.

UNIT II (06 Hours)

Number system & Mathematics

Number systems in India - Historical evidence, Salient aspects of Indian Mathematics, BhūtaSaṃkhyā system, Kaṭapayādi system, Measurements for time, distance, and weight, Piṅgala and the Binary system. Introduction to Indian Mathematics, Unique aspects of Indian Mathematics, Indian Mathematicians and their Contributions, Algebra, Geometry, Trigonometry, Binary mathematics, and

combinatorial problems in Chandaḥ Śāstra, Magic squares in India.

UNIT III (07 Hours)

Engineering Technology: Metal & Other applications

Wootz Steel: The rise and fall of a great Indian technology, The Indian S & T heritage, Mining and ore extraction, Metals and metalworking technology, Iron and steel in India, lost wax casting of idols and artifacts, Apparatuses used for extraction of metallic components. Irrigation systems and practices in South India, literary sources for science and technology, Physical structures in India, irrigation and water management, dyes and painting technology, the art of making perfumes, Surgical techniques, shipbuilding, sixty-four art forms (64 Kalās) status of Indigenous S & T.

UNIT IV (06 Hours)

Town Planning and Architecture:

Perspective of Artha sastra on town planning, Vāstu-śāstra – The science of architecture, eight limbs of Vaastu, town planning, temples in India: Marvelous stone architecture for eternity, temple architecture in India, Iconography.

UNIT V (07 Hours)

Knowledge Framework and classifications:

Indian scheme of knowledge, The knowledge triangle, Prameya – A vaiśeṣikan approach to physical reality, Dravyas – the constituents of the physical reality, Attributes – the properties of substances and Action – the driver of conjunction and disjunction, Sāmānya, viśēṣa, samavāya, Pramāṇa – the means of valid knowledge, Saṃśaya – ambiguities in existing knowledge, Framework for establishing valid knowledge, Deductive or inductive logic framework, Potential fallacies in the reasoning process, Siddhānta: established tenets in a field of study.

UNIT VI (07 Hours)

Linguistics

Introduction to Linguistics, Aṣṭādhyāyī, Phonetics, word generation, computational aspects, Mnemonics, Recursive operations, Rule based operations, Sentence formation verbs and prefixes, role of Sanskrit in natural language processing.

Textbooks / References:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), ―Introduction to Indian Knowledge System: Concepts and Applications‖, PHI Learning Private Ltd. Delhi.

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Indian Knowledge System (IKS): Concepts	Prof. B. Mahadevan, Dr. Vinayak Rajat	(IIMB), Chanakya University,	https://onlinecourses.swayam2.ac.in/imb23_

and Applications in Engineering	Bhat, Dr. R Venkata Raghavan	Bangalore	mg53/preview

24AF2612AU209	Disaster Management	0-0-2	Audit course
Exam Scheme			
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	--	Total 40 Marks

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

CO1	Learners will be able to understand the basic concept of disaster(s) and disaster management, their significance, and types.
CO2	Learners will develop the analytical skills to study relationship between vulnerability, disasters, disaster prevention and risk reduction
CO3	Learners will gain a preliminary understanding of approaches to Disaster Risk Reduction (DRR)
CO4	Learners will be empowered with the awareness of institutional processes in the country for Disaster Management

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

UNIT I (08 Hours)

Disaster Management: Disaster and Disaster Management – Concepts, Issues Concerned with Disaster Management. Disaster Management: Phases of Disaster Management, Phases of Disaster Management Types of Disasters: Bhopal Disaster: A Case Study, Types of Disasters-An Introduction, Natural Disaster, Man-made Disaster

UNIT II (08 Hours)

Types of Disasters: Slow onset Disasters & Rapid onset Disasters, Simple and Complex, Tsunami: A Case Study Disasters, Tsunami: A Case Study, Cyclone Phallin 2013: A Case Study

UNIT III (08 Hours)

Disaster Management in India -An Overview: Evolution of Disaster Management in India, Disaster and Disaster Management in India, National institute of Disaster Management, National Disaster Management Act 2005.

UNIT IV (08 Hours)

Disaster Management in India -An Overview: The National Policy on Disaster Management, 2009. Refugee Problem: National Plan on Disaster Management 2016, Refugee Problems, Impact of Disaster on the lives of Refugees. Refugee Problem: Problems of Women and Children during disasters, Principles of Psychosocial Care, Issues And Recovery During Emergency. Refugee Problem: Relationship between Disasters, Development and Vulnerabilities, Relationship between Disasters, Development and Vulnerabilities.

UNIT V (08 Hours)

Refugee Problem: Equity Issues in Disaster. Refugee Problem: Issues of Rehabilitation and Resettlement among the Disaster Survivors, Stakeholders in Disaster Relief Management - An Introduction. Stakeholders in Disaster Relief Management: Central Government. Stakeholders in Disaster Relief Management: State Government, District Administration. Armed Forces. Stakeholders in Disaster Relief Management: Para-Military Forces, Fire Services. Disaster Risk Reduction: Disaster Risk Reduction Strategies, Risk Reduction Preparedness Plans.

Textbooks / References:

1. Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.
2. Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi
3. An overview on natural & man-made disasters and their reduction, R K Bhandani, CSIR, New Delhi
4. World Disasters Report, 2009. International Federation of Red Cross and Red Crescent, Switzerland
5. Encyclopaedia of disaster management, Vol I, II and IIIL Disaster management policy and administration, S L Goyal, Deep & Deep, New Delhi, 2006
6. Encyclopaedia of Disasters – Environmental Catastrophes and Human Tragedies, Vol. 1 & 2, Angus M. Gunn, Greenwood Press, 2008
7. Disasters in India Studies of grim reality, Anu Kapur & others, 2005, 283 pages, Rawat Publishers, Jaipur.
8. Management of Natural Disasters in developing countries, H.N. Srivastava & G.D. Gupta, Daya Publishers, Delhi, 2006, 201 pages
9. Natural Disasters, David Alexander, Kluwer Academic London, 1999, 632 pages
10. Disaster Management Act 2005, Publisher by Govt. of India
11. High Power Committee Report, 2001, J.C. Pant
12. Disaster Mitigation in Asia & Pacific, Asian Development Bank
13. National Disaster Management Policy, 2009, GoI
14. Disaster Preparedness Kit, American Red Cross

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Disaster Management	Naveen Kumar Nanjundan	University Of Hyderabad	https://onlinecourses.swayam2.ac.in/cec19_hs20/preview

Semester- III

24AF2612PC301	Additive Manufacturing	PCC	3-1-0	Credits: 4
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

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

CO1	Understand the importance of Additive Manufacturing
CO2	Classify the different AM processes
CO3	Design for AM processes
CO4	Understand the applications of AM
CO5	Apply the AM Processes bio-medical applications

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2					1		1				
CO2	2				1	1						
CO3	2	2	2	2	1	1				1		
CO4	2				2							
CO5		2	3		3	2						2

Course Contents

Unit I: (08 Hours)

Introduction

Overview - Historical Development - Need – Classification - Additive Manufacturing Technology in product development – Materials for Additive Manufacturing Technology – Traditional v/s Additive Manufacturing – Tooling – Benefits and Applications.

Unit II: (08 Hours)

Geometric Model & Reverse Engineering

Basic Concept – Digitization Techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology, CAD model preparation – Interface Formats - Part Orientation and support generation – Model Slicing – Tool path generation.**AM Data Formats**: Reengineering for Digital Representation, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution.

Unit III: (08 Hours)

Liquid Based and Solid Based Additive Manufacturing Systems

Classification – Liquid based system – Stereolithography Apparatus (SLA) – Principle, process,

advantages and applications – Solid based system – Fused Deposition Modeling – Principle, process, advantages and applications, DMLS.

Unit IV: (08 Hours)

Powder Based Additive Manufacturing Systems

Selective Laser Sintering (SLS) – Principle, process, advantages and applications – Three-Dimensional Printing – Principle, process, advantages and applications – Laser Engineered Net Shaping (LENS), Electron Beam Melting – Shape deposition manufacturing, Laser deposition, Lamination, Electro-optical sintering.

Unit V: (08 Hours)

Rapid Casting and Segmental Object Manufacturing, Visible Slicing Implementation Rapid casting using wax patterns, acrylic patterns, dense polystyrene patterns – Expanded polystyrene process – Rapid manufacturing of metallic objects.

Textbooks:

1. Chua C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., "Rapid Prototyping", Hanser Gardener Publications, 2003.

References:

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2. Rapid Prototyping & Engineering Applications by Frank W.Liou, CRC Press,
3. Taylor & Francis Group, 2011.

24AF2630MD302A	Design Of Mechatronic Systems	Multidisciplinary Minor	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

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

CO1	Understand the theoretical foundations of mechatronics, including principles of system dynamics, control theory, and signal processing, with a focus on nonlinear control and digital systems.
CO2	Gain proficiency in mathematical modeling techniques for mechatronic systems, covering frictional dynamics, DC motors, manipulator dynamics, and their simulation using MATLAB.
CO3	Master advanced control methodologies, particularly Lyapunov theory, for designing robust and stable control systems capable of trajectory tracking in nonlinear dynamical systems
CO4	Develop practical skills in implementing digital signal processing techniques, including sampling, filtering, and interfacing with digital systems, essential for real-world mechatronic system implementation.
CO5	Explore cutting-edge research examples and case studies in mechatronics, such as the development of novel systems like 3D micro-printers and microfabrication platforms, to understand the application of theoretical concepts in innovative engineering solutions.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

UNIT 1: **Mechatronics Essentials** (08 Hours)

Introduction: Elements of mechatronics system: Sensor, actuator, plant, and controller. Applications of mechatronics system. Systems like CDROM, scanner

UNIT 2: Integrated Mechatronics: Design, Sensors, and Microprocessors (08 Hours)

Integrated mechanical-electronics design philosophy. Smart sensor concept, utility of compliant

mechanisms in mechatronics, Microprocessor building blocks, combinational and sequential logic elements, memory, timing and instruction execution fundamentals with example of primitive microprocessor.

UNIT 3: Microcontroller for Mechatronics (08 Hours)

Microcontrollers for mechatronics: Philosophy of programming interfaces, setting sampling time, and getting started with TIVA programming, Microcontroller programming philosophy emphasis on TIVA, programming different interfaces PWM, QEI etc. Mathematical modeling of mechatronic systems,

UNIT 4: Advanced Mechatronics: Dynamics, Control, and Simulation (08 Hours)

Modeling friction, DC motor, Lagrange formulation for system dynamics, Dynamics of 2R manipulator, Simulation using Matlab, Selection of sensors and actuators. Concept of feedback and closed loop control, mathematical representations of systems and control design in linear domain

UNIT 5: **Nonlinear Control and Digital Signal Processing** (08 Hours)

Basics of Lyapunov theory for nonlinear control, notions of stability, Lyapunov theorems and their application, Trajectory tracking control development based on Lyapunov theory, Basics of sampling of a signal, and signal processing, Digital systems and filters for practical mechatronic system implementation. Research example/ case studies of development of novel mechatronics system: 3D micro-printer, Hele Shaw system for microfabrication.

Textbooks/Reference:

1. Devdas Shetty, Richard A. Kolk, “Mechatronics System Design,” PWS Publishing company
2. Boukas K, Al-Sunni, Fouad M “Mechatronic,Systems Analysis, Design and Implementation,” Springer,
3. Sabri Cetinkunt, “Mechatronics with Experiments,” 2nd Edition, Wiley
4. Janschek, Klaus, “Mechatronic Systems Design,” Springer

24AF2630MD302B	Ethical Hacking	Multidisciplinary Minor	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Pre-Requisites: Computer Proficiency, Computer Networking

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

CO1	Gain a comprehensive understanding of ethical hacking concepts, methodologies, and its role in enhancing cybersecurity.
CO2	Acquire a solid grasp of cybersecurity principles, types of threats, and the importance of proactive defence strategies.
CO3	Develop proficiency in various hacking techniques, including reconnaissance, scanning, exploitation, and post-exploitation activities.
CO4	Perform effective vulnerability assessments on systems and networks, identifying potential security weaknesses and exposures.
CO5	Demonstrate the ability to conduct penetration tests, simulating real-world attacks to evaluate the strength of security measures

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1						3				
CO2		2	2					3				
CO3		2	2	2	3			3				
CO4	3	2	2	2	1			2				
CO5	1				3			2				1

Course Contents

UNIT I (08 Hours)

Introduction to ethical hacking. Fundamentals of computer networking. TCP/IP protocol stack. IP addressing and routing. TCP and UDP. IP subnets. Routing protocols. IP version 6.

UNIT II (08 Hours)

Installation of attacker and victim system. Information gathering using advanced google search, archive.org, net craft, dnsenum, NMAP tool, dig, etc.

UNIT III (08 Hours)

Vulnerability scanning using NMAP and Nessus. Creating a secure hacking environment. System Hacking: password cracking, privilege escalation, application execution. Malware and Virus. ARP spoofing and MAC attack.

UNIT IV (08 Hours)

Introduction to cryptography, private-key encryption, public-key encryption. Cryptographic hash functions, digital signature and certificate, applications. Steganography, biometric authentication, network-based attacks, DNS, and Email security.

UNIT V (08 Hours)

Packet sniffing using Wireshark and Burp suite, password attack using burp suite. Social engineering attacks and Denial of service attacks. Elements of hardware security: side-channel attacks, physical inclinable functions, hardware trojans.

Different types of attacks using Metasploit framework: password cracking, privilege escalation, remote code execution, etc. Attack on web servers: password attack, SQL injection, cross site scripting.

Textbooks / References:

1. Data and Computer Communications -- W. Stallings.
2. Data Communication and Networking -- B. A. Forouzan
3. TCP/IP Protocol Suite -- B. A. Forouzan
4. UNIX Network Programming -- W. R. Stallings
5. Introduction to Computer Networks and Cybersecurity -- C-H. Wu and J. D. Irwin
   Cryptography and Network Security: Principles and Practice -- W. Stallin

24AF2630MD302C	Sustainable Power Generation Systems	Multidisciplinary Minor	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Explain the principles of sustainability in the context of power generation and understand its significance in the global energy transition.
CO2	Identify and describe various renewable energy sources, including solar, wind, hydro, geothermal, and biomass, and explain their potential for power generation.
CO3	Examine and contrast pros and cons of various sustainable power generation technologies, accounting for factors like efficiency, scalability, reliability, and intermittency.
CO4	Assess environmental, social, and economic impacts of conventional and sustainable power generation methods, analyzing their roles in climate change mitigation and pollution reduction.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

Course Contents

UNIT I

Introduction to power generation: (08 Hours)

Global and Indian Context: An Examination of Current Power Generation Technologies and Renewable Energy Concepts Introduction to Renewable Energy-Based Power Plants Solar Thermal Power Generation: Exploring the Basics of Solar Thermal Energy Conversion, Design, and Analysis of Solar Thermal Power Plants (including flat plate and concentrator technologies), Overview of Organic Rankine Cycle (ORC), Rankine Cycle (RC), and Stirling Engine Applications.

UNIT II

Solar Photovoltaic Power Generation: (08 Hours)

Solar Photovoltaic (PV) Energy Conversion: Understanding PV Fundamentals, PV Power Plant Design, Performance Analysis of Standalone and Grid-Connected PV Systems. Wind Power Generation: Introduction to Wind Turbines, Component Classification and Analysis, Design and

Theory of Wind Turbines (Horizontal and Vertical Axis), and Wind Farm Analysis.

UNIT III

Hydro Power Generation: (08 Hours)

Hydropower Plants: Introduction to Hydro Power Plants, Micro, Mini, and Small Hydro Plants, Hydraulic Turbines, Selection and Design Criteria for Pumps and Turbines, Brief Theory, Design, and Analysis of Hydro Power Plants. Biomass Power Generation: Fundamentals of Bioenergy Production Technologies, Design and Analysis of Biochemical and Thermochemical Reactors for Clean Power Generation and Value-Added Products, Introduction to Integrated Gasification Combined Cycle (IGCC).

UNIT IV

Hydrogen energy and fuel cells (08 Hours)

Hydrogen Generation: Importance and Various Generation Routes, Basic Principles and Design of Fuel Cells, Applications, Prospects, and Introduction to Integrated Gasification Fuel Cell (IGFC). Geothermal Energy: Fundamentals, Classification, Theory, Design, and Analysis of Geothermal Power Plants.

UNIT V

Ocean Thermal Energy (08 Hours)

Ocean thermal power plant principles, categorization, theory, design, and analysis Tidal and Wave Energy, Understanding the Fundamentals, Classification, Theory, Design, and Analysis of Wave and Tidal Power Plants. **Energy Storage,** Energy Storage Technologies: Overview of Thermal, Mechanical, and Electrochemical Energy Storage Systems; Design and Analysis of Various Storage Technologies. Week 12: Module-12: Energy Economics Cost Analysis, Financial Metrics (Interest, Accounting Rate of Return, Payback, Discounted Cash Flow, Net Present Value, Internal Rate of Return), Inflation, and Life Cycle Analysis for Energy Systems.

Textbooks / References:

1. J. Twidell, T. Weir, Renewable Energy Resources, Taylor and Francis, 4th Edition, 2021.
2. G. Boyle (Editor), Renewable Energy: Power for a Sustainable Future, Oxford University press, 3rd Edition, 2012.
3. G. N. Tiwari, Solar Energy, Fundamentals, Design, Modeling and Applications, Narosa, 2002.
4. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley, 4th Edition, 2013.
5. R. Gasch, J. Twele, Wind Power Plants: Fundamentals, Design, Construction and Operation, Springer, 2nd Edition, 2012.
6. P. Breeze, Hydropower, Elsevier, 1st Edition, 2018.
7. S. C. Bhattacharyya, Energy Economics Concepts, Issues, Markets and Governance, springer, 2nd Edition, 2019.
8. S.p Sukhatme and J.K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata Mc-Graw Hill Education Private Limited, 3rd Edition, 2010.

24AF2612MD302A	Components and Applications of Internet of Things	Multidisciplinary Minor	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Identify IoT Components: Recognize and classify key components of IoT systems, including sensors, actuators, communication protocols, and data processing units.
CO2	Explore IoT Communication: Understand various wireless and wired communication technologies used in IoT networks and their suitability for different application scenarios.
CO3	Design IoT Applications: Create IoT solutions by integrating hardware and software components, demonstrating proficiency in prototyping, programming, and data handling.
CO4	Analyse Data from IoT Devices: Collect, analyse, and interpret data generated by IoT devices to extract meaningful insights and support informed decision-making.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

UNIT I (07 Hours)

Basics of IoT

Introduction to Internet of things, Various sensors, and sensing techniques. Technological trends in IoT. impact of IoT on society. Review of various IoT application domain including agriculture, healthcare, manufacturing, device management, and vehicle to vehicle communication and wearable computing devices.

UNIT II (06 Hours)

Microcontroller and Interfacing Techniques for IoT Devices

Introduction to IoT and architecture layers, IoT smart devices, Typical embedded computing systems, Introduction to ARM architecture and programming method, Embedded system development: a case study, Introduction to interfacing techniques.

UNIT III (07 Hours)

IoT Protocols & Security

Networking and basic networking hardware. Networking protocols, Interaction between software and hardware in an IoT device. IoT components and technologies to secure systems and devices.
Various security issues related to the IoT and security architectures. Hardware security threats and security vulnerabilities; protecting physical hardware

UNIT IV (06 Hours)

Location Tracking

Introduction to device localization and tracking; different types of localization techniques: time-of-arrival (TOA) based, time-difference-of-arrival (TDOA) based, angle-of-arrival (AOA) based, received signal strength (RSS) based, Radio-Frequency Identification (RFID) based and fingerprinting based; Monte-Carlo tracking; Kalman filter based tracking; Cramer- Rao lower bound (CRLB) for device location estimator; Device diversity/heterogeneity issue in IoT networks.

UNIT V (06 Hours)

Deep learning for IoT

This topic will focus on how to build a good model from the past data to predict correctly when the system is provided with a data-point. In this course mostly, supervised learning will be considered. Basics of neural networks, activation functions, back-propagation, etc. will be covered. At the end some of the challenges in the context of IoT will be mentioned.

UNIT VI (08 Hours)

IoT Applications

Smart grid: Introduction to smart grid, Integration of IoT into smart grid, Standardization activities for IoT aided smart grid, Applications of IoT aided smart grid, Architectures for IoT sided smart grid, Prototypes, Applications of big data and cloud computing, Open Issues, and challenges.

IoT-based Smart Home and Nano-grid Monitoring System

Sensor-Controller Coordination of a DC Microgrid in IoT Platform, Cyber physical system, dc microgrid, dc–dc power converter, distributed energy generator, sensor control and controller design. Low-Cost DC Nano-grid with Smart Remote Monitoring Unit, DC-DC converter modelling, closed loop control, placement of IoT devices, sensors, micro grid, solar energy, low-cost communication system design.
Introduction, objective, components of home monitoring system, control, and management, Zigbee, Wireless Sensor Network (WSN), Internet of Things (IoT).

Internet of Robotic Things (IoRT):

Introduction to stationary and mobile robots; Brief introduction to localization, mapping, planning, and control of robotic systems; Introduction to cloud-enabled robotics; Applications of IoT in robotics; Architectures for IoRT; Examples and case studies; Open issues and challenges.

Textbooks / References:

It will be provided in each of the lecture sessions. (Refer **NPTEL** platform)

NPTEL platform:

NPTEL Course	**Name of Instructor**	**Host Institute**	**Link**
Components And Applications of Internet of Thing	Dr. Sanjoy Kumar Parida	Indian Institute of Technology Patna	https://onlinecourses.swayam2.ac.in/arp20_ap03/preview

24AF2612MD302B	Linear Algebra	Multidisciplinary Minor	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test: 20 Marks	Continuous Assessment: 20 Marks	End-Sem Exam: 60 Marks	Total: 100 Marks	

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

CO1	Students will be able to understand the Euclidean vector spaces, subspaces, eigenvectors, eigen values and inner product spaces.
CO2	Students will be able to analyze concepts of vector space, linear Transformation, diagonalization
CO3	Students will be able to apply Cayley-Hamilton theorem and Rank-Nullity theorem, quadratic forms.
CO4	Students will be able to develop Matrix Transformations in R2, Gram-Schmidt process, Symmetric and Skew-symmetric bilinear forms

Mapping of course outcomes with program outcomes

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	2	2	1									
CO3	2	1	1									
CO4	2	1	1	1								

Course Contents

Unit I: Euclidean Vector Spaces: (08 Hours)

Vectors in 2-Space, 3-Space, and n-Space, Norm, Dot Product, and Distance in Rn, Orthogonally, The Geometry of Linear Systems, Cross Product

Unit II Vector Spaces: (08 Hours)

Basic concepts in linear algebra: vector spaces, subspaces, linear independence and dependence of vectors, bases, dimensions. Row and Column spaces, rank. Applications to systems of linear equations.

Unit III Linear Transformation: (08 Hours)

Definition and Examples, Properties, Equality, Kernel and range of a linear Transformation, Rank-Nullity theorem, Composite, and Inverse Transformation., Matrices and Linear Transformation., Basic Matrix Transformations in R2

Unit IV Matrix Forms: (08 Hours)

Normal matrices, Jordan canonical forms, Cayley-Hamilton theorem, **b**asis of eigenvectors, eigenvalues of special types of matrices, diagonalization of special matrices, inner product spaces,

orthonormal sets, Gram-Schmidt process

Unit V Quadratic forms: (08 Hours)

Bilinear and quadratic forms, Symmetric and Skew-symmetric bilinear forms. Non-negative matrices, Perron-Frobenius theory, generalized inverse of a matrix, spectral radius, similarity of matrices, spectral theorems.

Textbooks:

1. Kreyszig E, Advanced Engineering Mathematics, 10th Edition, Wiley (2015).
2. Strang G, Linear Algebra and Its Applications, 4th Edition, Cengage (2014).

References:

1. Artin M, Algebra , 2nd Edition, Pearson (2015).
2. Axler S, Linear Algebra Done Right, 3rd Edition, Springer (2015).
3. Friedberg S H, Spence L E and Insel A J, Elementary Linear Algebra, 2nd Edition, Pearson (2019)
4. Hoffmann K and Kunze R, Linear Algebra, 2nd Edition, Pearson (2015)
5. Howard Anton, Chris Rorres, Elementary Linear Algebra, Application Version, Ninth Edition, Wiley, 11th edition.

24AF2612MD302C	Artificial Intelligence and Machine Learning	Multidisciplinary Minor	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Identify the AI based problems.
CO2	Apply techniques to solve the AI problems.
CO3	Define learning and explain various logic inferences.
CO4	Discuss different learning techniques.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

UNIT I (08 Hours)

Introduction to AI and State space search, History of AI, Comparison of AI with Data Science, Need of AI in Mechanical Engineering, Introduction to Machine Learning. **Basics:** Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion and manipulation Introduction to unguided and guided search.

UNIT II (08 Hours)

Problems in search and solutions, Convex Genetic Algorithms Instance based Learning, Neural Networks, BPNN, learning process in BPNN.

UNIT III (08 Hours)

Machine Learning - Bayesian Learning: Bayes rule, Bayes classifier, MAP, MLE, EM, and Mixtures of Gaussians. Linear classifiers: perceptron, winnow. Expert's style: voting, bandits... Programming: Linear, Quadratic, nearest neighbors, regression (linear, locally weighted, kernel). Reinforcement Learning: Bellman, Q learning, TD learning, actorcritic.

UNIT IV (08 Hours)

Minimax and other game playing algorithms, using predicate logic for Knowledge Representation.

UNIT V (08 Hours)

Resolution and non-monotonic reasoning, Strong methods for Knowledge Representation; Fuzzy logic and CD, Scripts and Introduction to Expert systems, Developing expert systems and Machine learning.

Applications: -Human Machine Interaction, Predictive Maintenance and Health Management, Fault Detection, Dynamic System Order Reduction, Image based part classification, Process Optimization, Material Inspection, Tuning of control algorithms

Reference Books:

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
5. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach. III Edition.

Textbooks:

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015.
4. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson, 2003.
5. E. Rich, K. Knight & S. B. Nair - Artificial Intelligence, 3/e, McGraw-Hill.
6. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice Hal of India.
7. G. Luger, ―Artificial Intelligence: Structures and Strategies for complex problem Solving, Fourth Edition, Pearson Education, 2002.
8. N.P. Padhy ―Artificial Intelligence and Intelligent Systems‖, Oxford University Press- 2015.

24AF2612OE303A	Business to Business Marketing	OE-II	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

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

CO1	Foundational Knowledge: Gain a strong grasp of the core concepts and theories that form the basis of B2B marketing, enabling practical application.
CO2	Market Analysis Expertise: Develop skills to analyse B2B markets, segment customers effectively, and make informed marketing decisions.
CO3	Strategic Implementation: Acquire the ability to design and execute B2B marketing strategies tailored to the unique needs of business customers.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												

Course Contents

UNIT-I: (08 Hours)

Introduction to B2B Marketing: Business marketing and Business market customers, Market structure, Environment and Characteristics of Business Marketing, Strategic role of marketing, Commercial enterprises, Commercial and institutional customers.

UNIT-II: (08 Hours)

Organizational Buying and Buyer Behavior: Organizational buyers' decision process - A Stepwise Model and A Process Flow Model, Organizational and business markets - Government as a customer - Commercial enterprises - Commercial and institutional customers (08 Hours)

UNIT-III: (08 Hours)

B2B Marketing Strategy: Strategy making and strategy management process, Industrial product strategy– Managing Products for Business Markets-Managing Services for Business Markets-Managing Business Market Channels the Growth-Share Matrix, Multifactor Portfolio Matrix, The Balanced Scorecard. (08 Hours)

UNIT-IV: (08 Hours)

B2B Marketing STP: Market Segmentation, basic framework of segmentation, choosing target segments and positioning-Pricing strategies for Business Markets, B2B Advertising, Competitive bidding, Relationship marketing and CRM, (08 Hours)

UNIT-V: Business Marketing Communications and Channels- B2B Advertising, Digital marketing, - Trade shows, exhibitions, business meets - Managing the sales force - Deployment analysis - Business marketing channels and participants - Channel design and management decisions -B2B logistics management. (08 Hours)

Reference books:

1. Michael D. Hutt, Dheeraj Sharma, Thomas W. Speh, B2B Marketing: A South Asian Perspective Cengage 2014, 11th ed.
2. Sharad Sarin, Business Marketing: Concepts and Cases McGraw Hill 2013, 1st ed.
3. James C. Anderson, Das Narayandas, James A. Narus and D.V.R. Seshadri, Business Market Management (B2B): Understanding, Creating, and Delivering Value, Pearson 2010, 3rd ed.
4. Robert Vitale, WaldemarPfoertsch, Joseph Giglierano, Business to Business, Marketing, Pearson 2011
5. Krishna K Havaldar, Business Marketing: Text and Cases McGraw Hill 2014, 4th ed.
6. Armstrong, Gary and Philip Kotler, "Principles of Marketing", Prentice Hall, New Delhi, 2006

24AF2612OE303B	Organizational Behavior	OE-II	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

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

CO1	Students will be able to analyze and understand individual behaviors within organizational.
CO2	Students will develop and refine their interpersonal skills, enabling effective communication, collaboration, and conflict resolution within professional environments.
CO3	Students will gain the ability to assess and manage group dynamics, facilitating teamwork, addressing conflicts, and fostering a productive and cohesive group environment.
CO4	Students will apply their understanding of individual and group behaviors to enhance organizational effectiveness.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit – I Focus and Purpose (08 Hours)

Definition, need, and importance of organizational behaviour – Nature and scope – Frame work – Organizational behavior models, Organization and the environmental factors.

Organizational Theory, Organizational behavior modification. Misbehavior –Types

Unit – II Individual Behavior (08 Hours)

Personality – Types – Factors influencing personality – Theories.

Learning – Types of learners – The learning process – Learning theories. .

Attitudes – Characteristics – Components – Formation – Measurement- Values.

Perceptions – Importance – Factors influencing perception – Interpersonal perception- Impression Management. Emotions and Moods in workplace

Unit – III Group Behavior (08 Hours)

Organization structure – Formation – Groups in organizations – Influence – Group dynamics – Interpersonal Communication

Team building - Interpersonal relations – Group decision making techniques.
Meaning of conflict and its types, Conflict Redressal process

Unit – IV Leadership and Power (08 Hours)

Leadership – Meaning, importance, traits, styles and Theories. Leaders Vs Managers.
Sources of power – Power centers – Power and Politics.
Motivation at work – importance, need, types and its effects on work behavior. Motivation Theories : Maslow's, Herzberg, etc.

Unit – V Dynamics of Organizational Behavior (08 Hours)

Organizational culture and climate – Factors affecting organizational climate – Importance.
Organizational change – Importance – Stability Vs Change – Proactive Vs Reaction change – the change process – Resistance to change – Managing change. Stress – Work Stressors – Prevention and Management of stress – Balancing work and Life. Organizational Development – Characteristics & objectives.
Organizational effectiveness. Benchmarking- TQM and Six Sigma (Overview)

Reference Books:

1. Human Behavior at work — Keith Devis
2. Organizational Behavior; Concepts, Skills and Practices — Kinicki Kreitner Dimension of Organizational Behavior — T. Herbert
3. Organization & Management — R. D. Agrawal
4. Organizational Behavior and Performance — Aszilagyl & Walace
5. Organizational Behavior — K. Aswathapa
6. Organizational Behavior — Jit Chandan
7. Organizational Behavior — V. Ghosh
8. Organizational Behavior — Gregory Morehead
9. Organizational Behavior — Fred Luthans
10. Organizational Behavior — Rosy Joshi
11. Organizational Behavior — Stephen Robbin

24AF2630OE303B	Principles of Economics	Open Elective-II	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

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

CO1	Grasp key economic principles, like supply and demand, opportunity cost, and marginal analysis, forming a foundation for economic understanding.
CO2	Gain insights into market structures, pricing mechanisms, and factors influencing consumer and producer behavior.
CO3	Understand the role of government interventions, regulations, and fiscal/monetary policies in shaping economic outcomes.
CO4	Learn how societies allocate scarce resources efficiently, exploring topics like production, distribution, and factors of production.
CO5	Develop analytical thinking by applying economic principles to real-world scenarios, making informed personal and business decisions.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

UNIT I (08 Hours)

Principles of Economics, Thinking like an Economist; Interdependence and the gains from Trade, Economic models and analysis

UNIT II (08 Hours)

Market forces of supply and Elasticity, Application of elasticity; supply, demand, and government policies, Consumer behavior and utility maximization

UNIT III (08 Hours)

Consumer and producer surplus; cost of taxation and international trade, Externalities, and cost of production

UNIT IV (08 Hours)

Competitive market and monopoly market, Game theory and oligopoly, measures national income, measuring cost of living

UNIT V (08 Hours)

Production and growth; Saving, Investment and the financial system, the monetary system, Money growth and inflation

Textbooks / References:

1. N.Gregory Mankiw, Principles of Economics.
2. Microeconomics: Principles and Applications by Robert E. Hall and Marc Lieberman

NPTEL platform:

NPTEL Course	Name of Instructor	Host Institute	Link
Principles Of Economics	Prof. Sabuj Kumar Mandal	IIT Madras	Principles Of Economics – Course (nptel.ac.in)

24AF2956PC303	Intellectual Property Rights	OEC II	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test: 20 Marks	Continuous Assessment: 20 Marks	End-Sem Exam: 60 Marks	Total: 100 Marks	

Course Prerequisites: Product Design, Design Thinking

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

CO1	State the fundamental terms i.e. trademark, copyright, patents, trade secret etc.
CO2	Interpret laws of trademark, copyright, patents, trade secret and its registration processes.
CO3	Understand the roles and responsibilities of various international organizations, agencies, and treaties.
CO4	Manage and safeguard the intellectual property and protect it against unauthorized use.

Mapping of Course Outcomes with Program Outcomes:

POs→ COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1			1			1			1
CO2	1	1	1						1			1
CO3			1			1			1			1
CO4	2	1	1			1			1			1

Course Contents

UNIT I: Understanding and Overview of the IPR Regime (08 Hours)

Introduction, types of intellectual property- Copyright, Trademarks, Patents, Trade secrets. Need for Intellectual property rights, Rationale for protection of IPR. Impact of IPR on development, health, agriculture, and genetic resources. IPR in India- Genesis and Development. IPR abroad. International Organizations, agencies, and treaties.

UNIT II: Trademarks and Trade secret (08 Hours)

Rights of trademark-Kind of signs used as trademark types, Purpose and Function of a trademark, Trademark Protection, trademark registration, acquisition of trademark rights, protectable matters, selecting and evaluating trademark, trademark registration processes. Infringement of Trademark.

Geographical Indication of Goods: Geographical Indications (GI) laws, Indian Geographical Indications (GI) act, Types of Geographical Indications (GI), Need for protection, legal aspects.

Trade Secret: Trade Secret laws, determination of trade secret status, liabilities for misappropriation of trade secrets, protection for submission, trade secret litigation.

UNIT III: Copyrights (08 Hours)

Rights and Protection covered by copyrights- Laws of copyrights: Fundamental of copyright law, originality of material, rights of reproduction, rights to perform the work publicly, copyright ownership issues, obtaining copyright registration and process, international copyright law,

Infringement of copyright under copyright act, the role, and liabilities of IPRs in India.

UNIT IV: Patents (08 Hours)

Kinds of inventions protected by patent, Patentable and Non patentable inventions, process and product patent, Legal requirements for patents-Granting of patent-Rights of a patent-exclusive right, Patent application process: Searching a patent- Drafting of a patent- Filing of a patent- Types of a patent application. Patent document: specifications and claims, Management of IP asses and IP portfolio, Commercial exploitation of IP- Assignment, licensing, infringement. Different laws of the international patent system: national, regional and international options. Industrial Design protection.

UNIT V: New Development of Intellectual Property (08 Hours)

New development in trademark law, copyright law, patent law, trade secret law, Intellectual property audits. International overview on intellectual property, international trademark law, copyright law, international patent law and international trade secret law.

Textbooks:

1. Deborah, E. Bouchoux, "Intellectual Property Rights", Cengage learning.
2. Prabuddha Ganguli, "Intellectual Property right: Unleashing the knowledge economy", Tata McGraw Hill Publishing Company Ltd.

24AF2612OE303C	Introduction to Public Administration	OEC II	3-0-0	Credits: 3
Exam Scheme				
Mid-Sem Test: 20 Marks	Continuous Assessment: 20 Marks	End-Sem Exam: 60 Marks	Total: 100 Marks	

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

CO1	Define public administration and explain its role in society.
CO2	Identify and analyze the different types of public organizations.
CO3	Apply public administration theories and principles to real-world problems.
CO4	Develop the skills and knowledge necessary to pursue a career in public administration.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents

Unit – I Public Administration as a Discipline (08 Hours)

Public Administration: Meaning Nature, Scope and Significance of Public Administration. Difference between Public and Private Administration, Administration as an Art or Science, Evolution of Public Administration, E-Governance: Concept, Rationale, and significance.

Unit – II Theoretical Perspectives (08 Hours)

Theories of Organization – Classical, Neo classical and Modern theory, Approaches to the study of Public Administration: Structural – functional, systems, approach, Behavioral approach, Public Choice approach, Bureaucracy: Meaning types and Weberian model of Bureaucracy.

Unit – III Public Policy in Public Administration (08 Hours)

Concepts of Public Administration: Power, Authority, and responsibility, Decision Making: Meaning, Classification and Essentials of decision making, Process of decision making, techniques of decision making, approaches to decision making.

Unit – IV Public Administration in India (08 Hours)

Enactment of Indian Constitution - Union Government – The Cabinet – Central Secretariat -– All India Services – Training of Civil Servants – UPSC – Niti Ayog – Statutory Bodies: The Central

Vigilance Commission – CBI - National Human Rights Commission – National Women's Commission –CAG

Unit – V Emerging Issues & Major Approaches in Indian Public Administration (08 Hours)
Good Governance: Concept, characteristics, elements. Issues and Challenges, Leadership: Development of leadership, Qualities of leadership, Accountability, and control –Executive, Legislative, Judicial. Citizen and Administration: Issues and problems, Methods to promote good relationship.

References/Textbooks:

1. Felix, A. Nigro and C. Nigro Modern Public Administration (New York: Lloyd Harper and Row, Latest edition)
2. John Pfiffiner and Frank Sherwood Administrative Organization (New Delhi: Prentice Hall, Latest ed.).
3. Peter F. Drucker Management: Tasks, Responsibilities, Practices (Bombay: Allied Publishers, latest ed.).
4. H. Koontz and Cyril O'Donnell Principles of Management, (Tokyo: McGraw Hill, latest ed).
5. Amitai Etzioni Modern Organizations (New Delhi: Prentice Hall, latest ed.).
6. Robert T. Golembiewsky Public Administration as a Developing Discipline (New York: Marcel, latest ed.).
7. Mohit Bhattacharya Public Administration (Calcutta: World Press, latest ed).
8. Mamta Mokta, S.S.Chauhan, S.K. Mahajan and Simmi Agnihotri Challenges in Governance(ed) Anamica Publishers,New Delhi 2011
9. C.P. Bhambri Public Administration (Theory and Practice (Meerut: Educational Publishers, latest ed.).
10. Bertram Gross The Managing of Organisations (London: Free Press, latest ed.).
11. W.M. Newman, C. Summer and E.Warren Management Concepts, behaviour & practice, edu. Publishers Meerut.
12. P. Herseay and K.H. Blanchard Management of Organisational Behaviour (New Delhi:latest ed.).
13. Nicholas Henry Public Administration and Public Affairs, (New Jersey: Prentice Hall, latest ed.).
14. Herbert G. Hicks and Ray C. Gutlet Organisations: Theory and Behaviour (New York: McGraw Hill, latest ed.).
15. Ramesh, K. Arora (ed.) Perspective in Administrative Theory (New Delhi: Associated, latest ed.).
16. S.L. Kaushik and Pardeep Sahni (eds.) Public Administration in India: Emerging Trends (Allahabad: Kitab Mehal, latest ed.).
17. J.S. Vickers and George K. YarrowPrivatization: An Economic Analysis (Cambridge: MIT Press, latest ed.).
18. David Osborne and T. Gaebler Re-inventing Government: How the Entrepreneurial Spirit

is Transforming the Public Sector (New York: Addison Wesley, latest ed.).
19. A. R. Tyagi, Public Administration, Atma ram sons, New Delhi, 1983.
20. Avasthi and Maheswari,Public Administration in India,Agra:Lakshmi Narain Agarwal,2013

NPTEL platform:

NPTEL Course	**Name of Instructor**	**Host Institute**	**Link**
Introduction to Public Administration	By Prof. Y. Pardhasaradhi	Osmania University Hyderabad.	https://onlinecourses.swayam2.ac.in/cec21_hs06/preview

24AF2612EL304	Project Stage-I	ELC	0-0-4	Credits: 10
Exam Scheme				
Continuous Assessment 50 Marks		(PR/OR) 50 Marks		Total 100 Marks

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

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

Project-I is an integral part of the final project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation that may include mathematical model/SRS/UML/ERD/block diagram/ PERT chart, and layout and design of the proposed system/work. As a part of the progress report of project-I work; the candidate shall deliver a presentation on progress of the work on the selected dissertation topic.

The student shall submit the duly certified progress report of project -I in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.

Semester- IV

24AF2612EL401	Project Stage-II	ELC	0-0-4	Credits: 20
Exam Scheme				
Continuous Assessment 100 Marks		(PR/OR) 100 Marks		Total 200 Marks

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

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Course Contents:

In Project - II, the student shall complete the remaining part of the project which will consist of the simulation/ analysis/ synthesis/ implementation / fabrication of the proposed project work, workstation, conducting experiments and taking results, analysis and validation of results and drawing conclusions.

It is mandatory to publish the paper on the state of the art on the chosen topic in an international conference/ journal.

The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.