Mechanical Engineering

Semester VI						
S. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	CE301T	Environmental studies	3	0	0	6
2	ME208L	Control Systems and Laboratory	3	0	0	6
3	ME313T	Thermal Engineering	3	0	0	6
4	ME312T	Operations Research and Industrial Engineering	3	0	0	6
5		Open Elective	3	0	0	6
6	ME302L	Applied Thermodynamics Laboratory	3	0	0	3
7	ME301L	Kinematics and Dynamics of Machinery lab	3	0	0	3
8		Department Elective	3	0	0	6
		Total Credits				**42**

Mechanical Engineering

1	**Title of the course (L-T-P-C)**	**Environmental studies (3-0-0-6)**
2	**Pre-requisite courses(s)**	**Nill**
3	**Course content**	**Module A:** Natural Resources, Ecosystems, Biodiversity and its conservation: Natural resources and ecosystems, Forest, grassland, desert and aquatic ecosystems, biodiversity at global, national and local levels, conservation of biodiversity **Module B:** Air Pollution Introduction to understanding air quality management, fundamental processes of meteorology, Air Pollutants – Gaseous and particulate, Criteria for pollutants, ambient and source standards, Aerosols: Characterisation of aerosols, size distributions, measurement methods; Transport behaviour: diffusion, sedimentation, inertia; Visibility; principles of particulate control systems. **Module C:** Water Treatment Discussion of water quality constituents and introduction to the design and operation of water and wastewater treatment processes. **Module D:** Solid Waste Management and Climate Change Different aspects of solid and hazardous waste management. Climate change and greenhouse gas emissions, technologies would reduce the greenhouse gas emissions. Climate change and its possible causes. **Module E:** Sociology/Environmentalism Description: Environmentalism in sociological tradition, Sustainability, North-South divide, Political economy approaches in environmental studies, Debates over environmental issues. **Module F:** Economics Energy economics and financial markets, Market dynamics, Energy derivatives, Energy Efficiency; Sustainable Development: Concept, Measurement & Strategies, Interaction between Economic Development and the Environment **Module G:** Philosophy Environmental ethics, Deep ecology, Practical ecology, Religion and attitude towards environmental ethics, Ecofeminism and its evolution. **Module H**: Field work and project: visit to a local area to document environmental assets, case studies of a simple ecosystem and group discussions on current environmental issues.
4	**Texts/References**	**1.** Cunningham W.P. and Cunningham M.A. (2002), Principles of Environmental Science, Tata McGraw-Hill Publishing Company, New Delhi. **2.** Dasgupta, P. and Maler, G. (eds.), (1997), The Environment and Emerging Development Issues, Vol. I, Oxford University Press, New Delhi. **3.** Jackson, A.R.W. and Jackson, J.M. (1996), Environmental Sciences: The Environment and Human Impact, Longman Publishers. **4.** Nathanson, J.A., (2002), Basic Environmental Technology, Prentice Hall of India, New Delhi **5.** Redclift, M. and Woodgate, G. (eds.), (1997), International Handbook of Environmental Sociology. **6.** Srivastava, K.P. (2002), An Introduction to Environmental Study, Kalyani Publishers, Ludhiana. **7.** Review articles from literature.

1	**Title of the course** (L-T-P-C)	**Kinematics and Dynamics of Machinery lab (0-0-3-3)**
2	**Pre-requisite courses(s)**	
3	**Course content**	Fabrication or model demonstration of ● Lower and Upper joins ● Multi-degree of freedom linkages with verification of Kutzback's Equation ● Inversions of 4R, 3R-P and 2R-2P four-link linkages ● Grashof Criterion ● Approximate and Exact Straight line generating mechanisms ● Pantograph Linkages ● Ackerman's steering linkage ● Geneva Mechanism ● Simple, Compound and Planetary Gear trains – Verification of velocity analysis, velocity ratio, instantaneous centers – Demonstration of inversion in synthesis of Cam profiles – Examination of geometry of involute gears in mesh – Passive Vibration Analysis; Damped response – Active Vibration Analysis; Frequency Response; Resonance – Vibration of two degree of freedom systems – Balancing of rotating masses – Balancing of reciprocating masses – Critical speed of shafts
4	**Texts/References**	**1.** Kinematics, Dynamics, and Design of Machinery: Edition 3 **2.** Kenneth J. Waldron, Gary L. Kinzel, Sunil K. Agrawal, 10 May 2016 John Wiley & Sons

1	**Title of the course** (L-T-P-C)	**Thermal Engineering** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Basics of Fluid Mechanics and Thermodynamics: recapitulation Hydraulic Pumps and turbines: Components, Priming of Pumps, Head Developed by pump, NPSHA and NPSHR, Cavitation, Characteristics of pumps, Types of vanes, Specific speed, Hydraulic Energy and Types, Impulse and reaction Turbines: Performance Characteristics, Velocity triangles, Specific Speed, Degree of Reaction and Speed Ratio, Cavitation Gas and steam turbines: Elementary cascade theory, Cascade nomenclature, Euler work equation, Optimum space-chord ratio of turbine blades, Axial flow turbine, Efficiencies, Condition for maximum efficiencies, Compounding of turbines-Velocity and Pressure, Degree of reaction, Reaction Turbines Refrigeration: COP, refrigeration effect, reverse Brayton cycle, vapor compression cycles, vapour absorption cycles; subsystems for refrigeration: refrigerants, refrigerant compressors, condensers, expansion devices, evaporators, psychrometry, psychrometric processes, air-conditioning Internal combustion engines: four- and two-stroke cycles, performance parameters and characteristics, factors influencing performance, air-standard vs. real cycles, fuels for IC engines, alternative forms of IC engines. p-theta diagram. Combustion and knocking, fuel injection, engine emissions.
4	Texts/References	**Textbooks:** 1. S. Larry Dixon, Cesare Hall, Fluid Mechanics and Thermodynamics of Turbomachinery, 7e , Butterworth-Heinemann, 2013. 2. H I H Saravanamuttoo, G F C Rogers and H. Cohen. Gas Turbin Theory, 7e, Pearson, 2017. 3. Dossat R. J. and Horan T. J., Principles of Refrigeration, Pearson Education, 4e, 2004. 4. Arora C. P., Refrigeration and Air-conditioning, 4e, Tata McGraw Hill 2021. 5. John Heywood, Internal Combustion Engine Fundamentals, McGraw Hill, 2017. 6. Ganesan, V. Internal Combustion Engines. 4e, McGraw Hill, 2017 7. Cengel Y. A. and Boles M. A., Thermodynamics: An Engineering Approach, McGraw Hill, 8e, 2017. 8. Claus Borgnakke, Richard E. Sonntag, Souvik Bhattacharyya, Manoj Kumar Soni. Fundamentals of Thermodynamics, 10e, Wiley, 2022.

1	**Title of the course** (L-T-P-C)	**Operations Research and Industrial Engineering** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**Introduction to Operations Research**, **Linear Programming (LP):** Terminology and formulations, Graphical and Algebraic solutions to LP, **Simplex Algorithm**: Algebraic form, Tabular form, Types of LPs, Matrix method, Duality: Writing the dual of an LP, Primal-Dual relationships, **Dual:** Basic understanding, significance, interpretation, Dual Simplex algorithm, Transportation Problem, Assignment Problem, Traveling salesman problems, Solving LPs using Solver, Sensitivity analysis. **Introduction to Industrial Engineering** Work Study: Introduction, Work Study Human Component and Method Study, Recording Techniques for Method Study, Recording Techniques Critical Examination, Principles of Motion Economy, Work Measurement, Performance Rating Allowance, **Work Measurement:** Work Sampling, PMT System Standard Data Method, Ergonomics, Organization at Work, Working Conditions, Lights, Vibrations. Principles of assembly engineering, theory of dimensional chains, fully interchangeable and selective assembly. Quality Concepts, Value Engineering, Industrial Safety.
4	Texts/References	1. Wayne L Winston, Operations Research: Applications and Algorithms, Indian University, 4th edition, 2004. 2. Hiller & Liberman, Introduction to Operations Research, Tat McGraw-Hill. 3. Mark. S. Sanders and Ernest. J McCornick, Human Factor in Engineering and Design, McGraw-Hill Book Co., Inc., New York, 4th edition, 2013. 4. S. Dalela and Sourabh, Work Study and Ergonomics. Standard publishers, 2013. 5. Ralph M. Barnes, Motion and Time Study, Wiley International, 7th Edition. 6. B. Niebel and Freivalds, Niebel's Methods, Standards, and Work Design, McGraw-Hill, 12th Edition, 2009.

1	**Title of the course** (L-T-P-C)	**Control Systems and Laboratory (2-0-2-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• **Basic concepts:** Notion of feedback, open- and closed-loop systems. • **Modeling and representations of control systems:** Transfer function models of for suitable mechanical, electrical, thermal and pneumatic systems, Ordinary differential equations, Transfer functions, Block diagrams, Signal flow graphs, State-space representations. • **Performance and stability:** Time-domain analysis, Second-order systems, Characteristic-equation and roots, Routh-Hurwitz criteria. • **Basic modes of feedback control:** Proportional, Integral, Derivative. • **Root locus** method of design. • **Frequency-domain techniques:** Root-locus methods, Frequency responses, Bode-plots, Gain- margin and phase-margin, Nyquist plots. • **Compensator design:** Proportional, PI and PID controllers, Lead-lag compensators. • **State-space concepts:** Controllability, Observability, pole placement result, Minimal representations • Laboratory involves set of experiments following the theory component covered in the class
4	**Texts/References**	**1.** Norman Nise, Control System Engineering, Wiley, 6th Edition, 2011 **2.** K. Ogata, Modern Control Engineering, Pearson, 5th edition, 2010. **3.** Gene franklin et. al., "Feedback Control of Dynamic Systems", 7th Edition, Pearson **4.** B. Kuo, Automatic Control System, Wiley, 9th Edition, 2014