Semester V						
S. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	ME306T	Design of Machine Elements	3	0	0	6
2	EE205T	Introduction to Probability (1^{st} Half)	3	0	0	3
3	EE207T	Introduction to Data Analysis	3	0	0	3
4	HS201T	Economics	3	0	0	6
5	ME311T	Numerical Methods for Engineers	3	0	0	6
6	ME301T	Applied Thermodynamics	3	0	0	6
7	ME203L	Mechanical Measurements Lab	3	0	0	3
8	ME205L	Heat Transfer lab	3	0	0	3
9	ME206L	Manufacturing processes laboratory	3	0	0	3
		Total Credits				**36**

1	**Title of the course** (L-T-P-C)	**Introduction to Probability** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	Basic calculus
3	**Course content**	**Introduction**: Motivation for studying the course, revision of basic math required, connection between probability and length on subsets of the real line, probability-formal definition, events and σ-algebra, independence of events, and conditional probability, sequence of events, and *Borel-Cantell* Lemma. **Random Variables**: Definition of random variables, and types of random variables, CDF, PDF and its properties, random vectors and independence, brief introduction to transformation of random variables, introduction to Gaussian random vectors. **Mathematical Expectations**: Importance of averages through examples, definition of expectation, moments and conditional expectation, use of MGF, PGF and characteristic functions, variance and k-th moment, MMSE estimation. **Inequalities and Notions of convergence**: Markov, Chebychev, Chernoff and Mcdiarmid inequalities, convergence in probability, mean, and almost sure, law of large numbers and central limit theorem. **A short introduction to Random Process:** Example and formal definition, stationarity, autocorrelation, and cross correlation function, definition of ergodicity.
4	**Texts/References**	**1. Robert B. Ash**, ``Basic Probability Theory," Reprint of the John Wiley & Sons, Inc., New York, 1970 edition. **2. Sheldon Ross**, ``A first course in probability," Pearson Education India, 2002. **3. Bruce Hayek**, ``An Exploration of Random Processes for Engineers," Lecture notes, 2012. **4.** D.P. Bertsekas and J. Tsitisklis, "Introduction to Probability" MIT Lecture notes, 2000 (*link*: https://www.vfu.bg/en/e-Learning/Math--_Bertsekas_Tsitsiklis_Introduction_to_probability.pdf)

1	**Title of the course** (L-T-P-C)	**Design of Machine Elements** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**Fundamentals of Mechanical Engineering Design**: Mechanical engineering design, Phases of design process, Design considerations, Engineering Materials and their Mechanical properties, Standards and Codes, Factor of safety, Material selection, Static Stresses: Static loads. Normal, Bending, Shear and Combined stresses, Stress concentration factor **Design for Impact and Fatigue Loads**: Impact stress, Fatigue failure: Endurance limit, S-N Diagram, Stress concentration effects, Notch sensitivity, fluctuating stresses, Goodman & Soderberg relationship, cumulative fatigue damage.Curved Beams: Stresses in curved beams of standard cross sections used in crane hook, punching presses & clamps, closed rings and links **Threaded Fasteners & Power Screws:** Stresses in threaded fasteners, effect of initial tension, design of threaded fasteners under static loads, eccentrically loaded bolted joints, types of power screws, efficiency & self-locking, design of power screw, screw jack: (complete design) **Riveted Joints & Weld Joints:** Rivet types, rivet materials, failures of riveted joints, efficiency, boiler joints, Lozanze joints, riveted brackets, eccentrically loaded joints, types of welded joints, strength of butt, fillet welds, Welded brackets with transverse & parallel fillet welds, eccentrically loaded welded joints **Design of Shafts, Joints, Couplings and Keys:** Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under combined loads. Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling and Oldham's coupling, Design of Cotter and Knuckle joints, Design of keys- square, saddle, flat and feather **Mechanical Springs & Flexible mechanical Elements:** Types of springs, spring materials, stresses in helical coil springs of circular & non-circular cross sections. Tension & compression springs, concentric springs; springs under fluctuating loads Belts: Materials of construction of flat & V belts, power rating of belts,concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition, Selection of flat & V belts, length & cross section from manufacturers' catalogues. Construction & application of timing belts, Wire ropes: Construction of wire ropes, stresses, selection of wire ropes. Chain drive: Types of power transmission chains, modes of failure for chain, & lubrication of chains **Gear drives, Clutches & Brakes:** Classification of gears, materials for gears, standard systems of gear tooth, gear tooth failure modes and lubrication of gears, Spur Gears, Design of Clutches, Design of Brakes **Bearing Design:** Lubricants, their properties, bearing materials, properties; mechanisms of lubrication, hydrodynamic lubrication, Numerical examples on hydrodynamic journal & thrust bearing design, static, dynamic load carrying capacities, equivalent bearing load, load life relationship; probability of survival
4	**Texts/References**	**TEXTBOOKS:** 1. **Mechanical Engineering Design**, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition, 2009. **REFERENCES:** 2. **Machine Design, Robert L. Norton, Pearson Education Asia, 2001. DATA HANDBOOK: Design Data Hand Book**, K. Lingaiah, McGraw Hill, 2nd Ed.

1	**Title of the course** (L-T-P-C)	**Applied Thermodynamics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Introduction to the Course, General Scheme of things, Energy Resources, Heat Engines. Recap of I law for Closed and Open Systems. Classification of cycles as Open/Closed, Refrigeration/Power, Multi-component/ Single- component, Internal combustion/ external combustion, etc. Performance parameters: Network, thermal efficiency, heat rate, specific fuel consumption, work ratio, specific output, mean effective pressure, volumetric efficiency, COP, refrigeration effect. Carnot vs. other cycles. General stoichiometry and definition of terms (rich mixture, lean mixtures). Heat of formation, Heat of reaction, Calorific Value of fuel, Estimation methods for Calorific values, Exhaust Gas Analysis, Orsat Apparatus. Otto Cycles, Diesel Cycles, Air-standard cycles and Actual cycles, Dual cycle, p-theta diagram. Combustion and knocking in SI engine. Combustion and knocking in CI engine. Carburetion. Brayton cycle with explanation of various terms Modifications of Brayton cycle. Rankine cycle. Modifications to Rankine cycle. Feed Water Heaters and analysis. Moisture separators/ application of Rankine to Nuclear power plants. Vapour Compression and Reverse Brayton Cycles Vapour Absorption Cycles. Psychrometry. Reciprocating, rotary and centrifugal Compressors. Gas Power Cycles: Simple gas turbine cycle - single and twin shaft arrangements, intercooling, reheating, regeneration, closed cycles, optimal performance of various cycles, Ideal vs Real cycles; Jet Propulsion: turbojet, turboprop, turbofan, ramjet, thrust and propulsive efficiency; Rocket Propulsion; Direct Energy Conversion: thermionic and thermoelectric converters, photovoltaic generators, MHD generators, fuel cells.
4	**Texts/References**	1. Moran M. J. and H. N. Shapiro., Fundamentals of Engineering Thermodynamics, Third Edition, Wiley, New York, 1995. 2. Cengel Y. A. and Boles M. A., Thermodynamics: An Engineering Approach, McGraw Hill, 3rd Ed., 1998 3. Dossat R. J. and Horan T. J., Principles of Refrigeration, Pearson Education, 4th Indian Reprint, 2004. 4. Arora C. P., Refrigeration and Air-conditioning, Tata McGraw Hill, 2nd Ed., 2003. 5. H I H Saravana muttoo, G F C Rogers and H. Cohen, Gas Turbine Theory 4e, Pearson, 2003

1	**Title of the course** (L-T-P-C)	**Heat Transfer lab** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	1. Measurement of thermal conductivity of a composite material 2. Measurement of convective heat transfer coefficient 3. Transient heat conduction 4. Heat transfer through fins 5. Jet impinging 6. Boiling and Condensation 7. Critical heat flux measurement 8. Emissivity measurement 9. Heat flux meter calibration 10. Heat transfer in the tubular heat exchanger 11. Heat transfer by radiation
4	**Texts/References**	1. Incropera F. P. and Dewitt D. P., Fundamentals of Heat and Mass Transfer, 5th Ed., Wiley and Sons, New York, 2002. 2. Gayler J. F. W. and C. R Shotbolt, Metrology for Engineers, ELBS, 1990.

1	**Title of the course** (L-T-P-C)	**Data Analysis** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	The role of statistics. Graphical and numerical methods for describing and summarizing data. Probability. Population distributions. Sampling variability and sampling distributions. Estimation using a single sample. Hypothesis testing a single sample. Comparing two populations or treatments. Simple linear regression and correlation. Case studies.
4	**Texts/References**	**1.** Introduction to Probability and Statistics for Engineers and Scientists by Sheldon M. Ross, Elsevier, New Delhi, 3rd edition (Indian), 2014. **2.** Probability, Random Variables and Stochastic processes by Papoulis and Pillai, 4th Edition, Tata McGraw Hill, 2002. **3.** An Introduction to Probability Theory and Its Applications, Vol. 1, William Feller, 3rd edition, Wiley International, 1968.

1	**Title of the course** (L-T-P-C)	**Numerical Methods for Engineers** **3-0-0-6**
2	**Pre-requisite courses(s)**	-
3	**Course content**	**Interpolation by polynomials**, Lagrange Polynomials, Neville's algorithm, Newton forward and backward differences, divided differences, Hermite polynomials, Chebyshev polynomials, error of the interpolating polynomial, piecewise linear and cubic spline interpolation. (9 lectures) **Numerical integration**, trapezoidal rule, composite rules, Simpson's 1⁄3 and 38 rules, Romberg integration, error formulae. (6 lectures) **Solution of a nonlinear equation**, bisection and secant methods. False position method, Newton-Raphson method, fixed point iteration method, rate of convergence, Solution of a system of nonlinear equations (6 lectures) **Numerical Differentiation**, Taylor's series, Truncation errors, round-off errors, first-order differencing, forward, backward, and central differencing, second and higher-order methods, explicit, implicit, and semi-implicit time- integration (6 lectures) **Numerical solution of ordinary differential equations**, Euler, modified Euler, and Runge-Kutta methods, Adam-Bashforth multi-step methods, predictor-corrector methods, order of convergence (9 lectures) **Numerical solution of partial differential equations using** finite difference methods, numerical solutions of elliptic, parabolic, and hyperbolic equations. (6 lectures)
4	**Texts/References**	**Textbooks:** 1. Applied Numerical Analysis 7th Edition, Curtis F. Gerald, Patrick O. Wheatley, Pearson, 2007, ISBN: 978-8-13-171740-0 2. Numerical Analysis,. 9th Edition, R.L. Burden, J.D. Faires, Cengage Learning, Inc, 2010, ISBN: 978-0-53-873351-9 3. Numerical Methods Using Matlab, 4th edition, J.D. Mathews, K.D. Fink, Pearson Education India, 2015, ISBN: 978-9-33-254935-7 **References:** 1. Numerical Methods Using MATLAB, 4th edition, George Lindfield, John Penny, Academic Press, 2019, ISBN: 978-0-12-812256-3. 2. Python Programming and Numerical Methods: A Guide for Engineers and Scientists, 1st Edition, Q. Kong, T. Siauw, A. Bayen, Academic Press, 2020, ISBN: 978-0-12-819549-9

1	**Title of the course** (L-T-P-C)	**Manufacturing processes laboratory (0-0-3-3)**
2	**Pre-requisite courses(s)**	Manufacturing processes
3	**Course content**	**List of experiments:** 1. CNC milling programming 2. CNC turning programming 3. Surface Roughness testing 4. Eccentric Turning 5. Angle measurement using Sine bar 6. Chip Thickness measurement using microscope 7. Different type of drilling 8. Shaping 9. Green Sand moulding Casting process Solidification Study Digital Fabrication (3D printing)
4	**Texts/References**	• Val Marinov Manufacturing Process Design Laboratory Manual, Kendall/Hunt Publishing Company, ISBN 1465275312, 9781465275318 • R. K. Rajput A Textbook of Manufacturing Technology: Manufacturing Processes • Ghosh and A. K. Mallik, Manufacturing Science, Affiliated East West Press, 1985. HMT, Production Technology, Tata McGraw Hill, 1980. • J. Mcgeough, Advanced Methods of Machining, Chapman and Hall, 1988.

1	**Title of the course** (L-T-P-C)	**Economics (2-1-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Basic economic problems. resource constraints and Welfare maximizations. Nature of Economics: Positive and normative economics; Micro and macroeconomics, Basic concepts in economics. The role of the State in economic activity; market and government failures; New Economic Policy in India. Theory of utility and consumer choice. Theories of demand, supply and market equilibrium. Theories of firm, production and costs. Market structures. Perfect and imperfect competition, oligopoly, monopoly. An overview of macroeconomics, measurement and determination of national income. Consumption, savings, and investments. Commercial and central banking. Relationship between money, output and prices. Inflation - causes, consequences and remedies. International trade, foreign exchange and balance payments, stabilization policies : Monetary, Fiscal and Exchange rate policies.
4	**Texts/References**	**1.** P. A. Samuelson & W. D. Nordhaus, Economics, McGraw Hill, NY, 1995. **2.** A. Koutsoyiannis, Modern Microeconomics, Macmillan, 1975. R. Pindyck and D. L. Rubinfeld, Microeconomics, Macmillan publishing company, NY, 1989. **3.** R. J. Gordon, Macroeconomics 4th edition, Little Brown and Co., Boston, 1987. **4.** William F. Shughart II, The Organization of Industry, Richard D. Irwin, Illinois, 1990. **5.** R.S. Pindyck and D.L. Rubinfeld. Microeconomics The (7th Edition), Pearson Prentice Hall, New Jersey, 2009. **6.** R. Dornbusch, S. Fischer, and R. Startz. Macroeconomics (9th Edition), McGraw-Hill Inc. New York, 2004.

1	**Title of the course** (L-T-P-C)	**Mechanical Measurements Lab (0-0-3-3)**
2	**Pre-requisite courses(s)**	Exposure to Mechanical Measurements
3	**Course content**	**List of experiments:** • Study of the output characteristics of RC circuit for various inputs (Sine wave, square wave and step input) • Study of the output characteristics of LRC circuit for various inputs (Sine wave, square wave and step input) • Study of the working of orificemeter, venturimenter and rotameter • Steady state and transient calibration of temperature sensors (thermocouple and RTD) • Steady state and transient calibration of pressure sensors • Measurement of rotational speed by encoder, infrared sensor and stroboscope • Measurement of stress/strain through strain gage rosettes • Utility of operational amplifiers for generation of square wave, differentiator and integrator • Study of Analog to digital converter and digital to analog converter
4	**Texts/References**	1. E.O. Doebelin, Measurement systems: Application and Design, Fourth Ed., 1990, McGrawHill. 2. Richard S. Figliola, Donald E. Beasley, Theory and Design for Mechanical Measurements, John Wiley and Sons.