TECHNO INDIA UNIVERSITY
WESTBENGAL

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Curriculum and Syllabus for 4-Year B.Tech. (ME)

Semester-3

Course Code	Course Title	Contact Hrs. / Week			Credit
		L	T	P	
Theory					
TIUSD-301	Career Advancement & Skill Development-III	2	1	0	3
TIUMT	Mechatronics	3	0	0	3
TIUXXXX	Computational Fluid Dynamics	2	0	0	2
TIUHS-304	Engineering Economics and Costing	2	1	0	3
TIUME-301	Fluid Mechanics-I	3	1	0	4
TIUME-302	Thermodynamics-I	2	1	0	3
TIUYYYYY	Soft Computing and Introduction of Matlab	3	0	0	3
Practical					
TIUME-391	Workshop Process-II	0	0	3	2
TIUME-392	Fluid Mechanics Laboratory	0	0	3	2
Sessional					
TIUCSL-381	Entrepreneurship Skill Development-III	0	0	3	2
Total Credits					27

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Syllabus

Mechatronics

L-T-P:3-0-0 **Credit: 3**

Introduction to Mechatronics: Mechatronic system, measurement systems, control systems and response of systems. Measurement systems : static characteristics

Flow measurement: Rotameter, anemometer and comparison of characteristics of different flow meters.

Pressure measurement: McLeod gauges, comparison of characteristics of different pressure measuring devices. Level measurement, strain measurement – strain gauges, theory, types, strain gauge circuits, temperature compensation, load cells.

Temperature measurement: RTD, Thermocouples, pyrometers. Displacement and position sensors: LVDT, optical encoders – transnational and rotary

System Models: Mathematical models, introduction to mechanical, electrical, fluid and thermal systems. Rotational and transnational systems, electro – mechanical, hydraulic – mechanical systems. Control Systems: open loop, closed loop systems, transfer functions, feedback and feed forward control systems and their applications. System Response, modelling of dynamic systems, dynamic response of first order, second order systems to step, ramp and impulse inputs. Transfer functions, Bode plots, stability of systems. Control Actions: On – Off, proportional, proportional + integral, P + D. Proportional + integral + derivative control actions.

Control systems Components: Transmitters, controllers/ pressure/ flow/ level/ temperature/ limit/ proximimity/ magnetic switches and relays. Analog signal processing, introduction, principle, passive circuits, operational amplifiers -characteristics and specifications. Op–amp circuits for inverting, non-inverting, difference amplifiers, integrator, differentiator, comparator and sample and hold applications (no analytical treatment.) Digital Signal Processing: Timing diagrams, sequential logic, flip flops, D flip flop, JK flip flop, master slave flip flop. Applications of flip flop, decade counters, Schmitt trigger, 555 timers. A/D and D/A converters. Programming Logic Controllers: Relay logic, basic structure, input/output processing, timers, internal relays and counters, shift resisters, ladder diagram and programming, selection of PLCs, introduction to microcontroller

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Reference Books / Material:

1. Musa Jouaneh, "Fundamentals of Mechatronics", Cengage Learning, 1st edition.

2. GBolton W., "Mechatronics – Electronics Control Systems in Mechanical and Electrical Engineering", Pearson – Education (Singapore) Pt. Ltd., 5th editions.

3. P.C. Pandey, and H.S. Shan, "Modern Machining Processes", Tata McGraw-Hill Publishing Co. Ltd, New Delhi, 1980

Computational Fluid Dynamics

L-T-P:3-0-0 **Credit:3**

Equations of fluid dynamics: Basic concepts Eulerarian and Lagrangian methods of describing fluid flow motion, acceleration and deformation of fluid particle, vorticity. Laws governing fluid motion, continuity, Navier – stokes & energy equations. Boundary layer equation, Euler equations, potential flow equations, Bernoulli's equation and vorticity transport equation. Initial and boundary conditions. Classification of equation of motions – hyperbolic, parabolic, elliptic.

Mathematical Preliminaries: Numerical integration. Review of linear algebra, solution of simultaneous linear algebraic equations – matrix inversion, solvers – direct methods, elimination methods, ill conditioned systems; Gauss- Sidel method, successive over relaxation method.

Grid Generation: Transformation of coordinates. General principles of grid generation – structured girids in two and three dimensions, algebraic grid generation, differential equations based grid generation; Elliptic grid generation, algorithm, Grid clustering, Grid refinement, Adaptive grids, Moving grids. Algorithms, CAD interfaces to grid generation. Techniques for complex and large problems: Multi block methods

Finite difference discretization: Elementary finite difference coefficients, basic aspects of finite difference equations, consistency, explicit and implicit methods, errors and stability analysis. Stability of elliptic and hyperbolic equations. Fundamentals of fluid flow modeling-conservative property, upwind scheme, transporting property, higher order upwinding. Finite difference applications in heat transfer – conduction, convection.

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Finite Volume Method: Introduction, Application of FVM in diffusion and convection problems, NS equations – staggered grid, collocated grid, SIMPLE algorithm. Solution of discretised equations using TDMA. Finite volume methods for unsteady problems – explicit schemes, implicit schemes. Finite Element Method: Introduction. Weighted residual and variational formulations. Interpolation in one-dimensional and two-dimensional cases. Application of FEM to ID and 2D problems in fluid flow and heat transfer.

Introduction of Ansys Fluent: The set of problems designed to provide the student with the necessary tools for using sophisticated commercial Ansys fluent CFD software. Analyze the tasks through a series of increasingly complex flow and heat transfer simulations, requiring an understanding of the basic theory of computational fluid dynamics (CFD).

Reference Books/Material:

1. Ferziger J. H., Springer P.M, "Computational Methods for fluid Dynamics", Verlag Berlin
2. Anderson J. D. JR, "Computational fluid Dynamics", McGraw Hill Inc, 1995
3. Patankar S. P, "Numerical Heat Transfer & Fluid flow"
4. Sunderarajan M.K., "Computational Fluid Flow and Heat Transfer", 2nd Ed, Narosa Publishing

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Air Pollution Control:

Particulate emission control by mechanical separation and electrostatic precipitation, wet gas scrubbing, gaseous emission control by absorption and adsorption, Design of cyclones, ESP, fabric filters andabsorbers.

Water PollutionControl:

Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation.

Biological Treatment:

Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge and lagoons, aeration systems, sludge separation and drying.

Solids Disposal:

Solids waste disposal - composting, landfill, briquetting / gasification and incineration.

Engineering Economics and Costing

TIUHS-304

L-T-P:2-1-0 **Credit:3**

Introduction: engineering economy and its importance, want activity – satisfaction of wants. Resource planning and distribution in economic systems – Laissez.

Factors of production: the concept of optimum, laws of return; demand - elasticity of demand – demand- estimation market research; supply and industrial costs.

Money-value of money; quantity theory; inflation anddeflation.

Banking: role of commercial banks; credit and its importance in industrial functioning - source of finance; Reserve bank of India and its functions.

Business management and organisation: proprietorship, partnership and joint-stock company – theirformation.

Finance and management: elements of taxation, insurance, business combinations, basic principles of management.

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Industrial record-keeping: double entry system, journal, ledger, trial balance, cash book, preparation of final accounts – trading, profit and loss account, balance sheet, simple study of balance.

Industrial costs: classification – material cost control, labour cost control and overhead cost control; depreciation and replacement studies.

Financial control: ratio analysis and their interpretation for industrial control; budgetary control.

Value analysis and project evaluation: pay back, DCF, IRR.

Fluid Mechanics-I

TIUME-305

L-T-P:3-1-0 **Credit:4**

Introduction: Definition of fluid, continuum hypothesis, different properties of fluid, classification (like Newtonian/non-Newtonian, ideal/real etc.).

Fluid Statics: pressure at a point, Pascal's law, variation of pressure within a static fluid – equation of hydrostatic pressure distribution, variation of properties in static atmosphere; measurement of pressure; hydrostatic thrust on plane and curved surfaces; buoyancy, stability of submerged and floating bodies.

Fluid Kinematics: preliminaries of Eulerian and Lagrangian description of fluid flow; velocity and acceleration of fluid particles in rectilinear and curvilinear co-ordinates; different types of flow – steady and unsteady flow, uniform and non-uniform flow, one, two and three dimensional flow, rotational and irrotational flow, laminar and turbulent flow; stream line, streak line and path line; stream filament and stream tube; principle of conservation of mass – equation of continuity for a stream tube and for unsteady three dimensional flow; deformation of a fluid particle – linear and angular deformation and rotation; vortexmotion.

Fluid Dynamics: principle of conservation of linear momentum, Euler's equation of motion along a streamline and for unsteady three dimensional flow; derivation of Bernoulli's equation and physical significance of different terms; applications of Bernoulli's equation in flow measurement devices: stagnation tube, pitot tube, venturi meter, orificemeter.

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Application of Linear Momentum to Control Volume: linear momentum equation; analysis of force exerted by a fluid stream on a solid boundary – jet impingement, thrust on pipe bendsetc.

Application of Angular Momentum to Control Volume: Principle of Conservation of Angular Momentum and its applications.

Characteristics of Laminar and Turbulent Flow: Reynolds experiment, critical Reynolds number; laminar flow through pipe – Hagen Poiseuille equation.

Flow through Closed Conduits: Darcy Weisbach equation, friction factor of closed conduits, flow through noncircular ducts, Moody's diagram and its use; minor losses – at sudden expansion, at sudden contraction, at bends, at valves and fittings etc.; analysis of simple pipe networkproblems.

Recommended books

1. Fluid Mechanics by F.M. White, McGraw Hill Education (India) PrivateLimited.

2. Fluid Mechanics by R.W. Fox, A.T. McDonald and P.J. Pritchard,Wiley.

3. Introduction to Fluid Mechanics and Fluid Machines by S.K. Som, G. Biswas and S. Chakraborty, McGraw Hill Education (India) Private Limited.

4. Textbook of Fluid Mechanics and Hydraulic Machines by SukumarPati, McGraw Hill Education (India) PrivateLimited.

5. Fluid Mechanics: Including Hydraulic Machines by A.K.Jain,Khanna.

Thermodynamics-I

TIUME-306

L-T-P:2-1-0 **Credit: 3**

Introduction: Microscopic and Macroscopic viewpoints in thermodynamics. Fundamental concepts of System, Control volume, State, Property, Equilibrium, Processes etc.

The Zeroth law of thermodynamics: Thermal equilibrium. Temperature. Principle of thermometry. International practical temperature scale.

Energy: Different energy forms-stored energy, energy in transition. Definitions.

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Properties of pure substances: Thermodynamics properties of pure substances in solid, liquid and vapour phases. P-V-T behaviour simple compressible substances. Phase rule. State postulate. Thermodynamic property tables and charts. Ideal and Real gases. Equations of state. Compressibility factor. Generalised compressibility chart. Problems.

The First law of thermodynamics: The first law of thermodynamics for systems. Corollaries. Internal energy and enthalpy. First law for control volumes. Steady state and unsteady state applications. Process calculations for ideal and real gases using equations, tables and charts. Problems.

The Second law of thermodynamics: Limitations of the first law of thermodynamics. Steadily operating systems−Heat engine, Heat Pump and refrigerator. Thermal efficiency. Coefficient of Performance. Carnot cycle. Statements of the second law of thermodynamics. Equivalence of Kelvin Planck and Clausius statements of the second law of thermodynamics. Corollaries. Entropy. Reversibility and Irreversibility. Second law analysis of control volume. Entropy generation. Reversible work. Availability. Irreversibility. Problems.

Thermodynamic relationships: Tds relations. Maxwell equations. Clapeyron equation, ClausiusClapeyron equation. Joule-Thompson coefficient. Compressibility and expansion coefficient. Problems.

Recommended books

1. Thermodynamics: An Engineering Approach by Y.A. Cengel and M.A. Boles, McGraw Hill Education (India) PrivateLimited.

2. Fundamentals of Thermodynamics by C. Borgnakke and R.E. Sonntag,Wiley.

3. Thermodynamics by M.C. Potter, C.W. Somerton and SukumarPati, Tata McGraw Hill Education.

4. Engineering Thermodynamics by P.K. Nag, McGraw Hill Education (India) Private Limited.

5. Basic Engineering Thermodynamics by R. Joel, PearsonEducation.

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Soft Computing and Introduction of Matlab

L-T-P:3-0-0 **Credit:3**

Introduction to Soft Computing: Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, Fuzzy Computing, Neural Computing, Genetic Algorithms, Associative Memory, Adaptive Resonance Theory, Classification, Clustering, Bayesian Networks, Probabilistic reasoning, applications of soft computing**.**

Fundamentals of Artificial Neural Network: Introduction, Model of Artificial Neuron, Architectures, Learning Methods, Deep learning, Taxonomy of ANN Systems, Single-Layer ANN System, Supervised Learning Neural Networks, Perceptrons, Adaline, Backpropagation, MutilayerPerceptrons Applications of ANN in research.

Fuzzy Set Theory & Fuzzy Systems:Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, introduction & features of membership functions, Extension Principle, Fuzzy If-Then Rules, Fuzzy Inference Systems, Sugeno Fuzzy Models, Fuzzification, Defuzzification, Applications.

Genetic Algorithms and Hybrid Systems: Fundamentals of Genetic Algorithms, basic concepts, working principle, encoding, fitness function, reproduction, Genetic modeling, Hybrid Systems: Integration of Neural Networks, Fuzzy Logic and Genetic Algorithms, Research orientation of soft computing techniques.

Machine Learning: Machine Learning Techniques – Machine Learning Using Neural Network – Genetic Algorithms (GA). Applications of GA in Machine Learning - Machine Learning Approach to Knowledge Acquisition. Support Vector Machines for Learning – Linear Learning Machines – Support Vector Classification – Support Vector Regression - Applications.

Introduction of Matlab: Introduction with the basic tools of MATLAB. Solving different types of problems of ANN, Fuzzy Logic, GA with the help of MATLAB.

Reference Books/Material:

1.J.S.R.Jang, C.T.Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI, 2004, Pearson Education 2004.
2. Simon O. Haykin “Artificial Neural Network”, PHI, 2003
3. Elaine Rich, Kevin Knight, Artificial Intelligence TMH, 2009.

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4. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.

Workshop Process-II

TIUME-391

L-T-P:0-0-3 **Credit:2**

Selected jobs for practicing Machining: facing, drilling, boring, turning-straight, taper, eccentric, grooving, thread cutting, forming etc. in centre lathes surfacing, making regular polygons and cutting gear teeth in milling machines gear teeth generation in gear shaping machine and hobbing machine part programming and machining in CNC machining center setting and operation of EDM finishing by grinding Measurement of dimensions, forms and surface finish of machined products. Foundry Technology: The practice-cum-experiments to impart an understanding on the various steps in metal casting including pattern design, sand preparation, moulding and melting: (a) Study on various types of patterns and pattern materials (b) Layout of a pattern (a) Study on sand preparation (b) Study on variation of mould properties with different moulding machines Study on the effect of moulding parameters on the properties of moulds Study of melting furnace and melting of aluminium alloys including degasification. Welding: Practical classes designed with the objective of imparting hands on training as well as understanding of welding technology. Suggested exercises are: Understanding of welding machine characteristics and controls, electrode specifications, selection of electrode size and current, laying of beads. Study of joint configurationandspecification,requirededgepreparations;practiceonpreparingbothside

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square groove butt weld; grinding of weld crown to make bead flush with plate surface; visual inspection of defects and reporting. Study of various types of oxy-acetylene flames; practice on flame adjustment, gas welding/brazing. Study and practice on submerged arc welding/ MIG welding.

Fluid Mechanics Laboratory

TIUME-392

L-T-P:0-0-3 **Credit:2**

Experiments on Basic Concepts:

Verification of Bernoulli's Equation.

Reynolds Experiment.

Verification of Stokes' Law.

Experiments on Pipes:

Calibration of Venturi Meter.

Calibration of Orifice Meter.

Friction Losses in Pipes.

Experiments on Open Channels:

Calibration of Triangular Notch.

Calibration of Rectangular Notch.

Calibration of Trapezoidal Notch.

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Curriculum and Syllabus for 4-Year B.Tech. (ME)

Semester-4

Course Code	Course Title	Contact Hrs. / Week			Credit
		L	T	P	
Theory					
TIUSD-401	Career Advancement & Skill Development-IV	2	1	0	3
TIUMTH-402	Probability and Statistics	3	0	0	3
TIUME-401	Fluid Mechanics-II	3	1	0	4
TIUME-402	Thermodynamics-II	2	1	0	3
TIUME-403	Mechanics of Materials	2	1	0	3
TIUME-404	Casting, Forming and Welding	2	1	0	3
TIUABCDE	ROBOTICS ENGINEERING AND APPLICATIONS	3	0	0	3
Practical					
TIUME-491	Machine Drawing Practice	0	0	3	2
TIUME-492	Applied Mechanics Laboratory	0	0	3	2
Sessional					
TIUCSL-481	Entrepreneurship Skill Development-IV	0	0	3	2
Total Credits					28

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Syllabus

Probability and Statistics

TIUMTH-402

L-T-P:3-0-0 **Credit: 3**

Probability: Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence.

Random Variables: Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, moment generating function, Chebyshev'sinequality.

Special Distributions: Discrete uniform, Binomial, Geometric, Poisson, Exponential, Gamma, Normal distributions. Functions of a RandomVariable.

Joint Distributions: Joint, marginal and conditional distributions, product moments, correlation, independence of random variables, bivariate normal distribution.

Sampling Distributions: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions.

Fluid Mechanics-II

TIUME-403

L-T-P:3-1-0 **Credit:3**

Turbulent Flow: Basic concept of turbulence and turbulent flow.

Dynamics of Viscous Flows: Equation of motion for viscous flow – two-dimensional laminar flow between flat parallel plates andannulus.

Boundary Layer Theory: concept of boundary layer, boundary layer thickness, displacement thickness, momentum thickness, growth of boundary layer; Prandtl's boundary layer equations, Von Karman's momentum integral equation for a boundary layer,skin

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friction drag coefficient for laminar and turbulent boundary layer; boundary layer in pipe flow, friction velocity; separation of boundary layer, form drag, method of drag reduction; lift and drag on submerged bodies, aerofoils, stalling of aerofoils.

Compressible Flow: review of thermodynamic principles for perfect gases, adiabatic and isentropic relations; steady flow energy equation; speed of propagation of a small disturbance through a compressible fluid, sonic velocity, Mach number, Mach cone and Mach wave; isentropic flow, stagnation properties of a compressible flow, isentropic pressure, temperature and density ratios; compressibility correction factor in the measurement of air speed; area – velocity relationship for compressible flow through a variable area duct, mass flow rate through a duct, critical condition and choking; flow through convergent-divergent nozzle, over expansion and under expansion, performance of propulsive nozzles; normal shock, normal shock relations.

Flow of Ideal Fluids: rotation of a fluid particle, vorticity, rotational and irrotational motion; velocity potential function, circulation, stream function, flow net; governing equation for two dimensional irrotational motion, simple two dimensional irrotational flows like uniform flow, plane source, plane sink etc.; superposition of simple irrotational flows, combination of a source and a sink, combination of uniform flow and a source (Rankine half body), combination of a uniform flow and a source-sink pair (Rankine oval), doublet and its strength, superimposition of an uniform flow and a doublet (flow past a stationary cylinder); vortex motion –free and forced vortex, strength of a vortex; combination of a uniform flow, doublet and a free vortex (flow over a rotating cylinder), Magnus effect, Kutta-Joukowski's theorem.

Principles of Physical Similarity and Dimensional Analysis: Concept and types of physical similarity; Dimensional analysis and Buckingham Pi theorem; similarity and model studies.

Recommended books

1. Fluid Mechanics by F.M. White, McGraw Hill Education (India) PrivateLimited.

2. Fluid Mechanics by R.W. Fox, A.T. McDonald and P.J. Pritchard,Wiley.

3. Introduction to Fluid Mechanics and Fluid Machines by S.K. Som, G. Biswas and S. Chakraborty, McGraw Hill Education (India) Private Limited.

4. Textbook of Fluid Mechanics and Hydraulic Machines by SukumarPati, McGraw Hill Education (India) PrivateLimited.

5. Fluid Mechanics: Including Hydraulic Machines by A.K. Jain,Khanna.

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Thermodynamics-II

TIUME-404

L-T-P:2-1-0 **Credit: 3**

Vapour Power Cycles: Carnot cycle, Rankine cycle, Reheat cycle, Regenarative cycles with open and closed Feed Water Heaters. Availability analysis of cycles.

Gas Power Cycles: Air Standard Cycles− Otto, Diesel, Dual, Stirling, Brayton cycles. Gas turbine cycles with intercooling, reheating and regeneration. Use of air tables for gas power cycle analysis.

Refrigeration Cycles: Vapour Compression Refrigeration cycles, Vapour Absorption Refrigeration cycles, P-h chart, Air Refrigeration cycle.

Cogeneration and Combined Cycles: Binary vapour cycle, Cogenerative cycles, Combined Gas Vapour cycles.

Thermodynamics of Mixtures: Mixture of ideal gases, Mixture of ideal gas and vapour, Laws of thermodynamics for gas-vapour mixtures, Psychrometry, Thermodynamic analysis of psychrometric processes, Thermodynamic relations for multi-componentsystems.

Fuels and Combustion: Fuels, Air requirements, Analysis of Combustion products, enthalpy of formation, Calculation of enthalpy of combustion and adiabatic flame temperature, HHV and LHV of fuels, Second law analysis of chemically reacting systems.

Chemical and Phase Equilibrium: Criteria for equilibrium, Equilibrium between multi-component and multi-phase systems, Gibbs phase rule, Metastable equilibrium, Chemical equilibrium, Determination of equilibrium composition and equilibrium temperature in chemically reacting systems. Ionization.

Recommended Books:

1. Thermodynamics: An Engineering Approach by Y.A. Cengel and M.A. Boles, McGraw Hill Education (India) PrivateLimited.

2. Fundamentals of Thermodynamics by C. Borgnakke and R.E. Sonntag,Wiley.

3. Thermodynamics by M.C. Potter, C.W. Somerton and SukumarPati, Tata McGraw Hill Education.

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4. Engineering Thermodynamics by P.K. Nag, McGraw Hill Education (India) Private Limited.

5. Basic Engineering Thermodynamics by R. Joel, PearsonEducation.

Mechanics of Materials

TIUME-405

L-T-P:2-1-0 **Credit: 3**

Concept of stress and strain : Normal stress, shear stress, state of stress at a point, ultimate strength, allowable stress, factor of safety; normal strain, shear strain, Hooke's law, Poisson's ratio, generalized Hooke's law; analysis of axially loaded members.

Torsion: Torsion of cylindrical bars, torsional stress, modulus of rigidity and deformation, torsion of closely coiled helical springs.

Beam Bending: Shear and moment in beams; load, shear and moment relationship; shear and moment diagrams; flexure formula; shear stress in beams; differential equation of the elastic curve, deflection of beams, direct integration method, moment area method, method of superposition, Castigliano's theorems for statically determinate and indeterminate beams.

Analysis of thin-walled pressure vessels and thick cylinders

Transformation of stress and strain: Transformation of stress and strain, principal stresses, principal strains, Mohr's circle for stress and strain.

Combined loading: Axial and torsional; axial and bending; axial, torsional and bending.

Columns: Buckling of slender columns, Euler bucking load for different end conditions.

Recommended Books:

1. Elements of Strength of Materials by S.P. Timoshenko and D.H. Young, East WestPress

2. Strength of Materials by D. Nag and A. Chanda,Wiley-India.

3. Mechanics of Materials by R.C. Hibbeler, PearsonEducation.

4. Mechanics of Materials by F.P. Beer, E.R. Johnston, J.T. Dewolf and D.F. Mazurek, McGraw Hill Education (India) PrivateLimited.

5. Strength of Materials by S. Ramamrutham, R. Narayanan, DhanpatRaiPublications.

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Casting, Forming and Welding

TIUME-406

L-T-P:2-1-0 **Credit:3**

Casting: The basic idea, patterns, moulding materials - properties and mould making; various casting processes; cores, gating and risering; foundry furnaces; special casting methods; casting defects, inspection and repair.

Forming: hot and cold working; rolling; forging and forging dies; drawing, deep drawing; extrusion; bending; coining, hubbing, embossing, thread rolling, tube piercing etc.; HERF processes; press working etc.; Defects in metal working.

Welding and joining processes: classifications; gas welding; flame cutting; arc welding- electric arc welding -theory of heat generation, power source selection, arc structure, arc characteristic; metal transfer in arc welding; different are welding processes- SMAW, Carbon Arc Welding, Atomic Hydrogen Welding, MIG, TIG, CO_2- MIG, FCAW; other welding processes like ESW, EBW, PAW, USW, Explosion Welding etc.; welding consumables; characteristics of weldment; welding defects and inspection; welding of non-traditional materials; Introduction to newer processes of welding; soldering and brazing.

Recommended Books:

1. Manufacturing Technology: Foundry, Forming and Welding by P.N. Rao, Tata Mcgraw Hill Education Private Limited.

2. Manufacturing Processes for Engineering Materials by S. Kalpakjian and S.R. Schmid, PearsonEducation.

3. Welding and Welding Technology by R.L. Little, McGraw-Hill Education (India) Pvt. Limited.

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ROBOTICS ENGINEERING AND APPLICATIONS

L-T-P:3-0-0 **Credit:3**

INTRODUCTION: Basic concepts - Robot anatomy - Manipulators - kinematics: Forward and inverse kinematics - Precision movement, robot specifications and Work volume, Types of Robot drives - Basic robot motions - Point to point control, continuous path control.

END EFFECTORS: End effectors - classification – mechanical, magnetic, vacuum and adhesive gripper - gripper force analysis and design. Robot control - unit control system concept – servo and non-servo control of robot joints, adaptive and optimal control.

SENSORS: Sensor devices, Types of sensors - contact, position and displacement sensors, Force and torque sensors - Proximity and range sensors - acoustic sensors - Robot vision systems - Sensing and digitizing - Image processing and analysis.

ROBOT PROGRAMMING: Robot language classification – programming methods - off and on line programming - Lead through method - Teach pendent method - VAL systems and language, simple program.

INDUSTRIAL APPLICATIONS: Application of robots - Material handling - Machine loading and unloading, Assembly, Inspection, Welding, Spray painting, Mobile robot, Microbots – Recent developments in robotics- safety considerations

Reference Books/Material:

1. Deb, S. R., Robotics technology and flexible automation, Tata McGraw Hill publishing company limited, New Delhi, 1994
2. Mikell P. Groover, Industrial Robotics Technology Programming and Applications, McGraw Hill Co., Singapore, 1995
3. Klafter, R. D, Chmielewski, T. A. and Noggins, Robot Engineering : An Integrated Approach, Prentice Hall of India Pvt. Ltd., New Delhi, 1994.
4. Fu, K. S., Gonzalez, R. C., & Lee, C.S.G., Robotics control, sensing, vision and intelligence, McGraw Hill Book Co., Singapore, 1987.
5. Craig, J. J., Introduction to Robotics mechanics and control, Addison-Wesley, London, 1999.

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Machine Drawing Practice

TIUME-491

L-T-P:0-0-3 **Credit:2**

Thread profile, nuts & bolts, stud, riveted joint, welded joint, hooks/cotter/knuckle joint, pulley, shaft coupling (rigid/flexible), stuffing box, Plummer Block.

Applied Mechanics Laboratory

TIUME-492

L-T-P:0-0-3 **Credit:2**

Simple experiments of Mechanics and Strength of Materials – Moment of inertia of flywheel, spring testing, tension, torsion, bending tests, Hardness tests, impact tests etc.

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Curriculum and Syllabus for 4-Year B.Tech. (ME)

Semester-5

Course Code	Course Title	Contact Hrs. / Week			Credit
		L	T	P	
Theory					
TIUSD-501	Career Advancement & Skill Development-V	2	1	0	3
TIUME-501	Kinematics of Machines	2	1	0	3
TIUME-502	Heat Transfer	3	1	0	4
TIUME-503	Metal Cutting and Machine Tools	2	1	0	3
TIUME-504	Material Science and Engineering	2	1	0	3
TIUME-505	Fluid Machinery-I	2	1	0	3
Practical					
TIUME-vvv	ENGINEERING GRAPHICS USING SOLIDWORKS	0	0	3	2
TIUME-592	Heat Transfer Laboratory	0	0	3	2
TIUME-bbb	COMPUTER AIDED MACHINE DRAWING (Using SolidWorks)	0	0	3	2
Sessional					
TIUCSL-581	Entrepreneurship Skill Development-V	0	0	3	2
Total Credits					27

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Syllabus

Kinematics of Machines

TIUME-502

L-T-P:2-1-0 **Credit: 3**

Review of velocity analysis: (resolution & composition, instantaneous axis and relative velocity methods) and acceleration analysis (graphical & analytical methods), Kennedy's theorem, analytical treatment by using complex notation, Lagrangian co-ordinates.

Linkage: 4-bar linkage, space linkage, Freudenstein equation, crank & rocker mechanism, drag link mechanism, non-parallel crank linkage, automobile steering mechanism, slider-crank mechanism, swinging block mechanism, oscillating arm quick return mechanism, icicles linkage, elliptic trammel, toggle mechanism, straight line mechanism, pantograph, universal joint, etc.

Transmission of motion by direct contact: pitch point, angle of action, pressure angle, conjugate curves.

Bodies in pure rolling contact.

Cam & follower: plate cam, cylindrical cam – displacement, velocity & acceleration diagram, analytical treatment in the design of different types of cams.

Gears: Law governing profile of gear tooth, analysis of tooth profile foe circular and non-circular gears for fixed centre distance, interference, minimum no. of teeth, gear tooth of involute & cycloid profile, spur gear, bevel gear, rack & pinion, worm gear.

Gear train: differential gear train, epicyclic gear train, bevel gear differential of automobile.

Belt drive: open & cross belt, quarter twist belt, stepped pulley, equal stepped pulley, guide pulley, crowning of pulley.

Chain drive. Differential screw, Compound screw.

Geneva wheel mechanism, intermittent motion from continuous motion.

Recommended books

1. Theory of Machines by S.S. Rattan, McGraw Hill Education (India) PrivateLimited.

2. Theory of Machines: Kinematics and Dynamics by Sadhu Singh, PearsonEducation.

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3. Theory of Machines (Kinematics) by V. Ravi,PHI.

4. Theory of Machines by R.S. Khurmi and J.K. Gupta, S.Chand.

5. Theory of Mechanisms and Machines by A. Ghosh and A.K. Mallik, East-WestPress.

Heat Transfer

TIUME-503

L-T-P:3-1-0 **Credit:4**

Introduction: Heat and Thermodynamics. Modes of heat transfer. Combined heat transfer processes.

Conduction: Fourier law of heat conduction for isotropic material. Thermal conductivity. Derivation of general heat conduction equation. Non-dimensionalisation - thermal diffusivity and Fourier number. Types of boundary conditions. Solution of steady one dimensional conduction problem with and without heat generation. Analogy with electrical circuits. Critical thickness of insulation. Fins-rectangular and pin fins. Fin effectiveness and efficiency. Lumped parameter approach and significance of time constant. Biot number. Solution of 1-D transient heat conduction equation without generation using productsolution.

Radiation: Physical mechanism of thermal radiation. Laws of radiation. Definition of black body, emissive power, radiation intensity, reflectivity,transmissivity. Radiosity and irradiation. Radiation exchange between black bodies Concept of grey surface. Exchange between grey-diffuse-isotropic surfaces by radiation network method. Radiation shielding.

Convection: Introduction. Newton's law of cooling and significance of heat transfer coefficient. Momentum and energy equation in two-dimensions. Non-dimensionalisation and significance of non-dimensional quantities. Scale analysis for flow over flat-plate. Velocity and thermal boundary layer thickness by integral method. Natural convection-effect of coupling on the conservation equation. One dimensional solution for Couette and Poiseuille flow. Concept of developing and developed flow. Correlations in forced convection for external and internal flows. Natural convection over a vertical flat-plate.

Heat exchangers: Types of heat exchangers. Introduction to LMTD. Correction factor. Fouling factor. Effectiveness-NTU method for heat exchangers, rating and sizing.

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Recommended Books:

1. PrinciplesofHeatandMassTransferbyF.P.Incropera,D.P.Dewitt,T.L.Bergmanand A.S. Lavine, Wiley India Pvt. Ltd.

2. Heat and Mass Transfer by Y.A. Cengel and A.J. Ghajar, McGraw Hill Education (India) Private Limited.

3. Heat and Mass Transfer by P.K. Nag, McGraw Hill Education (India) PrivateLimited.

4. Heat Transfer by J.P. Holman, McGraw Hill Education (India) PrivateLimited.

5. Fundamentals of Heat and Mass Transfer by M. Thirumaleshwar, PearsonIndia.

Metal Cutting and Machine Tools

TIUME-504

L-T-P:2-1-0 **Credit:3**

Theory of metal cutting: tool geometry, specification, conversion and selection; basic mechanisms and geometry of chip formation of orthogonal cutting, continuous and discontinuous chips, built up edge; mechanics of metal cutting, theory, measurement of shear angle; tool dynamometer; thermal aspects of metal cutting; weld theory of friction and action of metal cutting fluids, tool wear and tool life; economics of machining.

Machine tool: features of construction; layout of speed for various machine tool drives; introduction to hydraulic and electric drives; design of gear boxes for speed and feed changes; rigidity and vibrationanalysis.

Numerical control machine tools: basic concepts, field of applications, coordinate system and machine motions, types of NC systems, MCU and other components, NC part programming- manual and computer assisted; engineering analysis; CNC, DNC.

Basic concepts of open loop, closed loop and adaptive control systems.

Recommended Books:

1. Manufacturing Technology: Metal Cutting and Machine Tools by P.N. Rao, McGraw Hill Education (India) PrivateLimited.

2. A Course in Workshop Technology Vol. 2 by B.S. Raghuwanshi, DhanpatRai&Co.

3. Elements of Workshop Technology Vol. 2 by S.K. Hajra Choudhury, A.K. Hajra Choudhury and Nirjhar Roy, MediaPromoters.

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Material Science and Engineering

TIUME-505

L-T-P:2-1-0 **Credit: 3**

Structure: Crystal structure of materials, crystal systems, unit cells and space lattices, miller indices of planes and directions, packing geometry in metallic, ionic and covalent solids. Imperfections in crystalline solids and their role in influencing various properties.

Diffusion: Fick's laws and application of diffusion in sintering, doping of semiconductors and surface hardening ofmetals.

Mechanical Properties: stress-strain diagrams of metallic, modulus of elasticity, yield strength, tensile strength, toughness, elongation, plastic deformation, viscoelasticity, hardness, impact strength, creep, fatigue, ductile and brittlefracture.

Electronic Properties: Concept of energy band diagram for materials – conductors, semiconductors and insulators, electrical conductivity effect of temperature on conductivity, intrinsic and extrinsic semiconductors, dielectric properties.

Metals and Alloys: Solid solutions, solubility limit, phase rule, binary phase diagrams, intermediate phases, intermetallic compounds, iron carbide phase diagram, heat treatment of steels; cold and hot working of metals; recovery, recrystallization and grain growth; microstructure, properties and applications of ferrous and non-ferrous alloys.

Ceramics: Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: Classification, polymerization, structure and properties, additives for polymer products, processing and applications.

Composites: Powder Metallurgy; Properties and applications of various composites.

Introduction to Advanced Materials and Tools: Smart materials, exhibiting ferroelectric, piezoelectric, optoelectric, nanomaterials, synthesis, properties and applications, biomaterials, superalloys, shape memory alloys. Materials characterization techniques.

Environmental Degradation: Corrosion and oxidation of materials, prevention.

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Recommended Books:

1. Callister's Materials Science and Engineering by R. Balasubramaniam,Wiley.

2. Material Science and Metallurgy by U.C. Jindal, PearsonEducation.

3. Materials Science by M.S. Vijaya and G. Rangarajan, McGraw Hill Education (India) Private Limited.

4. Materials Science and Engineering: A First Course by V. Raghavan,PHI.

FLUID MACHINERY-I

TIUME-506

L-T-P:2-1-0 **Credit:3**

Introduction: Definition, Classification and Application of fluid machines.

Turbomachines: Classification and constructional Features: Incompressible and compressible flow machines, Pump, Turbines and Compressor. Radial, axial and mixed flow type machines; Impulse and reaction turbines; Impeller, volute casing, diffuser, runner and inlet guide vane. Principles of Energy Transfer, Euler one dimensional pump and turbine equations, Euler head, Bernoulli's equation, Rotor work and efficiency for incompressible flow turbomachines, Velocity diagrams for radial and axial flow machines, Blade twist. Different heads and efficiencies for pumps, fans and turbines.

Special Devices: Analysis of flow through propellers and windmills, Slipstream and actuator disc theory; Jet propulsion devices, Analysis of thrust and other performance parameters; Jet pump.

Positive Displacement Pumps: Reciprocating and rotary Pumps, Working principle and indicator diagram for reciprocating pump, Air vessel.

Recommended Books:

1. Hydraulic Machines by K. Subramanya, McGraw Hill Education (India) PrivateLimited.

2. Hydraulic Machines including Fluidics by J. Lal, Metropolitan BookCo.

3. Fluid Mechanics and Thermodynamics of Turbomachinery by S.L. Dixon, Elsevier India Pvt.Ltd.

4. A Treatise on Turbomachines by G.C. Gopalakrishnan, ScitechPublications.

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ENGINEERING GRAPHICS USING SOLIDWORKS

TIUME

L-T-P:0-0-3 **Credit:2**

Unit I	Sections of solids Introduction to Sections of Solids.
Unit II	Development of Surfaces Development of Surfaces.
Unit III	Isometric Projection Isometric Projection and drawing.
Unit IV	Solid Modelling –I Solid Modelling of Engineering Components using SolidWorks.
Unit V	Solid Modelling –II Solid Modelling of Engineering Components using SolidWorks.
Text Books	Venugopal K &Prabhu Raja V (2009) A Textbook of Engineering Graphics, New AGE International Publishers
References	1. K.V.Natarajan (2009) A text Book of Engineering Graphics, Dhanalakshmi Publisher. 2. N.D.Bhatt (2012) Engineering Drawing", Charotar public

Heat Transfer Laboratory

TIUME-592

L-T-P:0-0-3 **Credit:2**

Study of conduction heat transfer and determination of thermal conductivity.

Study of heat transfer through a fin and determination of fin performance parameters.

Study of forced convective heat transfer and determination and validation of heat transfer coefficient and Nusseltnumber.

Study of free convective heat transfer and determination and validation of heat transfer coefficient and Nusseltnumber.

Study of various types of heat exchangers, like shell and tube heat exchanger, plat heat exchanger, tubular heat exchanger etc. Determination of heat exchanger performance parameters.

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Study of radiative heat transfer: determination of emissivity of gray surface, determination of Stefan-Boltzmann constant.

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COMPUTER AIDED MACHINE DRAWING (Using SolidWorks)

TIUME-

L-T-P:0-0-3 **Credit:2**

Unit I	Drawing Standards Code of Practice for Engineering Drawing - BIS specifications –Conventional representation – Welding symbols - riveted joints - keys - fasteners – Reference to hand book for the selection of standard components like bolts - nuts - screws - keys etc.
Unit II	Limits, Fits and Tolerances Limits - Fits and tolerances – Allocation of fits for various mating parts – Tolerance data sheet – Tolerance table preparation –Geometric tolerance.
Unit III	Computer Aided Assembly and Detailed Drawing Solid modeling of simple and intricate machine and automobile components - Surface modelling of automobile body and Appliances(electrical and domestic) - Preparation of assembled and detailed drawings of I.C.Engine components viz: Cylinder head - Piston - Connecting rod and Crankshaft assembly - Carburettor - Fuel pump etc.
Text Books	James Barclay, Brian Griffiths, (2003), Engineering Drawing for Manufacture.
References	1. Cecil Jensen, Jay Helsel and Donald D. Voisinet (2000) Computer-aided engineering drawing, McGraw-Hill: New York 2. N. D. Bhatt (2008), Machine Drawing, Charotar Publishing House Pvt Ltd.

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Curriculum and Syllabus for 4-Year B.Tech. (ME)

Semester-6

Course Code	Course Title	Contact Hrs. / Week			Credit
		L	T	P	
Theory					
TIUSD-601	Career Advancement & Skill Development-VI	2	1	0	3
TIUME-601	Dynamics of Machines	2	1	0	3
TIUME-602	Machine Design-I	3	1	0	4
TIUME-603	Internal Combustion Engines	2	1	0	3
TIUME-604	Machining Technology and Metrology	2	1	0	3
TIUME-605	Fluid Machinery-II	2	1	0	3
Practical					
TIUME-691	Dynamics of Machines Laboratory	0	0	3	2
TIUME-692	IC Engine Laboratory	0	0	3	2
TIUME-693	Machine Design Practice	0	0	3	2
Sessional					
TIUCSL-681	Entrepreneurship Skill Development-VI	0	0	3	2
Total Credits					27

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Syllabus

Dynamics of Machines

TIUME-602

L-T-P: 2-1-0 **Credit: 3**

Force analysis of slider crank mechanism, Turning Moment Diagrams and flywheel.

Balancing of rotating masses, Balancing of Reciprocating masses. Applications to balancing of inline, V and radial engines.

Introduction to Kinetics of Mechanisms.

Review of SDOF theory - free undamped, free damped, forced vibration, detailed engineering applications inclusive of Transmissibility, rotor vibration, principles of vibration measurement etc.

Transient and Non harmonic vibration of SDOF systems.

Introduction to random vibration of SDOF systems. Preliminary treatment of MDOF systems - natural frequency and mode shape, harmonic excitation and applications inclusive of vibration absorption.

Approx. methods - Dunkerly & Rayleigh.

Recommended books

1. Theory of Machines by Sadhu Singh, Pearson Education.
2. Theory of Machines by V.P. Singh, Dhanpat Rai Publishing.
3. Theory of Machines by S.S. Rattan, McGraw Hill Education (India) Private Limited.
4. Fundamentals of Vibrations by Leonard Meirovitch, Waveland Press.

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Machine Design-I

TIUME-603

L-T-P: 3-1-0 **Credit: 4**

Introduction to design: Design philosophy, Optimised design, Modes of failure, Review of stress calculation in various situations - axial, bending, torsion loads and combined effect, stress concentration, Factor of safety, Theories of failure and choice of failure theory of design.

Manufacturing aspects of design: Manufacturing processes (casting, forming, machining, welding etc.) Fit and tolerance, surface roughness.

Design of shaft – FOS, ASME Code /IS Code Design, strength and rigidity (Axial bending, torsion & combined loading), Effect of keyway and splined, stepped shaft.

Endurance diagram and Design criteria: Design for fatigue life, Cumulative fatigue damage, Strain life equation.

Design of pin-joints – Cotter / Knuckle & Universal joint

Screw joints / bolted joints, Transmission screws, Riveted joints, Welded joints.

Helical springs: Extension and compression spring, spring material, set removal. Design for static and dynamic loading, Failure diagram, Factor of safety, problems. Critical frequency of helical spring, surge and governing equation. Leaf spring: Multi leaf spring, graduated leaf spring, load- deflection equation, nipping, preloading, problems.

Recommended Books:

1. Design of Machine Elements by V.B. Bhandari, McGraw Hill Education (India) Private Limited.

2. Mechanical Engineering Design by J.E. Shigley, C.R. Mischke, R.G. Budynas and K.J. Nisbett, McGraw Hill Education (India) Private Limited.

3. Design of Machine Elements by M.F. Spotts, L.E. Hornberger, T.E. Shoup, S.R. Jayaram and C.V. Venkatesh, Pearson India.

4. Machine Design: An Integrated Approach by R.L. Norton, Pearson India.

5. Machine Design by U.C. Jindal, Pearson India.

6. A Textbook of Machine Design by P.C. Sharma and D.K. Aggarwal by S.K. Kataria & Sons.

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Internal Combustion Engines

TIUME-604

L-T-P: 2-1-0 **Credit: 3**

Introduction: Principle of working, Basic Engine Types, Components of IC Engine etc.

Cycles: Analysis of air standard cycles (Otto, Diesel, Dual), fuel-air cycles and actual cycle. Availability aspects of cycles.

Fuels: Review of the family of hydrocarbon fuels, Classification of IC engine fuels, Desirable characteristics of SI & CI engine fuels, Rating of SI & CI engine fuels, Alternative fuels for SI and CI engine (liquid, gaseous, hydrogen, LPG, CNG, Biogas etc.), Air requirement, Analysis of combustion products, HHV and LHV of fuels.

Introduction to SI engine: Carburetion: Air-fuel ratio requirement, Working principle, Analysis of a simple carburettor, Defects of a simple carburettor and its remedy.

Gasoline injection: Mechanical & electronic fuel injection systems and their control.

Introduction to CI engine: Classification of diesel fuel injection systems, Working principle, Engine requirements, Injection pumps and nozzles.

Ignition: Battery, magneto and electronic ignition systems, Ignition timing and spark advance.

Combustion: Theories of normal and abnormal combustion in SI & CI engine, parameters influencing combustion, prevention of abnormal combustion in SI & CI engine. Types of combustion chamber & principle of combustion chamber design in SI & CI engine.

Supercharging and scavenging: Engine requirements, supercharging limits, turbocharging. Scavenging of two stroke SI & CI engine, scavenging parameters, ideal & actual scavenging processes, scavenging pumps.

Lubrication: Principles of lubrication, properties of lubricating oil, lubrication systems.

Cooling: Principles of cooling, air & water cooling systems.

Performance and Testing: Performance parameters and their measurement, different types of dynamometers, heat balance, performance characteristics, governing methods.

Pollutant Emission: Formation and control of pollutants.

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Recommended Books:

1. Internal Combustion Engines by V. Ganesan, Tata Mcgraw Hill Education Private Limited.

2. Internal Combustion Engines by M.L. Mathur and R.P. Sharma, Dhanpat Rai Publications.

3. Fundamentals of Internal Combustion Engines by H.N. Gupta, PHI Learning.

4. Engineering Fundamentals of the Internal Combustion Engine by W.W. Pulkrabek, PHI Learning.

Machining Technology and Metrology

TIUME-605

L-T-P: 2-1-0 **Credit: 3**

Machining: Machining principles, motions required and chief elements in machining; basic idea of machine tool; classification/ types of machine tools.

Basic machine tools: Lathe, shaping machine, planning machine, slotting machine, drilling machine, milling machine, broaching machine, and grinding machine- their important constructional features and mechanisms; basic and auxiliary motions, types, specifications and applications/ operations, including taper turning, thread cutting, gear cutting, helical milling etc.; estimation of machining time; job holding devices, indexing and elementary idea about jigs and fixtures; honing, lapping and super-finishing processes.

Preparation of process sheet.

Cutting tools: Materials of cutting tools, elementary idea of tool geometry, tool wear etc.

Introduction to the principles and applications of non-conventional machining processes; emerging areas in machining technology.

Surface quality: Waviness, roughness, surface integrity; influence of surface unevenness on performance of machined components.

Metrology: Machining accuracy, various types of error, the concepts of maximum attainable accuracy and economically feasible accuracy, the factors affecting accuracy; principles of measuring and gauging; accuracy, precision and sensitivity of measuring instruments; line and end standards of measurement; limits, fits and tolerances; plug and snap gauges; limit gauges- Taylor's principle; comparators; measurement of lengths, angles and tapers; optical flat- principle of use and applications; measurement of elements of threads and gears;

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coordinate measuring machine- an introduction; assessment of surface roughness- the various parameters and measurement principles; introduction to laser metrology.

Recommended Books:

1. Manufacturing Technology: Metal Cutting and Machine Tools by P.N. Rao, Tata Mcgraw Hill Education Private Limited.

2. Machine Tools by R. Kesavan and B. Vijaya Ramnath, Laxmi Publications.

3. Fundamentals of Metal Cutting and Machine Tools by B.L. Juneja, G.S. Sekhon and N. Seth, New Age International.

4. Metrology and Measurement by A.K. Bewoor and V.A. Kulkarni, McGraw Hill Education (India) Private Limited.

5. Engineering Metrology by R.K. Jain, Khanna Publishers.

6. Engineering Metrology and Measurements by N.V. Raghavendra and L. Krishnamurthy, Oxford University Press.

FLUID MACHINERY-II

TIUME-606

L-T-P: 2-1-0 **Credit: 3**

Miscellaneous Hydraulic Machinery and Devices: Fluid coupling and Torque converter − Working Principle.

Analysis of axial flow machines: Introduction to isolated aerofoil and cascade theory − C_L and C_D for blade design, blade nomenclature, degree of reaction, stalling.

Performance characteristics: Pumps and Fans − Radial, Mixed flow and Axial flow. Turbines − Francis, Kaplan and Pelton wheel-operating characteristics and Muschel curves, Governing of turbines.

Dimensional analysis for fluid machinery: Dimensionless quantities and their use in design, selection and testing.

Cavitation: NPSH, Thoma's cavitation parameter and specific speed.

Elements of pump and turbine systems: General description and functions-foot valves, NRV, Penstock, Draft tube, regulating valves etc., guide vanes and flow straightener.

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Interaction of pumps and turbines and systems: Series and Parallel operation of Pumps, Performance and selection of Pumps for different systems characteristics, Surging in Pipelines and method of control.

Introduction to sump design: Surface and sub-surface vortices, basic geometry and dimensions.

Unsteady flow: water hammer.

Recommended Books:

1. Hydraulic Machines by K. Subramanya, McGraw Hill Education (India) Private Limited.

2. Hydraulic Machines including Fluidics by J. Lal, Metropolitan Book Co.

3. Fluid Mechanics and Thermodynamics of Turbomachinery by S.L. Dixon, Elsevier India Pvt. Ltd.

4. A Treatise on Turbomachines by G.C. Gopalakrishnan, Scitech Publications.

Dynamics of Machines Laboratory

TIUME-691

L-T-P: 0-0-3 **Credit: 2**

Experiments to be conducted on Single DOF Vibratory Systems; Static and Dynamic balancing of rotating masses; Balancing of reciprocating masses; Governors; Gyroscope.

IC Engine Laboratory

TIUME-692

L-T-P: 0-0-3 **Credit: 2**

1. Study of IC engines.

2. Determination of valve timing diagram of a single cylinder CI Engine.

3. Performance test of single cylinder CI engines test rig.

4. Performance test of a variable compression ratio SI engine.

5. Performance test of an air compressor.

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6. Morse Test on four-cylinder four-stroke Petrol Engine.

Machine Design Practice

TIUME-693

L-T-P: 0-0-3 **Credit: 2**

Design calculation and drawings of the followings:

Assignment 1: Generation of geometric profiles of gears and cams.

Assignment 2: Dimensioning concept and detail drawing of machine components.

Assignment 3: Design and drawing of a gear box.

Assignment 4: Design and drawing of Brake or Clutch.

Assignment 5: Design of a

pressure ves

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Curriculum and Syllabus for 4-Year B.Tech. (ME)

Semester-7

Course Code	Course Title	Contact Hrs. / Week			Credit
		L	T	P	
Theory					
TIUSD-701	Career Advancement & Skill Development-VII	2	1	0	3
TIUME-701	Steam Power Plant	3	1	0	4
TIUME-702	Machine Design-II	3	1	0	4
TIUME-703	Mechanical Measurement and Instrumentation	3	1	0	4
TIUME-704	Industrial Management	3	1	0	4
Practical					
TIUME-791	Vocational Training	0	0	0	2
TIUME-ccc	PRODUCT DESIGN FOR MANUFACTURING	0	0	3	2
TIUME-793	Project-I	0	0	3	2
Sessional					
TIUCSL-781	Entrepreneurship Skill Development-VII	0	0	3	2
Total Credits					27

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Syllabus

Steam Power Plant

TIUME-702

L-T-P:3-1-0 **Credit: 4**

Vapour Power Cycles: Effect of operating variables on Regenerative cycles, Binary vapour cycle. Co generative cycles. Availability analysis of cycles.

Boilers:

(i) Introduction: Classification. Fire-tube and water-tube boilers. Mountings andAccessories.

(ii) Coal and combustion: Coal analysis. Combustion calculations using both mass and energy balance, heatingvalues.

(iii) Types of coal feeding and firingmethods.

(iv) Introduction to power stationboiler.

(v) Circulation theory andprocesses.

(vi) Auxiliary heating surfaces: Superheater, reheater, economizer, airpreheater.

(vii) Draft: Definition, classifications and calculations.

(viii) Losses in boilers. Equivalent evaporation. Boilerefficiency.

(ix) Basics of watertreatment.

(x) Basics of ashhandling.

Steam Turbine:

(i) Parts & classifications.

(ii) Nozzles: types, flow through nozzles, nozzleefficiency.

(iii) Impulse turbine: Flow through impulse blading, velocity diagram, work done, Blade efficiency.

(iv) Multistaging of turbines: pressure compounding and velocitycompounding.

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(v) Impulse-Reaction turbine: Flow through impulse-reaction blading, velocity diagram, Degree of reaction, ParsonsTurbine.

(vi) Principles of turbine governing.

(vii) Different losses in turbine, bladeerosion.

Condenser: Classification, Elements of condensing plant, Power plant condensers, Air leakage - effect and removal.

Power plant economics: Load curve, load factor, utilization factor etc. Fixed and variable operating cost, Principle of load sharing.

Recommended Books:

1. Power Plant Engineering by P.K. Nag, McGraw Hill Education (India) PrivateLimited.

2. Powerplant Technology by M.M. El-Wakil, McGraw Hill Education (India) Private Limited.

3. Power Plant Engineering by Black & Veatch, CBSPublisher.

4. Steam & Gas Turbines and Power Plant Engineering by R. Yadav, Central Publishing House.

5. A Textbook of Power Plant Engineering by R.K. Rajput, LaxmiPublications.

Machine Design-II

TIUME-703

L-T-P:3-1-0 **Credit:4**

Clutches: Use of clutch, Classification of clutches based on actuating method, operating principle, coupling method, Description of friction clutch, mechanically operated clutch release mechanism, Actuating force and frictional torque equation based on uniform pressure and uniform wear, friction materials.

Brakes: Band Brake, short shoe brake, self-energizing and de-energizing brake, long shoe drum brake – pressure distribution, force and torque analysis etc.

Couplings: Rigid, Flexible, Resilient, Fluid, Magnetic etc.

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Design of gear drive: (i) Spur Gear – Introduction, Modes of Gear tooth failure, Beam strength of gear tooth and Lewis equation, Lewis form factor, Service factor dynamic load, Buckingham equation, Spott's equation, Error on gear tooth, Wear strength, Derivation of load stress factor, Buckingham equation for wear, problems.

(ii) Helical Gear- Type of helical gears, virtual no. of teeth, Minimum face width, Force analysis, Beam strength, Dynamic load, Wear strength,problems.

(iii) Bevel Gear: Force analysis, Formative no. of teeth, Beam strength, Dynamic load, Wear strength,problems.

(iv) Worm Gear: Uses, drawback, self- locking arrangement, centre distance calculation, force analysis, friction in worm gear, efficiency, selection of material,problems.

Design of rotors: Shafts and axles with bearing mountings, High-speed rotor - constant thickness and variable thickness design in post-elastic region, limit speed analysis, interference fits in rotors.

Chain drive: Types, roller chain - constructions, polygonal effect, power rating, failure Sprocket wheel, chain lubrication.

Rolling contact bearings: Types, static load capacity- Stribeck equation, dynamic load capacity, equivalent load, load-life relation, bearing life selection, load factors, Bearing selection from Manufacturer's catalogues, Selection of taper roller bearing, Design for cyclic load and speed, Bearing reliability, lubrication, mountings.

Recommended Books:

1. Design of Machine Elements by V.B. Bhandari, McGraw Hill Education (India) Private Limited.

2. Mechanical Engineering Design by J.E. Shigley, C.R. Mischke, R.G. Budynas and K.J. Nisbett, McGraw Hill Education (India) PrivateLimited.

3. Design of Machine Elements by M.F. Spotts, L.E. Hornberger, T.E. Shoup, S.R. Jayaram and C.V. Venkatesh, PearsonIndia.

4. Machine Design: An Integrated Approach by R.L. Norton, PearsonIndia.

5. Machine Design by U.C. Jindal, PearsonIndia.

6. A Textbook of Machine Design by P.C. Sharma and D.K. Aggarwal by S.K. Kataria& Sons.

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Mechanical Measurement and Instrumentation

TIUME-704

L-T-P:3-1-0 **Credit:4**

Introduction. Functional elements of an instrument. Active Passive transducers. Analog/digital mode of operation. Null/deflection methods of measurement. Generalized I/O configuration of measurementsystems.

Methods of correction of interfering and modifying inputs.

Static characteristics: Static calibration. Basic statistics. Uncertainty analysis. Least square calibration curve. Static sensitivity. Linearity, Threshold, noise floor, Resolution, Hysteresis Dead space, Span, Scale readability.

Loading effects.

Dynamic characteristics: Generalized mathematical model, Operational and sinusoidal transfer functions. Zero order instrument. First order instrument: Step, Ramp, Frequency and impulse response of first order instruments. Second order instruments: Step, Terminated-ramp, Ramp, frequency and impulse response of second order instruments. Dead time elements.

Logarithmic plotting of frequency response curves. Response of general form of instruments to periodic and transient inputs.

Wheatstone bridge application with examples. Measuring instruments for measurement of Displacement, Velocity, Acceleration, Force, Pressure, Flow and Temperature.

Signal conditioning and Data acquisition systems.

Recommended Books:

1. Experimental Methods for Engineers by J.P. Holman, McGraw Hill Education (India) Private Limited.

2. Instrumentation, Measurement and Analysis by B.C. Nakra and K.K. Chaudhry, McGraw Hill Education (India) PrivateLimited.

3. Mechanical Measurements by T.G. Beckwith, J.H. Lienhard V and R.D. Marangoni, Pearson.

4. Mechanical Measurements and Instrumentation by R.K. Rajput, S.K. Kataria&Sons.

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5. A Course in Mechanical Measurements and Instrumentation & Control by A.K. Sawhney and PuneetSawhney, DhanpatRai&Co.

Industrial Management

TIUME-705

L-T-P:3-1-0 **Credit: 4**

Introduction: Concepts of Management and Industrial Management; Development of management thoughts and ideas – Contribution of Taylor and others; System concepts in management.

Organization: Organization structure, various types, organization principles – unity of command, responsibility, authority, span of control, structural balance, communication, division of labour, etc.

Types of Production – Plant location and plant layout (various types).

Materials Management – Inventory – types, different cost, EOQ and EPQ models, Basic ideas of MRP and MRP II, purchasing functions, vendor rating etc., ABC analysis, Basic ideas of supply chain management.

Forecasting – Factors affecting demand, Types of forecasts and forecasting techniques, Time series analysis and various qualitative and quantitative forecasting techniques, forecasting errors.

Scheduling – Gantt chart, network scheduling – PERT, CPM, crashing.

Linear Programming – Fundamentals, formulations, various variables, graphical solutions etc., Sequencing – simple cases, introduction to transportationmodels.

Quality Control and Inspection – Concept of quality, quality control and inspection, Acceptance sampling – OC curve, control charts, Introduction to ISO 9000 standards, Total quality management, quality circle, brainstorming, fishbone diagram, Pareto analysis.

Work Study – Work measurement, time study, motion study, method study, job evaluation, merit rating.

Queuing Theory – Basic concept and a simple model.

Maintenance Management – Types of maintenance, replacement models, bath tub curve, terotechnology and some fundamentals of safety management.

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Break Even Analysis – Some basic ideas and applications.

Reliability Analysis and Risk Management – Basic concepts, hazard rate, reliability functions,MTTF.

Basic ideas of Agile Manufacturing, Lean manufacturing, Flexible manufacturing and group technology, Ergonomics.

Recommended Books:

1. Operations Research by A.M. Natarajan, P. Balasubramani and A. Tamilarasi, Pearson Education.
2. Operations Research by P.J. Jha, McGraw Hill Education (India) PrivateLimited.
3. Operations Research by P.K. Gupta and D.S. Hira, S. Chand & CompanyLtd.
4. Operations Research: Theory and Applications by J.K. Sharma, Macmillan Publishers IndiaLtd.
5. Industrial Engineering and Management by O.P. Khanna, DhanpatRaiPublications.
6. Industrial Engineering and Management by P. Kumar, PearsonEducation.

Vocational Training

TIUME-791

L-T-P:0-0-0 **Credit:2**

Vocational Training of four weeks at an Institute approved organization to be done during vacation in Semester VI, credit to be given in Semester VII. Students shall have to submit a report endorsed by the Industry Training Manager/ Lab-in-charge of R & D organisation.

PRODUCT DESIGN FOR MANUFACTURING

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TIUME-XXX

L-T-P:0-0-3 **Credit:2**

Unit I	**Introduction to Product design** Introduction to Product design: Asimow‟s Model - Product design practice in Industry - Strength consideration in product design - Design for stiffness and rigidity
Unit II	**Principles and evaluation methods** Principles and evaluation methods of various aspects of Design for X (machining - sheet metal working - injection molding - environment - service and repair - etc.).
Unit III	**Manufacturability requirements** Manufacturability requirements - Forging design - Pressed component design - Casting design - Die Casting and special castings.
Unit IV	**Assembly and assembly process** Assembly and assembly process - principles of Design for assembly and applications (Boothroyd/Dewhurst Method – case studies using DFMA software.)
Unit V	**Other supporting techniques** Other supporting techniques for new product development processes such as quality function deployment - and quality engineering and Taguchi Method.
Text Books	Boothroyd Geoffrey, Peter Dewhurst, Winston A. Knight (2010) Product Design for Manufacture and Assembly, CRC Press, 3rd Edition
References	1. Bralla, J.G., (1999) Design for Manufacturability Handbook, McGraw-Hill. 2. A.K. Chitale, R.C. Gupta (1997) Product Design and Manufacturing.,Printice –Hall of India. 3. James G. Bralla (1999) Hand Book of Product Design for Manufacturing, McGraw Hill

Approved By:
External Expert VC Registrar Dean of Academics Mentor of the Dept. HOD

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Project-I

TIUME-793

L-T-P:0-0-3 **Credit:2**

Each student has to work on a research topic or advanced design and analysis project for two semesters. The evaluation is to be carried out in each semester separately. The project can be selected from different specialization branches related to Mechanical Engineering (Heat Power/Fluid Mechanics/Machine Design/ Applied Mechanics/ Production). A list of topics will be offered by the department. Students have to submit a project report to the respective supervisors and give a presentation of the work done in front of a specialization specific evaluation board. For each project, distribution of marks will be: 50 marks to be evaluated by the supervisor and 50 marks to be evaluated by the specialization specific evaluation board.

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Curriculum and Syllabus for 4-Year B.Tech. (ME)

Semester-8

Course Code	Course Title	Contact Hrs. / Week			Credit
		L	T	P	
Theory					
TIUSD-801	Career Advancement & Skill Development-VIII	2	1	0	3
TIUME-801	Material Handling	2	1	0	3
TIUME-802	Refrigeration and Air Conditioning	3	1	0	4
TIUME-803	Elective-I	2	1	0	3
TIUME-804	Elective-II	2	1	0	3
Practical					
TIUME-891	Heat Power Laboratory	0	0	3	2
TIUME-892	Project-II	0	0	3	2
TIUME-806	Comprehensive Viva Voce	0	0	0	3
Sessional					
TIUCSL-881	Entrepreneurship Skill Development-VIII	0	0	3	2
Total Credits					25

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External Expert VC Registrar Dean of Academics Mentor of the Dept. HOD

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Material Handling

TIUME-802

L-T-P: 2-1-0 **Credit: 3**

Definition of material handling, classification of materials, bulk load, unit load, their characteristics.

Classification of mechanical handling equipment, different types of elevators and lowerers for handling materials in bulk and unit loads, their working principles and estimation of handling capacity.

Belt conveyors and their construction, capacity and power requirements, other conveyors, steel plate and slat conveyors, flight and screw conveyors, vibrating and oscillating trough conveyors – estimation of handling capacity and power requirement, Automatic feeding devices for elevators and conveyors.

Gravity chutes and gravity roller runways accessories of gravity roller conveyors viz. humper, stacker and gadget, live rollers, pneumatic and hydraulic methods of conveying, monorails, and blast furnace hoists.

Loading/unloading and operation of railway wagons, motor trucks and fork lift trucks. Wire ropes, pulley blocks, crab winch, grabs and lifting magnets, different types of cranes.

Definition and types of robots – basic concept, working principle and application of robotics, manipulators.

Automation, Automated Guided Vehicles (AGVs) and application, Automated production and transfer lines.

Recommended Books:

1. Material Handling Systems: Designing for Safety and Health by Charles Reese, Taylor & Francis.

2. Introduction to Materials Handling by S. Ray, New Age International.

Refrigeration and Air Conditioning

TIUME-803

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L-T-P: 3-1-0 **Credit: 4**

Introduction: Concepts of Refrigeration and Air-conditioning, Unit of refrigeration.

Simple Vapour Compression Refrigeration System (Simple VCRS): Vapour compression cycle on p-h and T-s diagrams, Cycles with subcooling and superheating, their effects. Effect of changes in evaporator pressure and condenser pressure on the performance of a simple VCRS, dry compression and wet compression of refrigerant, actual Vapour Compression cycle.

Air Refrigeration System (ARS): open-air and dense-air system, limitations of Bell-Coleman refrigerator, COP determination, actual air-refrigeration cycle.

Vapour Absorption Refrigeration System (VARS): Advantages of VARS over VCRS, working principle of simple VARS, practical VARS, limitations of VARS, maximum COP of a VARS, LiBr-water system and Aqua-ammonia systems.

Equipment and Control: Major Refrigeration Equipment − Compressors: Types, reciprocating, rotary & centrifugal, volumetric efficiency; Condensers: types used in refrigeration systems; Evaporators; Expansion devices: capillary tubes and thermostatic expansion valves.

Other Refrigeration Systems: Basic idea of Thermoelectric refrigeration system, Steam-jet (vapour-jet) refrigeration system.

Psychrometry: Basic definitions and principles related to Psychrometry, Psychrometric charts & their uses. Heating, cooling, heating & humidification & cooling & dehumidification processes. Adiabatic saturation, By-pass factor, Sensible Heat Factors. Simple cases of Heat Load estimation.

Types of Air-conditioning systems: Window air conditioners & split air conditioners. Single duct, double duct & V A V systems.

Air-conditioning equipment: chillers, air handling units, cooling towers, cooling coils.

Recommended Books:

1. Refrigeration and Air Conditioning by C.P. Arora, McGraw Hill Education (India) Private Limited.

2. Refrigeration and Air Conditioning by R.C. Arora, PHI Learning Pvt. Ltd.

3. A Textbook of Refrigeration and Air Conditioning by R.S. Khurmi and J.K. Gupta, S Chand.

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4. A Textbook of Refrigeration and Air-Conditioning by R.K. Rajput, S.K. Kataria & Sons.

Elective-I

TIUME-804

Finite Element Methods

TIUME-804A

L-T-P: 2-1-0 **Credit: 3**

Introduction to FEA, General Comments, Need for FEA, Solution of Differential equations.

Integral Formulations and Variational Methods: Need for Weighted Integral forms, weak formulation of boundary value problems, weighted integral and weak formulations, variational methods of approximation, Rayleigh-Ritz method, the method of weighted residuals.

Finite Element Analysis of One-Dimensional Problems: Basic Steps of Finite Element Analysis, Model BVP, Discretization and derivation of element equations, imposition of boundary conditions, applications in heat transfer, fluid mechanics and solid mechanics

Bending of Beams: The Euler-Bernoulli Beam element, governing equation, discretization, derivation and assembly of equations, imposition of boundary conditions, examples.

Finite Element Error Analysis: Approximation errors, various measures of errors, accuracy and convergence of solutions.

Recommended Books:

1. An Introduction to the Finite Element Method, by J.N. Reddy, McGraw Hill Education (India) Pvt. Ltd.

2. Concepts and Applications of Finite Element Analysis, by R.D. Cook, D.S. Malkus, M.E. Plesha and R.J. Witt, Wiley.

Non-Conventional Energy Sources

TIUME-804B

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L-T-P: 2-1-0 **Credit: 3**

Energy scenario and renewable energy sources: Global and Indian situation, potential of non-conventional energy sources, economics.

Solar energy: Radiation, flat plate and concentrating collectors, fluid flow and heat transfer analysis, estimation of solar radiation, Active systems, solar pond, passive space conditioning, power generation, photovoltaics.

Principles and applications of wave energy, tidal energy, biomass energy, OTEC and Geothermal energy.

MHD Engineering, Fuel Cells, Wind Energy potentials.

Recommended Books:

1. Non-Conventional Energy Resources by B.H. Khan, McGraw Hill Education (India) Private Limited.

2. Non-Conventional Energy Resources by G.S. Sawhney, PHI.

3. Non-Conventional Energy Sources and Utilisation by R.K. Rajput, S Chand.

Computer Integrated Manufacturing

TIUME-804C

L-T-P: 2-1-0 **Credit: 3**

Concept of Computer Integrated Manufacturing (CIM), Basic components of CIM, Distributed database system, distributed communication system, computer networks for manufacturing, future automated factory, social and economic factors.

Computer Aided Design (CAD): CAD hardware and software, product modelling, automatic drafting, engineering analysis, FEM design review and evaluation, Group Technology Centre.

Computer Aided Manufacturing (CAM): Computer assisted NC part programming, Computer assisted robot programming, computer aided process planning (CAPP), computer aided material requirement planning and MRP, computer aided production scheduling, computer aided inspection planning, computer aided inventory planning, flexible manufacturing system (FMS), concept of flexible manufacturing, Integrating NC machines, robots, AGVs, and other NC equipment, Computer aided quality control, business functions, computer aided forecasting.

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Management Information Systems (MIS), Various CIM systems - examples.

Recommended Books:

1. CAD/CAM: Theory and Practice by I. Zeid and R. Sivasubramanian, McGraw Hill Education (India) Private Limited.

2. CAD/CAM: Principles and Applications by P.N. Rao, McGraw Hill Education (India) Private Limited.

Elective-II

TIUME-805

Linear Vibrations

TIUME-805A

L-T-P: 2-1-0 **Credit: 3**

Concepts of Vibrations: Newtonian mechanics, concept of linearity, superposition

Response of SDOF systems to initial excitations: Free vibration of undamped, viscously damped and Coulomb damped systems to initial displacements and velocities.

Response of SDOF systems to harmonic and periodic excitations: response to harmonic excitations through frequency domain analysis, rotating eccentric masses, systems with harmonically moving support, vibration isolation and measuring instruments

Response of SDOF systems to non-periodic excitations: unit impulse, unit step and unit ramp functions, state transition matrix, shock spectrum

TDOF systems: eigenvalue problems, natural modes and frequencies, response to harmonic excitations, vibration absorbers, response to non-periodic excitations using convolution integrals.

Recommended Books:

1. Fundamentals of Vibrations by Leonard Meirovitch, Waveland Press.

2. Mechanical Vibrations by S.S. Rao, Pearson Education.

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Gas Dynamics

TIUME-805B

L-T-P: 2-1-0 **Credit: 3**

Introduction to compressible flow, velocity of sound and Mach number, isentropic flow, flow with friction and heat transfer, Rayleigh line and Fanno line, analysis of flows with normal and oblique shock waves, supersonic flows, Introduction to two dimensional compressible flow.

Recommended Books:

1. Modern Compressible Flow: With Historical Perspective by J.D. Anderson, McGraw Hill Education (India) Private Limited.

2. Compressible Fluid Flow by P.H. Oosthuizen and W.E. Carscallen, McGraw Hill.

3. Gas Dynamics by E. Rathakrishnan, PHI.

Rapid Prototyping

TIUME-805C

L-T-P: 2-1-0 **Credit: 3**

Importance and overview of Rapid Prototyping, Tooling and Manufacturing; Typical Process Chain; Introduction to CAD and Data Exchange Formats; Data format details, conversion, checking, repairing and transmission; Part slicing and orientation.

Classification of Rapid Prototyping (RP), Tooling (RT) and Manufacturing (RM) processes; Materials for RP/RT/RM; Operating principles, characteristics and analysis of current and developing RP/RT/RM processes; Selection of RP/RT/RM processes based on the product requirements; Case studies.

Recommended Books:

1. C.K. Chua, K.F. Leong and C.S. Lim, Rapid Prototyping: Principles and Applications, World Scientific.

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2. N. Hopkinson, R.J.M. Hague and P.M. Dickens, Rapid Manufacturing: An Industrial Revolution for the Digital Age, Wiley.

Comprehensive Viva Voce

TIUME-806

L-T-P: 0-0-0 **Credit: 3**

Each student will have to appear at a viva voce examination in front of a board of examiners comprising of faculty members from all the specializations on all subjects completed during the course of his/her undergraduate study.

Heat Power Laboratory

TIUME-891

L-T-P: 0-0-3 **Credit: 2**

1. Determination of dryness fraction of steam.
2. Determination of critical pressure ratio for an orifice.
3. Measurement of temperature by different methods.
4. Refrigeration laboratory unit.
5. Air conditioning laboratory unit.
6. Study of steam turbine.
7. Study of boiler.

Project-II

TIUME-892

L-T-P: 0-0-3 **Credit: 2**

Syllabus common with TIUME-793.

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