Course Outline and Detailed Syllabus for B. Tech. Mechanical Engineering (7th Semester)

Semester-VII

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC401C	Hydraulics & Hydraulic Machines	**3**	**0**	**0**	**3**	**3**
2.	MEC402C	Industrial Engineering	**3**	**0**	**0**	**3**	**3**
3.	MTH403C	Numerical Methods in Engineering	**3**	**0**	**0**	**3**	**3**
4.	MECXXXE	Elective-III (Discipline Centric)	**3**	**0**	**0**	**3**	**3**
5.	XXXXXXX	Elective-IV (Generic)	**X**	**0**	**0**	**-**	**X**
6.	MEC410C	Industrial Engineering Lab	**0**	**0**	**2**	**2**	**1**
7.	MEC411C	Fluid Machines Lab	**0**	**0**	**2**	**2**	**1**
8.	MEC412C	Minor Project	**0**	**0**	**6**	**90 (Total)**	**3**
9.	-	Open Elective	**-**	**-**	**-**	-	**-**
Total Credits							**17+X**

Electives (Discipline Centric)

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC401E	Control Systems	**3**	**0**	**0**	**3**	**3**
2.	MEC402E	Advanced Welding Technology	**3**	**0**	**0**	**3**	**3**
3.	MEC403E	Energy Management	**3**	**0**	**0**	**3**	**3**
4.	MEC404E	Industrial Automation	**3**	**0**	**0**	**3**	**3**

Note:

1. *Discipline Centric electives are offered to the students of the Department of Mechanical Engineering only.*
2. *The students of the Department of Mechanical Engineering have to choose Discipline Centric Electives from the above list.*

Electives (Generic)

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC401G	Finite Element Methods	**3**	**0**	**0**	**3**	**3**
2.	MEC402G	Non-Conventional Sources of Energy	**3**	**0**	**0**	**3**	**3**
3.	MEC403G	Principles of Management	**3**	**0**	**0**	**3**	**3**

Note:

1. *Generic electives are offered to the students of the School of Engineering and Technology including the students of the Department of Mechanical Engineering.*
2. *The students of the Department of Mechanical Engineering have to choose Generic Electives from the list of courses offered by all the Departments of School of Engineering and Technology.*

Open Electives

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC001	Optimization Techniques	**3**	**0**	**0**	**3**	**3**
2.	MEC002	Quality Management	**3**	**0**	**0**	**3**	**3**
3.	MEC003	Concurrent Engineering	**3**	**0**	**0**	**3**	**3**
4.	MEC004	Maintenance Engineering	**3**	**0**	**0**	**3**	**3**
5.	MEC005	Fundamentals of Manufacturing Processes	**3**	**0**	**0**	**3**	**3**
6.	MEC006	Solar Energy	**3**	**0**	**0**	**3**	**3**
7.	MEC007	Basic Automobile Engineering	**3**	**0**	**0**	**3**	**3**
9.	MEC008	Basic Mechanical Engineering	**3**	**0**	**0**	**3**	**3**

Note:

1. *Open electives are offered to the students of all Departments of the university other than the Department of Mechanical Engineering.*
2. *The students of the Department of Mechanical Engineering have to choose Open Electives offered by the departments other than the Department of Mechanical Engineering.*

MEC401C Hydraulics and Hydraulic Machines 3-0-0

Hydraulics: Power plant layout, hydrodynamic force of jets on stationary and moving flat, inclined and curved vanes, jet striking centrally and at tip, velocity triangles at inlet and outlet, expressions for work done and efficiency-angular momentum principle, applications to radial flow turbines.

Hydraulic Turbines: Classification; energy transfer between rotor and fluid in turbomachines; impulse and reaction turbines-Pelton, Francis, Kaplan and tubular turbines – theory, losses, efficiencies, performance curves; draft tube, cavitation, governing, similarity laws, specific speed, model testing, governing, instrumentation for testing of hydraulic machines.

Pumps and compressors: Classification; centrifugal & axial flow pumps –theory, working principle, heads, losses, efficiencies, performance curves, surging, cavitation, hydraulic lifts.

Positive Displacement Pumps: Reciprocating Pump, gear pump, vane pump and screw pump, hydraulic systems: accumulator, intensifier, hydraulic lift, fluid coupling, torque converter, and fluidics.

Text Books/Reference Books:

1. Shepherd D. J., Principles of Turbo-Machines, *McGraw Hill Education (India).*
2. Jagdish Lal, Hydraulic Machines, *S Chand Publishers*
3. Cherkasky, Pump, fan and Blowers, *Mir Publications*
4. Stephonov ,Axial Flow Compressors, *Mir Publications*

MEC402C Industrial Engineering 3-0-0

Introduction: Definition and scope of industrial engineering, role of an industrial engineer in industry, functions of industrial engineering department and its organization, qualities of an industrial engineer, principles of industrial engineering, system and review of growth and development of industrial engineering and scientific management.

Plant Layout and Material Handling: Different types of layouts viz. product, process and combination layouts, introduction to layouts based on GT, JIT and cellular manufacturing systems, development of plant layout, types of material handling equipment, relationship of material handling with plant layouts.

Work Study: Use and Applications, techniques, human factors in the application of work study, method study objectives, basic procedure, various charting techniques, use of photographic techniques, SIMO charts, principles of motion economy, work measurement techniques, time study, work sampling, predetermined motion time standards (PMTS), analytical estimation.

Production Planning and Control: Functions, forecasting techniques, product design, process planning, machine loading and scheduling, dispatching, progress reporting, corrective action, inventory control - different costs, determining economic order quantity, quantity discounts, re-order level, re-order cycle systems, ABC, VED, FSN models.

Quality Control: Meaning of quality and quality control, quality of design, quality of conformance and quality of performance, functions of quality control, introduction to statistical quality control-control charts and sampling plans.

Text Books/Reference Books:

1. Khanna O. P., Industrial Engineering and Management, *Khanna Publishers*.
2. Dalela S., Mansuor Ali, Industrial Engineering and Management systems, *Standard Distributors and Publishers, New Delhi*.
3. Ralph M. B., Motions and Time Standards, *John Wiley & Sons*.
4. ILO - Introduction to Work Study, *International Labor Office, Geneva*.
5. Jain K. C., Agarwal L. N., Production Planning Control & Industrial Management, *Khanna Publishers*.

MTH403C Numerical Methods in Engineering 3-0-0

Finite Differences and Interpolation: Difference Table and its usage. The difference operators Δ, ∇ and the operator E. Interpolation with equal intervals, Newton's advancing difference formula. Newton's backward difference formula. Interpolation with unequal intervals. Newton's divided difference formula. Lagrange's interpolation formula.

Central Differences and Inverse interpolation: The central difference operator δ and the over raging operator μ. Relations between the operators. Gauss forward and backward interpolation formula, Sterlings, Bessel's, Laplace and Everetts formulae. Inverse interpolation by (i) Langrange's (ii) Methods of successive e approximation & (iii) Methods of elimination of third differences

Numerical solution of algebraic and Transcendental Equations and Numerical differentiation & Numerical Integration: Graphic Method, Regula-Fast method, Balzano's Process of bisection of intervals, Newton-Raphson Method and its geometrical significance. Numerical differentiation of a function. Differential coefficient of a function in terms of its differences. Numerical Integration, General Quadrature Formula, Trapezoidal rule, Simpson's one-third and three-eight rules, Weddles' rule, Euler- Maclaurin expansion formula.

Difference Equations and Numerical Solution of ordinary differential equations: Linear homogeneous and non-homogeneous difference equations of order n with constant coefficient, and their solution, methods of undetermined coefficient. Numerical solution of ordinary differential equations, Picard's method.Taylors series method, Euler's method, Runge-Kutta Method.

Numerical solution of simultaneous equations and Eigen value problem: Gauss elimination method, Gauss Jordon method, Gauss- Jacobi and Gauss- Seidel iteration methods, power methods for solving Eigen value problems.

Text Books/Reference Books:

1. Jain M. K., Iyengar S. R., Jain R. K., Numerical Methods for Scientists and Engineering, *Wiley Eastern Ltd.*
2. Scarborough S. C., Mathematical Numerical Analysis, *Oxford and IBH publishing Company*.
3. Sastry S. S., Introductory methods in Numerical Analysis, *Prentice Hall of India.*
4. Jain M. K., Numerical Solution of Differential equations, *New Age International Publishers.*
5. Stanton R. G., Numerical Methods for Science & Engineering, *Prentice Hall of India.*

MEC401E Control Systems 3-0-0

Introduction: Scope of Control System Engineer, Classification, Historical developments, Application in Engineering and non-Engineering fields; Mathematical modelling of physical systems, Transfer function, Block diagram algebra, Signal flow graphs.

Feedback Characteristics of Control systems: Feedback and non-feedback systems, Control over system dynamics, disturbances by use of feedback, Linearizing effect of feedback, Regenerative feedback.

Control Systems and Components: Nonlinearities, Linearization, Analogue Systems; Controller components: DC and AC Servomotors, Tacho-generators, Potentiometers and optical encoders, Stepper motors, etc.

Time Response Analysis and Design Specifications: Standard Test Signals, Time response of first order systems, Time response of a second order system; Steady State Errors and Error Constants; Effect of adding a zero to a system; Design specification of second order systems;

Stability and Algebraic Criteria: The concept of stability, Necessary conditions, Hurwitz stability criterion, Routh Stability Criterion, Relative stability analysis.

The Root Locus Technique: Angle and Magnitude Criterion, Properties of Root Loci, Construction of Root Locus Diagram, Closed Loop Transfer Function and Time Domain response, Determination of Damping ratio, Gain Margin and Phase Margin from Root Locus. MATLAB exercises on the above.

Frequency Response Analysis: Correlation between Time and frequency response, Frequency Domain Specifications; Polar Plots; Bode Diagrams; Minimum Phase, Non-minimum phase and all pass systems, Log Magnitude vs Phase plots; Nyquist stability criterion, Assessment of relative stability using Nyquist Criterion. MATLAB exercises on the above.

Text Books:

1. Norman S. Nise, Control Systems Engineering, *John Wiley & Sons.*
2. Nagrath I. J., Gopal M., Control System Engineering, *New Age International Publishers.*

Reference Books:

1. Kuo B. C., Automatic Control Systems, *John Wiley & Sons.*
2. Katsuhiko Ogata, Modern Control Engineering, *Prentice Hall India (Pearson), New Delhi.*

MEC402E Advanced Welding Technology 3-0-0

Introduction to welding and joining processes: Introduction to consolidation processes, Classification of welding processes, some common concerns, types of fusion welds and types of joints, Design considerations, Heat effects, Weld ability and join ability. Welding terms and definitions, welding positions, elements of and construction of welding symbols.

Welding Metallurgy (Physical Metallurgy and Solidification of Weld Metal): Fundamentals of physical metallurgy: Need, phase diagrams: Fe-C, Al-Cu, Cu-Zn system, phase transformations in Fe-C system, TTT diagram, CCT diagram, carbon equivalent, Schaffer diagram, relevance of above in welding. Solidification of weld metal: Principle of solidification of weld metal, modes of solidification, effect of welding parameters on weld structure, grain refinement principle of weld metal, method of weld metal refinement, inoculation, arc pulsation, external excitation.

Welding Metallurgy (HAZ, Weld Metal and Metallurgical issue of Weld Metal): Heat affected zone and weld metal: Transformations in HAZ of steel, factors affecting changes in microstructure and mechanical properties of HAZ, reactions in weld pool- gas metal reaction, slag metal reaction. Metallurgical issue in weld joint: Mechanisms, causes and remedy of cold cracking, solidification cracking, nonmetallic inclusions, lamellar tearing, hydrogen damage, banding, segregation.

Chemical, Metallurgical, and Mechanical testing of weldment: Comparison of destructive and non-destructive tests, chemical tests, forms of corrosion, testing for corrosion resistance, metallographic tests.

Weldment Inspection: Codes governing welding inspection: Structural welding code; ASME boiler and pressure vessel code, spot examination of welded joints, duties of the inspector, ASTM standards, API standards. Visual and liquid penetrant inspection, Magnetic particle and Radiographic inspection, Ultrasonic inspection and Eddy current inspection, acoustic emissions, proof tests and leak tests.

Text Book:

1. Larry J and Jeffus L, "Welding Principles and Applications", 5th edition, *Delmer Publications*

Reference Book:

1. Parmer R. S., 'Welding Engineering and Technology', *Khanna Publishers, 1997*

MEC403E Energy System Management 3-0-0

Basic Fundamentals: Review of thermodynamics, fluid flow and heat transfer; concept of heat and work, different kinds of work, laws of thermodynamics; Fluid flow: laminar and turbulent flows, control mass and control volume, internal and external flows; Heat Transfer: modes of heat transfer, Fourier's law, forced and natural convection, radiation, Stefan-Boltzman's Law, Wein's displacement law, Kirchoff's law

Energy conversion systems: Furnaces: Turbine and its types, impulse and reaction turbines; Boilers: types, construction, and working principle, heat balance; internal combustion engines: SI, CI, gas turbines, operation and performance; Heat exchangers: types, construction. parallel flow, counter flow, cross-flow, effectiveness of heat exchanger, NTU method.

Energy storage systems: Need for energy storage; Thermal energy storage technologies: sensible heat storage, latent heat storage, thermochemical storage: salt hydrates, metal hydrides, mechanical storage systems: pumped hydro, flywheel, electrochemical energy storage: batteries

Energy Management: Energy conservation: laws and regulations, present state of implementation and standardization and labeling in India, energy efficiency ratings for buildings and appliances, Energy monitoring, supply and demand estimation, energy pricing, CDM

Energy Audit and economics: Purpose, methodology, components of an energy audit, types of audits:, energy auditing techniques: characteristic method employed in certain energy intensive industries, indoor air quality, economic analyses

Text Books:

1. Goswami D. Y., Kreith F., Energy conversion. *CRC Press.*
2. Cengel Y. A., Thermodynamics: An Engineering Approach, *McGraw Hill Education India.*

Reference Books:

1. Eastop T. D., Applied Thermodynamics for Engineering Technologist, *Pearson Education.*
2. Petrecca, Giovanni, Energy Conversion and Management, *Springer Publications.*
3. Younger W. J., Thumann A., Handbook of Energy Audits, *Fairmont Press.*

MEC404E Industrial Automation 3-0-0

Introduction to Automation: Socio Economic Consideration, Low Cost Automation, Fluid Power Control-Fluid Power Control Elements and Standard Graphical Symbols. Construction and Performance of Fluid Power Generators, Hydraulic and Pneumatic Cylinders- Construction, Design and Mounting; Hydraulic and Pneumatic Valves for Pressure, Flow and Direction Control, Servo Valves and Simple Servo Systems with Mechanical Feedback, Governing Differential Equation and Its Solution for Step Position Input, Basic Hydraulic and Pneumatic Circuits.

Pneumatic Logic Circuits: Design of Pneumatic Logic Circuits for a given Time Displacement Diagram or Sequence of Operations.

Fluidics: Boolean Algebra, Truth Tables, Conda Effect, Fluidic Elements – Their Construction Working and Performance Characteristics, Elementary Fluidic Circuits.

Transfer Devices and Feeders: Classification, Construction Details and Application of Transfer Devices and Feeders, Vibratory Bowl Feeder, Reciprocating Tube and Centrifugal Hopper Feeder.

Electrical and Electronic Controls: Introduction to Electrical and Electronic Controls such as Electromagnetic Controllers - Transducers and Sensors, Microprocessors, Programmable Logic Controllers (PLC); Integration of Mechanical Systems with Electrical, Electronic and Computer Systems.

Text Books:

1. Anthony Esposito, Fluid Power with Applications, *Prentice Hall of India, New Delhi*.
2. Majumdar S. R., Pneumatic Control, *Tata McGraw Hill, New Delhi*.
3. Deb S. R., Robotics and Flexible Automation, *Tata McGraw Hill, New Delhi*.

Reference Books:

1. Kuo B. C., Automatic Control Systems, *Prentice Hall, New Jersey*.

MEC405E Metrology and Inspection 3-0-0

Introduction to Metrology: Definition, types, need of inspection, terminologies, methods of measurement, selection of instruments, measurement errors, units, Measurement standards, calibration, statistical concepts in metrology, Steel rule, calipers, vernier caliper, vernier height gauge, Vernier depth gauge, micrometers, universal caliper, Limits fits and tolerances, Interchangeability, selective assembly, limits, fit and tolerances, limit gauging, design of limit gauges, computer aided tolerancing.

Types of Measurements: Measurement of straightness, flatness, squareness, parallelism, roundness and cylindricity, non-contact profiling systems. Taper measurement, angle measurement, radius Measurement.

Measurement of Surface Finish: Introduction, terminology, specifying roughness on drawings, surface roughness parameters, factors affecting surface roughness, ideal surface roughness, roughness measurement methods, precautions in measurement, surface microscopy, surface finish softwares.

Screw Thread Metrology and Gear Measurement: Introduction, screw thread terminology, screw thread measurement. types of gears, gear terminology, errors in gears, advanced measurement of spur gear.

Interferometry: Principle of interference, interference bands, interference patterns, flatness interferometer, Gauge length interferometer.

Advanced Metrology: Advanced measuring machines, CNC systems, Laser vision, In-process gauging, 3D metrology, metrology softwares, Nano technology instrumentation, stage position metrology, testing and certification services, optical system design, lens design, coating design, precision lens assembly techniques, complex opto mechanical assemblies, contact bonding and other joining technologies.

Text Books / Reference Books:

1. Hume K. J., Engineering Metrology, *Macdonald and Co. Publishers, London.*
2. Smith G. T., Industrial Metrology, *Spinger Publications.*
3. John W. Greve, Frank W. Wilson Hand book of industrial metrology, *Prentice Hall of India.*
4. Anthony D. M., Engineering Metrology, *Pergamon Press.*
5. Khare M. K., Dimensional Metrology, *Oxford Publishers.*

MEC401G Finite Element Methods 3-0-0

Introduction to Finite Element Method: Introduction to finite element method, weak formulations, variational formulations, approximation functions, weighted residual methods, virtual work principle, natural and essential boundary conditions.

One Dimensional Problems: Discretization of domain, elemental equations, connectivity of elements, interpolation functions and their properties, linear, quadratic and higher order shape functions, assembly of element equations, local and global stiffness matrix and its properties, boundary conditions, solution of equations, applications to solid mechanics, heat transfer and fluid mechanics problems, axisymmetric problems, transient problems.

Two Dimensional Problems: Single variable problems in 2-D, triangular elements, linear and higher order triangular elements, area coordinates, rectangular elements, higher order rectangular elements, natural coordinates, serendipity elements, numerical integration, master element, coordinate transformations, Jacobian matrix, evaluation of element matrices, boundary integrals, assembly of element equations, post computations, computer implementation.

Trusses: Basic truss element, plane truss, local and global coordinate systems, stress calculations, solution of practical problems.

Plane Elastic Problems: Governing equations for plane stress and plane strain, Weak formulations, finite element models for plane elastic problems, evaluation of boundary integrals.

Text Books:

1. Reddy J. N., An Introduction to Finite Element Methods, *McGraw Hill Education (India).*

Reference Books:

1. Fish J. and Belytschko T., A First Course in Finite Elements, *John Wiley and Sons.*
2. Rao S. S., The Finite Element Method in Engineering, *Elsevier Publications.*
3. Liu G. R. and Quek S.S., The Finite Element Method; A Practical Course, *Butterworth Heinmann.*

MEC402G Non-Conventional Sources of Energy 3-0-0

Introduction: Role of energy in the development of society, Indian Energy Scenario, Conventional and Non-Conventional Sources, Energy demand and availability, Impact of energy use on the environment, Economic aspects.

Solar energy: Solar energy as an alternative source, Solar energy collectors, Focusing collectors, Estimation of direct and diffuse radiation, Analysis of flat plate collectors for air and water heaters.

Applications of solar energy: Solar heating and cooling of buildings, solar refrigeration, power generation from solar energy, solar ponds and solar stills, solar energy storage, principles of photovoltaic and solar cells.

Wind Energy resources: Global wind circulations; Indian sites for wind power; Aerodynamic design of wind turbine, Darreus rotor design, propeller type rotor design, blade loads, Governor and Yaw control; Economics of wind power.

Other non-conventional sources of energy: Biomass Conversions, MHD (Magneto-Hydro-Dynamic) Power generation system; Geothermal Energy; Energy from Ocean (Ocean Thermal Energy Technology and Energy from Tides).

Text Books/Reference Books:

1. Sukhatme S.P., Nayak J.K., Solar Energy and Applications, *McGraw Hill Education (India)*.
2. Khan B.H., Non-Conventional Energy Resources, *McGraw Hill Education (India)*.
3. Twidell J., and Weir T., Renewable Energy Resources, *Routledge*

MEC403G Principles of Management 3-0-0

Definition of management, science or art, manager vs entrepreneur; Types of managers managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches; Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management.

Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes.

Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management.

Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.

Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

Text Books/Reference Books:

1. Robins S.P. and Couiter M., Management*, Prentice Hall India.*
2. Stoner JAF, Freeman RE and Gilbert DR, Management, *Pearson Education.*
   Tripathy PC & Reddy PN, Principles of Management*, Tata McGraw Hill.*

MEC410C Industrial Engineering Lab 0-0-2

List of Experiments:

1. Ergonomic design of a product, equipment or work environment; at least 05 exercises and sessions.
2. To assemble and dissemble a given product and record the cycle time and draw learning curve of the operator performing the assembly.
3. Draw Out line process chart and two hand flow process charts for the assembly performed in experiment no. 2, and analyse the present method and also suggest improved method/s.
4. Study and draw of flow process charts (some suitable assembly operation)
5. Study and draw multi activity chart of a suitable method and propose better method/s.(Man and machine)
6. Study suitable movements/travel of man, material or equipment, and draw string diagram, travel chart and flow diagrams.
7. To calculate the standard time of a suitable job, using predetermined time standard techniques.

MEC411C Fluid Machines Lab 0-0-2

List of Experiments:

1. Performance Characteristic Tests on Pelton Wheel
2. Performance Characteristic Tests on Francis Turbine
3. Performance Characteristic Tests on Kaplan Turbine
4. Performance Characteristic Tests on Single Stage, Multi Stage Centrifugal Pumps at Constant Speed & at Variable Speed.
5. Performance Characteristic Tests on Axial Flow Pump.
6. Performance Characteristic Tests on Hydraulic Ram.
7. Performance Characteristic Tests on Reciprocating Pump at Constant Speed and at Variable Speed.
8. Performance Characteristic Tests on Gear Pump.
9. Performance Characteristic Tests on Screw Pump.