Syllabi of the Modules in Revised Curriculum

B.Sc. Engineering Honours Degree Programme
Mechanical Engineering Specialization
Department of Mechanical Engineering

Module Code	**ME1032**	**Module Title**	**Mechanics**			
Credits	**2.0**	**Hours/Week**	**Lectures**	**2**	**Pre – requisites**	**None**
GPA/NGPA	**GPA**		**Lab/Assignments**	**3/4**		

Learning Outcomes

After completing this module, the students should be able to demonstrate

- the ability to calculate rigid body forces and motions
- the ability to perform simple mechanics experiments
- the understanding of the basic concepts of dynamics
- the ability to model and solve basic systems in dynamics

Outline Syllabus

- Properties of plane areas
- Internal forces and principle of superposition
- Determination of forces in assemblies of rigid bodies
- Kinematics of particles and rigid bodies, 2D link mechanisms
- Kinetics of particles and rigid bodies, work and energy methods
- Mechanical vibrations (Free vibrations of single degree of freedom systems)

Module Code	ME1952	Module Title	Engineering Design			
Credits	1.5	Hours/Week	Lectures	2	Pre – requisites	None
GPA/NGPA	NGPA		Lab/Assignments	3/1		

Learning Outcomes

After completing this module, the students should be able to

- appreciate different design aspects of a product
- carryout challenging design tasks with limited resources
- develop creative solutions for engineering design problems

Outline Syllabus

Stage 1: Design Principles

- Introduction to Engineering Design
- Life Cycle of Engineering Products and Processes
- Design process and Design Tools
- Concurrent Engineering
- Creativity and Reasoning
- Analysis, synthesis, simulation, evaluation and decision makingBecoming professional engineer

Stage 2: Case Studies

Several simple but comprehensive design case studies selected from different disciplines of engineering addressing following topics:

- Design for manufacturing
- Mechanical and material aspect in design
- Electrical, Electronic and IT aspects in Design

Stage 3: Group based design assignments

- Introduction to design projects
- Improving creativity
- Appreciation of design aspects of existing product/s

Module Code	ME1962	Module Title	Engineering Skills Development			
Credits	1.5	Hours/Week	Lectures	1	Pre – requisites	None
GPA/NGPA	NGPA		Lab/Assignments	6/1		

Learning Outcomes

After completing this module, the students should be able to

- use a CAD software package for draughting and 3D modelling
- use basic machine tools and processes in an engineering workshop
- use free hand sketching for communicating engineering information
- develop and interpret engineering drawings for simple machine elements

Outline Syllabus

- *Introduction to computer aided draughting & modelling*
  - Draw orthographic projections using a CAD package
  - Introduction to 3-dimensional modelling on a CAD package
  - Carry out Engineering Graphics on the CAD system

- *Workshop practice*
  - Introduction to basic machining processes
  - Introduction to basic joining processes
  - Workshop safety

- *Engineering Drawing*
  - Orthographic Projection Methods: First angle projection, Third angle projection
  - Draw Orthographic Views: Draw orthographic views of objects from given pictorial views, Draw the third view from two orthographic views, Draw sectional views, Draw orthographic views of an assembled object Draw orthographic views of an assembly of a set of given components.
  - Isometric views: Drawing Isometric views with an isometric scale

Module Code	ME2122	Module Title	Engineering Drawing & Computer Aided Modelling			
Credits	3.0	Hours/Week	Lectures	2	Pre – requisites	ME1962 or MT1960
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes

After completing this module, the students should be able to

- draw the orthographic projections of a given mechanical part or assembly
- memorize graphical construction techniques in Engineering Graphics
- draw orthographic projections on a CAD package
- develop 3-dimensional models using a CAD package so as to be able to carry out Engineering Graphics on the CAD system
- describe the principles of parametric solid modelling with CAD packages
- use a CAD package to generate orthographic views a 3D model.

Outline Syllabus

Throughout the course, the concepts in Engineering Drawing will be taught using both manual draughting techniques as well as Computer-Aided Draughting.

Engineering Drawing

- *Orthographic Projection Methods:* First angle projection, Third angle projection

- *Orthographic Views:* Orthographic views of objects from given pictorial views, Third view from two orthographic views, Sectional views, Orthographic views of an assembled object Orthographic views of an assembly of a set of given components.

- *Loci:* Construction of Cycloids, Involutes, Helices

- *Lines and Planes:* Graphical Estimation of True lengths, Inclinations, Traces, Auxiliary Projection Methods & True Shapes of Sections

- *Interpenetration Curves:* Construction of Interpenetration curves of Cylinder, Cone, Sphere, Pyramid etc.

- *Developments:* Construction of Developments of Prism, Cylinder, Cone, Pyramid and Developments by the Method of triangulation

- *Isometric views:* Drawing Isometric views with an isometric scale

Computer-Aided Modelling

- *Draw orthographic projections using a CAD package*
- *Introduction to 3-dimensional modelling on a CAD package*
- *Carry out Engineering Graphics on the CAD system*
- *Introduction to parametric 3-dimensional modelling using Pro Engineer / SolidWorks*
- *Generate orthographic projections from the solid model.*

Module Code	ME1042	Module Title	Introduction to Mechanical Engineering Systems			
Credits	2.0	Hours/Week	Lectures	1	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes

After completing this course module, the students will be able to,

- Explain the scope of Mechanical Engineering field confidently
- Appreciate the application of Mechanical Engineering science in the products / systems used in day to day life
- Make informed decisions on intended specializations in the Mechanical Engineering field

Outline Syllabus

- *Introduction*
  Historical development of Mechanical Engineering field, Appreciation of Sri Lankan indigenous knowledge, Application areas of Mechanical Engineering, Difference between Engineering and Science.

  Case example – Automobile (The following areas of Mechanical Engineering should be introduced by taking an automobile as a case example. Students should be introduced how to prepare a portfolio for the course module. All the assignment outcome should be included in the portfolio)

- *Engineering Product Design*
  User needs, open ended nature of design problems, design aspects, use of CAD tools for design, future trends in product design, CAE, optimization, life cycle design, user population, environmental impact, recycling & reuse, value engineering

- *Engineering Communication*
  Importance of communication, technical report writing, technical presentations, use of physical models, use of software tools in engineering communication, use of Information Technology (IT).

- *Engineering materials*
  Introduction to different materials used to manufacture different parts of the automobile, properties of materials, importance of selecting right materials, factors considered in material selection, future materials

- *Manufacturing*
  Different manufacturing processes employed in manufacturing selected parts of the automobile, Introduction to advanced manufacturing processes, CAM

- *Mechanics of Machines*
  Mechanisms used in automobile propulsion systems, Importance in dynamic balancing of moving elements involved in an automobile, Optimal design of suspension units in minimizing noise and vibration of the automobile.

- *Energy & Thermal Systems*
  Different forms of energy, depletion of fossil fuel, renewable energy sources, energy audits, need for energy conservation, air pollution, EV technology, hybrid vehicles, and future energy sources for automobiles.

  Introduction to heat engine, heat transfer, air-conditioning, etc. using subsystems in an automobile. Attempts made to improve thermal efficiency, historical developments, and future trends.

- *Fluid Power Systems and aerodynamics*
  Introduction to aerodynamics of an automobile, fluid power systems, fans and blowers, lubricants.

- *Control Systems, automation and Mechatronics*
  Historical development of control systems, Introduction of centrifugal governor to control of a steam engine by James Watt, Importance of control system to achieve desired optimal performance, improved quality, reliability taking some simple examples from automobile vehicle, extreme importance of control systems in space vehicles, missile guidance and air craft piloting, modern trends in control systems and use of digital computers as a controller, Introduction to micro controllers.

  Introduction to Mechatronics systems in an automobile, use of sensors for monitoring, air flow, temperature, cam position, crank position, throttle position, amount of oxygen in exhaust gas and control of fuel injection for optimum performance, improvement of fuel economy, importance of mathematics in modeling and analyzing control system problems, man – machine interaction, development of robots GPS, driverless vehicles.

- *System Design*
  Integration, interfacing , synergy, compatibility, system approach in design, system optimization, constraints (technological, resource, knowledge …etc)

- *Human factors engineering*
  Ergonomic considerations in vehicle design, safety and comfort.

- *Electrical/ Electronic Systems*
  Introduction to electrical/electronic systems in an automobile, historical development of pure mechanical systems to electro-mechanical systems, future trends

- *Management*
  Project management, Design (data management), Manufacturing (production and operation management), Maintenance (maintenance of productive systems), Sales and marketing, financial management

Module Code	ME1052	Module Title	Fundamentals of Engineering Thermodynamics			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- explain basic laws of Thermodynamics and estimate heat and work quantities and thermal efficiency and the difference between various forms of energy
- recognize connections between thermodynamics and other related areas of study
- explain the concept of thermodynamic process and describe the different types of processes
- evaluate the limitations of, and the potential for, thermal-mechanical energy conversion in engineering cycles and devices
- apply the basic principles and laws of thermodynamics to an availability analysis of an energy conversion system.

Outline Syllabus

- *Introduction to Thermodynamics*
  Historical development, Thermodynamics Concepts and Terminology, Units and Conversions

- *Energy*
  Heat and Work and their estimations

- *Ideal gases and pure substances.*
  Introduction to properties of ideal gases and real substances

- *First Law of Thermodynamics*
  Closed and Open Systems, Steady state steady flow processes, Transient processes

- *Second Law of Thermodynamics*
  Reversible and Irreversible Processes, Entropy, Second Law Applications

- *Thermodynamic Cycles*
  Heat engines, Heat pumps

- *Availability Analysis*
  Concept of availability, Availability transfer with heat and work interaction, Availability of closed and open systems and quantification of irreversibilities,

Module Code	ME1062	Module Title	Public Speaking & Negotiation Skills			
Credits	1.0	Hours/Week	Lectures	0.5	Pre – requisites	None
GPA/NGPA	NGPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- apply different negotiation strategies to conduct winning negotiations.
- apply psychology principles to negotiate effectively.
- successfully solve different conflicts that arise in organizations and in society with different levels of people.
- deliver motivational and persuading speeches.
- apply different public speaking techniques to make effective and attractive speeches at any event.
- deliver technical presentations effectively

Outline Syllabus

- *Fundamentals of public speaking*
  How to overcome nervousness in public speaking; How to organize a speech considering opening, body, conclusion and timing constraints; How to be a credible speaker

- *Different techniques of making effective presentations/ speeches*
  Use of body language, facial expressions and vocal variety to convey the message effectively; Use of visual aids effectively; Use of power and emotion to persuade an audience which is apathetic, hostile or mixed; How to inspire an audience

- *Use of different technical presentation techniques*

- *Key elements of negotiation*
  Understand the relationship between conflict and negotiation, Identify the key roles and responsibilities required by the negotiation team

- *Types and levels of conflicts*
  Organizational conflict, social conflicts; Intra- personal conflict, inter- personal conflicts, intra- group conflicts, inter-group conflicts

- *Implementing an effective negotiation process,*
  Preparation, opening position, bargaining, movement, closing

Module Code	ME2022	Module Title	Manufacturing Processes I			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- explain the mechanics of machining processes, and their applications for different operations
- make a proper selection of manufacturing materials and tool materials for a given manufacturing process
- select the best machining operation(s), and plan out optimum machining process(es) for same
- use the principles of engineering metrology to assure quality of products.

Outline Syllabus

- *Overview of Manufacturing Engineering in the present context,*
- *Introduction to selected manufacturing processes*
  Casting, Fabrication, Hand tools and their importance.
- *Introduction to machining operations*
  Classification of machining operations and machine tools, Mechanics of Machining, Mechanics of chip formation, types of chips, Built-up-Edge, Tool life, Surface finish, integrity, Cutting forces and power.
- *Engineering materials and Tool materials*
  Selection of work-piece materials and tools, correlating them to process and each other.
- *Detailed study of principal Machining Processes*
  Machines and Tools used, Sawing, Drilling, Boring, Reaming, Tapping, Lathe, Shaper, Milling, Grinding, Abrasive machining, Finishing, Planing, Broaching, Gear manufacture etc
- *Introduction to Numerical Control (NC) and Computer-Aided Design & Manufacturing (CAD/CAM).*
- *Surface treatment and finishing*
  Painting, Galvanizing, Cold galvanizing, Epoxy coating, Electroplating, etc., Powder spray technology and its use as a refilling and repair technology for expensive and large items.
- *Engineering Metrology and Instrumentation*
  Basic measuring instruments in precision metrology, Tolerances, Limits and fits, Measurement of surface texture and geometric errors, Coordinate measuring machine, Advanced measuring instruments.

Module Code	ME2112	Module Title	Fluid Dynamics			
Credits	2.0	Hours/Week	Lectures	1.5	Pre – requisites	CE1022
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this course, the students should be able to

- appreciate the concepts of fluid dynamics and recognize associated engineering problems
- describe ideal fluid flow analysis techniques and solve simple problems
- describe the viscous effects in real fluid flow and solve problems of flow through simple bounded systems
- explain the techniques of dimensional analysis and similarity theory and solve typical problems in mechanical engineering applications.

Outline Syllabus

- *Introduction*
  Properties of fluid in motion. Classification of fluids and flows. Behaviour of real fluids: Laminar and Turbulent flow, Reynolds Number, Basic flow analysis techniques and associated engineering problems.

- *Governing Equations in Fluid Mechanics*
  Continuum Approach, Methods of description of fluid motion, total derivative, conservation of mass, kinematics of flow - flow lines, fluid rotation and rate of deformation, angular velocity, circulation and vorticity, shear rate, stresses, hydrodynamic pressure, constitutive relation, conservation of momentum and energy, Navier-Stokes equation. Boundary conditions.

- *Ideal Fluid Flow*
  Euler's and Bernoulli's equations. Stream function and velocity potential function in steady, two dimensional flows. Flow singularity modeling - flows resulting from simple combinations of a uniform stream, source, sink, doublet and point vortex. Applications of flow singularity modeling - ideal flow around a circular cylinder with circulation.

- *Viscous Flow*
  Characteristics of viscous flow over a solid boundary - boundary layer formation, laminar flow, transition to turbulent, flow separation and formation of wake. Characteristics of turbulent flow.
  Viscous flow through bounded systems - entry region, fully developed laminar and turbulent flow. Applications - steady, fully developed laminar flow of Newtonian and Non-Newtonian fluids through simple bounded systems, velocity and shear stress distributions, energy loss due to friction, Darcy formula.

- *Dimensional Analysis and Similarity Theory*
  Introduction, fundamental and derived dimensions, dimensional homogeneity. Methods of dimensional analysis - Rayleigh's method, Buckingham's Pi - theorem. Physical significance of non-dimensional groups. Theory of physical similarity and model testing. Application - Flow through bounded systems, flow around submerged bodies, free-surface flows, distorted models.

Module Code	ME2092	Module Title	Mechanics of Machines I			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	ME1012
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- demonstrate a sound knowledge and understanding of the important principles in Mechanics of Machines
- analysis and solve simple but realistic problems in Engineering Mechanics
- recognize the relevance of the principles of Mechanics of Machines in the Design of Machine Elements.

Outline Syllabus

- *Method of Virtual Work*.
  Principle of virtual work, Equilibrium and stability based on potential energy.

- *Planar Linkages.*
  (Velocity Diagrams), Acceleration diagrams, Linkages involving sliding connections, Coriolis acceleration, Kinetics of plane mechanisms, estimation of loads on elements including inertia effects.

- *Gear Drives*.
  Geometry of spur gearing, External and internal gearing, Epicyclic gear trains, Speed – Torque relationships.

- *Balancing of Rotating Masses*.
  Static and dynamic balancing of shaft-rotor systems

- *Balancing of Reciprocating Masses*.
  Out of balance in slider-crank mechanism, Balancing of in-line engines and V-engines.

- *Single Degree of Freedom Vibrations*.
  Response of viscous damped systems to harmonic excitation, Response of viscous damped systems to ground vibration, dynamic magnification, transmissibility.

- *Turning Moment Diagram and Flywheel.**

  Engine torque computation, Fluctuation of speed and energy, Moment of inertia of flywheel.

* To be carried out as a course-work assignment.

Module Code	ME2012	Module Title	Mechanics of Materials I			
Credits	2.0	Hours/Week	Lectures	1.5	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- explain the basic concepts and laws of Mechanics of Materials and their application in the analysis and design of actual engineering structures and machine components
- analyze certain problems of particular Mechanical Engineering interest with emphasis on their importance to safe design
- recognize the relevance of these concepts in understanding the subject ME 2142 Machine Elements & Innovative Design.

Outline Syllabus

- *Introduction*
  Types of engineering components, Different forms of loading and support conditions, Types of joints,
- *Concept of stress*
  Static equilibrium , Internal forces, Direct stress, Shear stress, Uni-axial stress systems
- *Introduction to Elasticity : Stress and strain*
  Direct and shear strains, Deformations, Displacements, Boundary conditions, elastic properties of materials, Hooke's Law, Poisson's Ratio, Thermal strain and deformation, Saint-Venant's Principle, Statically indeterminate problems. Elastic strain energy, Thin-walled spherical and cylindrical pressure vessels.
- *Bending of Beams*
  Shear forces & bending moments in beams, Theory of simple bending, Bending stress distribution, Combined loading
- *Torsion of circular bars*
  Torsional shear stress distribution in circular bars, Angle of twist, Torsional strain energy applications: shaft coupling, propeller shafts.
- *2D Stress transformation*
  Transformation of stresses in 2D problems, Principal stresses, Mohr's circle of stress, combined loading
- *Deflection of beams*
  Moment-curvature relation, Governing differential equation, Direct integration solutions, Singularity functions
- *Buckling Instability of Columns*
  Euler critical loads for combinations of free, pinned and built-in end conditions, limiting stress conditions

Module Code	ME2602	Module Title	Motor Vehicle Technology			
Credits	2.0	Hours/Week	Lectures	1.5	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the student should be able to

- locate and recognize the different parts of an automobile.
- identify different types of motor vehicle systems.
- describe basic principles behind automotive system operations.
- classify automobile systems based on the operation.
- carryout performance calculation of automobile systems.

Outline Syllabus

- *Introduction to Motor Vehicle Systems.*
  History of Automobiles, Types of motor vehicles, layout and configuration, Introduction to Power train and Vehicle Performance, Introduction to automotive subsystems, Body and chassis.

- *Working Principles of Engines*
  Types of engines, Different engine layouts. Introduction to gasoline engines, Introduction to diesel engines, Measurements and testing of engines.

- *Transmission System*
  Different engine and gearbox layouts, Clutch, Manual gearboxes, Final drive. Transmission calculations, Introduction to automatic gearboxes.

- *Braking System*
  Vehicle dynamics in acceleration and braking, Drum brakes, Disk brakes, Brake components, Introduction to advances in brake technology.

- *Steering System*
  Basic steering geometry, Layout and operation, Power assisted steering.

- *Suspension System*
  Basic suspension geometry and operation, Introduction to advances in suspension technology.

- *Electrical System*
  Basic electrical system and ignition circuit, EFI and ECU

- *Legislation*
  Motor Traffic Act, Fitness tests, Emission standards

<table>
<tr><td>Module Code</td><td>ME2902</td><td>Module Title</td><td colspan="4">Industrial Visits</td></tr>
<tr><td>Credits</td><td>1.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>-</td><td rowspan="2">Pre – requisites</td><td rowspan="2">None</td></tr>
<tr><td>GPA/NGPA</td><td>NGPA</td><td>Lab/Assignments</td><td>6/2</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

After completing this module, the student should be able to
• describe important aspects of industrial processes and environment,
• demonstrate the ability to understand the application of theory into practice,
• appreciate the real life applications of engineering principles.
• appreciate the responsibilities of an Engineer in the industrial sector.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

• Visits to the facilities of selected industrial sectors,
• Discussions and Presentation of findings.</td></tr>
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Module Code	ME2032	Module Title	Thermodynamics of Heat Engines & Work Transfer Devices			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	ME1052
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- analyze and estimate the behavior and performance of standard vapour and gas power cycles and their derivatives.
- analyze the performance and behavior of compressing and expanding, work transfer devices.
- analyze steady compressible fluid flow and related applications.
- explain the principles of combustion and analyze combustion processes.

Outline Syllabus

- *Review:*
  Heat engines, heat pumps, Ideal cycles, Difficulties encountered in physically realizing ideal cycles.
- *Brief Overview of Thermodynamic Cycles:* The concept of a Working fluid, Vapor Power Cycles and Electrical Power Generation, Gas Power Cycles, Refrigeration Cycles.
- *Vapour Power Cycles:* Carnot and simple Rankine cycle, Actual vapour power cycle, Means to increase the efficiency of the Rankine cycle, Second law analysis of vapour power cycles, Cogeneration, Binary cycles.
- *Gas Power Cycles:* Air standard assumptions, Otto, Diesel, Ericsson and Stirling cycles, Brayton Cycle with inter-cooling, reheating and regeneration, Deviation of actual cycles from ideal cycles, Open and closed circuit gas turbine cycles, Combined cycles and Jet Propulsion.
- *Turbines:* Classification of turbines, Governing equations and velocity diagrams, Axial flow impulse turbines – simple, velocity and pressure compounded, Axial flow reaction turbines, diagram efficiency and reheat factor, Sizing of turbines, Gas Turbine Performance.
- *Air Compressors:* Reciprocating and rotary compressors, Multi stage compression with inter-cooling, Performance indices of volumetric efficiency.
- *Compressible Fluid Flow:* One dimensional flow of gases and vapours through nozzles and diffusers, Critical conditions and choking, Concept of stagnation properties, Mechanism of shock wave generation and analysis of flow with shock waves, simple consideration of jet propulsion.
- *Combustion:* Fuels and their characteristics, Combustion of fuels, First law analysis, Adiabatic flame temperature, Burners, Combustion chambers.

Module Code	ME3072	Module Title	Manufacturing Processes II			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	ME2022
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- explain the metal-casting processes available and their applicability and suitability in the relevant context
- differentiate the mechanisms of Fabrication processes and identify their applicability and suitability in relevant context
- select appropriate metal forming processes based on their applicability and limitations.
- recommend different methods for forming & shaping of plastics and processing of powder metals & ceramics
- select appropriate composites for various engineering applications.

Outline Syllabus

- *Metal Casting*
  Sand casting, Shell mould casting, Slurry processes, Investment casting, Die-casting, Centrifugal casting, Continuous casting, Melting practice, Cast structures , properties and defects, Basic mould design.

- *Fabrication*
  Mechanical Fasteners, Metallurgical processes,Welding, Brazing, and Soldering, Bonding processes.

- *Mechanics of Forming,*
  Yielding and Plastic flow, Tresca's criteria, Hydrostatic stress systems, Hot/Cold/Warm Forming, Re-crystallization and Work-hardening, Grain structure, Comparison of Machining and FormingSheet Metal Forming Processes,
  Bending, Shearing, Roller shears, Punching, Blanking, piercing etc, Dies and punch sets, Cup/Deep Drawing, Drawing ratios and limitations, Spinning, Shear and Flow Forming, equipment and machinery used Tolerances and parameters etc.

- *Volume Forming Processes,*
  Upsetting, Open die forging, Closed die forging, Roll Forging, Swaging, Extrusion, Machinery & lubricants used), Drawing, Rolling, Bending of Bars, Pipes, Tubes, and machinery used and precautions to be taken, Hammers, Presses and their Characteristics, Bolt and Nut Formers and Basics of their tool design.

- *Glass, Rubber, Plastics, ceramics and Epoxies in engineering applications*
  Use of Fibre glass and fibre glass manufacturing technologies – Basic processes, making moulds, Filament winding techniques, Spray methods, Fibre glass combined with other reinforcements, Composites and honeycomb structures.

- *Processing of Powder Materials & Ceramics*

Module Code	ME3032	Module Title	Mechanics of Machines II			
Credits	2.0	Hours/Week	Lectures	1.5	Pre – requisites	ME2092
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- demonstrate a sound knowledge and understanding of the important principles of Three Dimensional Kinematics and Kinetics of Rigid Bodies
- demonstrate a sound knowledge and understanding of the methods of Modeling and Analysis of Vibrations of Multi Degree of Freedom Systems and Continuous Systems
- analysis and solution of realistic problems in Three Dimensional Dynamics and Advanced Vibrations of a moderate level of difficulty.

Outline Syllabus

- *Three Dimensional Kinematics of Rigid Bodies.*
  Time derivative of a vector in a moving frame, Applications including computation of linear velocities and angular velocities of bodies undergoing motion in three dimensions.

- *Three Dimensional Kinetics of Rigid Bodies.*
  Angular Momentum, Inertia Tensor, Relationship between the moment of forces and the rate of change of angular momentum about a moving point, Gyroscopic Couple, Choice of origin for angular motion, Euler's Dynamical Equations, Applications including computation of the gyroscopic couple acting on bodies undergoing three dimensional motion.

- *Two Degree of Freedom Vibrations.*
  Free and forced vibrations of two degree of freedom systems, Undamped vibrations, Natural frequencies and natural modes, Viscous damped vibrations, Vibration absorbers.

- *Vibrations of Multi Degree of Freedom Systems.*
  Mass matrix, Stiffness matrix, Mode shapes, Orthogonality of modes, Dunkerley's method, Rayleigh's method, Rayleigh-Ritz method, Matrix iteration method, Torsional vibrations, Holzer method, Applications including torsional vibrations of power transmission systems.

- *Undamped Vibration of Continuous Systems.*
  Governing equations, Natural Frequencies and modes of vibration of simple continuous systems, Approximate methods including the assumed modes method, Applications including vibrations of beams.

- *Whirling of Shafts.*

Module Code	ME3062	Module Title	Mechanics of Materials II			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	ME2012
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- explain the basic concepts of mechanics of materials and their application in engineering practice.
- demonstrate knowledge and understanding of various failure mechanisms and the appropriate criteria for their assessment
- apply this knowledge to a Comprehensive Design Project (eg. ME 3052 Machine Design & Project).
- use the techniques, skills, and modern engineering tools necessary for contemporary engineering practice.
- assess the safety and economy of design for key engineering components.

Outline Syllabus

- *Theory of Elasticity*
  Equilibrium, 3D stress at a point, Strain-displacement relationship, Equations of compatibility, Stress-strain relationship, Introduction to Stress Function approach (plane stress/ strain)

- *Unsymmetrical Bending of Beams*
  Bending of beams of asymmetric cross sections, Composite beams

- *Shear Stresses in Beams*
  Introduction, Shear flow, Shear stress distribution in beams, Shear stress in beam flanges, Centre of shear, Stresses in closely coiled helical springs

- *Torsion*
  Torsion of non-circular sections, Thin-walled closed sections & open sections

- *Strain Measurements*
  Generalised Hooke's Law, Mohr's circle of strain , Strain measurements, Strain gauges

- *Failure Criteria*
  Failure by yielding and fracture, Yielding theories of failure, Comparison of the yielding theories

- *Axi- Symmetric Components*
  Cylinders, shafts and discs under axi-symmetric loading, Thick-walled cylinders, Lame's equations, Application of failure theories, Compound cylinders, Rotating discs,

- *Energy methods*

Introduction, Strain energy and complementary strain energy theorems, Castigliano's theorem, Statically indeterminate systems

- *Theory of Plasticity*
  Introduction, Theory of plastic bending, plastic limit analysis of beams, Collapse load of structures, Elastic-plastic torsion, Elastic-plastic stresses in thick cylinders and rotating discs

- *Fatigue Failure*
  Cyclic loading, Failure criteria for metal fatigue, Fatigue life under combined loading, Cumulative damage, Low-cycle fatigue

- *Creep and Viscoelasticity*
  Failure by creep, Introduction to viscoelastic materials

- *Numerical Methods*
  Introduction, Finite difference equations, Finite element method (FEM), Formulation of the FEM

Module Code	ME2142	Module Title	Machine Elements and Innovative Design			
Credits	3.0	Hours/Week	Lectures	2	Pre – requisites	
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes

After completing this module, the students should be able to

- design basic machine elements considering design criteria such as strength, rigidity, reliability, fatigue life, etc.
- demonstrate the ability to develop innovative solutions for basic design problems
- communicate design information through production drawings, calculation reports, etc.

Outline Syllabus

- *Introduction*
  Basic Design Considerations, Design Methodology, Traditional and Innovative Design, Design Standards, Designing for static and dynamic loading.

- *Load and Stress analysis*
  Analyze the flow of forces through simple machine elements and compute stresses in critically loaded sections. Analysis of common causes of failure of machine components.

- Introduction to design of machine elements using a case study of a design problem
  Design of riveted, threaded, welded and press-fitted joints, Design of keys and splines, bearings, couplings, Design of shafts and axles, gear drives, belt drives, Springs, Cams and Flywheels

Module Code	ME2952	Module Title	Social/Community Project			
Credits	1.0	Hours/Week	Lectures	-	Pre – requisites	ME1032
GPA/NGPA	NGPA		Lab/Assignments	3/1		

Learning Outcomes

After completing this module, the students should be able to

- demonstrate the desire for fulfilling social responsibilities.
- demonstrate the ability to recognize the diverse needs of the society
- provide technical solutions for basic needs of the society.

Outline Syllabus

- *Visits to selected social groups / villages / rural industries*
- *Identification of real social needs*
- *Develop and Implement solutions for identified problems through social projects.*

Module Code	CS2882	Module Title	Object Oriented Programming using C++			
Credits	3.0	Hours/Week	Lectures	2	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes

After completing this module, the students should be able to

- develop programs to solve problems in the field of Mechanical engineering
- develop objects for applications in specialized areas of interest
- apply the basic concepts in Object Oriented Programming for application development in ICT.

Outline Syllabus

- *Introduction to C++*
- *Basic elements of C++*
  Variables, constants, control structures, single and multi dimensional arrays
- *Functions*
  Built in functions, User defined functions, Function overloading, Template functions
- *Pointers and strings*
- *Structures and Classes*
- *Object Oriented Programming*
- *Inheritance & Polymorphism*
- *Operator overloading and data type conversions*
- *Exception handling Console I/O Operations and File handling*
- *Introduction to UML and visual programming*

Module Code	ME3012	Module Title	Control Systems & Instrumentation			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	EN 2852 EE 2852
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- identify the sensors and transducers commonly used and describe the basic principle of operation
- select the required signal conditioning for a particular application and explain the basic principles of operation
- describe the use of instrumentation and data loggers
- model basic physical systems related to electro-mechanical systems, fluid systems etc.
- explain the basic principles and compare the differences and similarities among motors and actuators
- explain the behavioral patterns of open loop and closed loop control systems
- find the system stability in a closed looped control system
- describe the behavior of the system response from a Root Locus Diagram, Frequency response analysis from Bode plot, polar plot
- program a programmable logic controller for a given logic function, time intervals and counting purposes and download and upload the PLC program.
- recognize the basics of PID controller for closed loop systems

Outline Syllabus

- *Sensors, signal conditioning and instrumentation:* Sensors, Transducers, Signal conditionings, Measurement systems, Data loggers and recorders
- *Motors, actuators and valves:* characteristics of pneumatic, electrical and hydraulic actuators and valves, characteristics of electro-mechanical, electro-pneumatic and electro-hydraulic valves
- *Mathematical modeling of physical systems:* Mathematical modeling related to mechanical, electrical, hydraulic and pneumatic systems, electro-mechanical systems and combined systems. Laplace transforms, Simplify the system using block diagram algebra
- *Introduction to Control Systems:* Definitions, Open loop and Closed loop systems, Open loop and closed loop transfer functions
- *Stability and time domain analysis for control systems*
  Dynamic response of systems, Time domain analysis of first order and second order control systems. Routh's Stability criterion, Root locus techniques
- *Frequency domain analysis*
  Frequency responses, Bode plot, Polar plot, Relative stability with definition of Gain margin and Phase margin.
- *Programmable logic controllers:* Basic use of PLC, Ladder logic, Timers and counters
- *Closed Loop controllers:* Two step control, P, PD, PI and PID controllers

Module Code	ME3022	Module Title	Fluid Power Systems & Machinery			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	ME2112
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- appraise the concepts of fluid dynamics and associated engineering problems.
- classify fluid machinery and determine their performance characteristics.
- analyze fluid power transmission systems.
- analyze simple problems associated with boundary layers.
- investigate engineering problems associated with particle mechanics.
- classify lubrication regimes and analyze engineering problems associated with lubrication.
- analyze fluid flow systems encountered in mechanical engineering applications.

Outline Syllabus

- *Fluid Power Transmission Systems:* Introduction to pneumatics and hydraulic power transmission systems. Hydraulic oils, Components in a fluid power systems, International standard symbols, Circuit diagrams, Pump-Motor Characteristics, Load characteristics, Basic circuits: Flow, pressure and directional control valves, accumulators, basic hydraulic circuits, Circuit design.

- *Lubrication:* Functions of lubrication, types and properties of lubricants. Regimes of lubrication, Hydrostatic lubrication - Pressure distribution and load carrying capacity, Hydrodynamic thrust bearings - Pressure distribution and load carrying capacity, Summerfeld solutions.

- *Boundary Layer Theory:* Boundary layer flow over a flat plate - Laminar and turbulent, Boundary layer thickness, Von-karman momentum integral, Boundary layer control, Turbulent flow.

- *Particle Mechanics:* Characteristics of flow around a particle - Pattern of flow, pressure distribution and force coefficients at different Reynolds number regimes, Motion of a particle in a gravitational field – trajectory, Flow through packed bed of solid particles - Karman-Kozeny equation for fixed bed, Fluidization, Industrial applications.

- *Fluid Machinery:* Classifications - Pumps, Fans, Blowers, Compressors and Turbines and Hydraulic actuators, Pumps - Head-Flow rate characteristics, Euler equation, pump losses, Cavitation, Dimensional analysis, Pump selection, Pump system performances, Pump control techniques.

- *Design of Industrial Flow Systems:* Energy loss in fluid flow systems, Resistance to flow in straight circular conduits, Darcy formula, Moody diagram, losses in non-circular sections, equivalent diameter, curved ducts, Local losses - Resistance to flow in equipment and fittings: Methods of representation, K - Factor method, Equivalent length method, entrance loss, exit loss, losses in pipe bends, junctions, Losses in fluid flow equipment.

Module Code	ME3052	Module Title	Machine Design and Project			
Credits	4.0	Hours/Week	Lectures	3	Pre – requisites	ME2122 ME2142
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes

After completing this module, the students should be able to

- develop innovative solutions to real problems
- carryout a comprehensive design task with confidence
- communicate design information through technical reports, engineering drawings, computer representations, oral communication, etc.
- demonstrate the ability to work as a team to manage a comprehensive design project.

Outline Syllabus

- *Design Methodology*
- *Design optimisation*
- *Conceptual design*
  Concept generation techniques, Concept selection
- *Selection of materials*
- *Detailed design calculation*
  Load and stress analysis, Electric motors and selection
- *Geometric modelling*
- *Production drawings*
- *Project*
  Design of a practical industrial machine or equipment

Module Code	ME4042	Module Title	Production and Operations management			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	2/2		

Learning Outcomes

After completing this module, the students should be able to

- describe the importance of production and operation management; and the role of production and/or operations manager
- apply the knowledge appropriately to identify the problems and provide solutions in forecasting, facilities planning and inventory management
- identify and make relations among different planning functions in production systems
- develop skills in collaborative learning.

Outline Syllabus

- *Introduction to Production Management*
  Production and operations systems, Production and operation strategy and competitiveness, Role of Production and/or operations manager
- *Production and Sales Forecasting*
  Demand management, Types of forecasting, Qualitative methods of forecasting, product development, new products, time series forecasting, moving average, exponential smoothing, trend correction and seasonal trends
- *Facilities Planning*
  Issues in facility location, Selection of plant location, Strategic (long term) capacity planning, Basic production layout format, Systematic layout planning (SLP), Materials handling, equipment & mathematical models, Assembly lines and their types, Manual and automatic assembly process, Inter-station buffers, Assembly line balancing: Kode-row method, method of ranked-positional-weights
- *Introduction to Project Management*
  Concepts and techniques of project management, Applications of project management in industries, Gantt charts, CPM, PERT, Application of tools & techniques
- *Production Planning*
  Overview of production planning activities, Aggregate planning methods, linear programming models, Conversion of forecasts to production quantities, Master production scheduling
- *Inventory Management*
  Basic concepts and procedures in inventory management, Independent and dependent demand environments, Economic Batch Quantity (EBQ), Reorder point, Deterministic and probabilistic situations, Safety stock

Module Code	ME3082	Module Title	Technical Report Writing			
Credits	1.0	Hours/Week	Lectures	0.5	Pre – requisites	None
GPA/NGPA	NGPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- effectively communicate technical information in written format
- prepare technical documents depending on the target audience.

Outline Syllabus

- *Document design*

- *Technical writing process*
  Audience analysis, Topic ideas, brainstorming, narrowing and outlining, Note taking and rough-drafting, Power-revision techniques, Referencing, Strategies for peer-reviewing and team-writing.

- *Technical writing guidelines*
  Basic patterns and elements of a sentence, common grammar, usage and punctuation problems, Common spelling problems.

- *Critically evaluating document*
  Explaining a point, Agreeing to a point, Disagreeing to a point, Defending a decision.

- *Effective use of software tools for document formatting*

- *Technical writing scenarios & applications*
  Types of technical reports and different types of content, Project proposals, Progress reports, instructions, User guides, Feasibility, evaluation and recommendation reports, Business plans, Writing abstracts, introductions and conclusions.

Module Code	ME3612	Module Title	Intellectual Property			
Credits	2.0	Hours/Week	Lectures	2	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	-		

Learning Outcomes

After completing this module, the students should be able to

- interpret basic concepts and principles of IP and act(s) and related treaties.
- explain the scope(s), applications and limitations of IP related laws.
- explain the relation and interaction of patents with Inventions and Innovations.
- write a basic draft of a patent and evaluate a simple Patent.

Outline Syllabus

- *Introduction to IP:* Basic norms of IP and Rationale and policy underlying IP, IP act No. 36 of 2003 of Sri Lanka and other provisions

- *Overview of International IP regulations and covering treaties:* WIPO, Paris convention, Berne convention, TRIPS agreement and Patent Cooperation Treaty.

- *Overview of Basic Divisions of IP:* Copyrights, Subject matter, Protected works, 'Originality', Idea and Expression, Works not protected, Protected rights, Limitations to rights including fair use, Duration of Copyrights, Acquisition and ownership, Infringement and remedies, Protection in other countries.

- *Industrial Designs:* Subject matter and rationale, Protectable designs and Novelty, Ownership, Acquisition and registration, Rights and limitations of registered owner, Assignment and License contract, Protection in other countries, Enforcement and remedies.

- *Marks:* Subject matter and rationale, Rights of the owner and limitations, Acquisition, Assignment and license, Infringement and remedies, Protection of unregistered marks, Protection in other countries.

- *PATENTS:* Definition of a Patent, Inventions and patentability, Inventor's right to a patent in general, Acquisition of rights, Specifications, Disclosure of the invention, Abstract and Claims, Rights of the owner and limitations, Exceptions to patentability, Assignment and Licensing, Enforcement, Protection in other countries, PCT applications, Basics of drafting a Patent applications, Examination of a Patent,

- *Unfair Competition and Confidentiality:* Honest practices and unfair competition in commerce, Protection of Inventions and other IP rights, Undisclosed information, Trade secrets etc.

Module Code	ME3992	Module Title	Industrial Training			
Credits	6.0	Hours/Week	Lectures	-	Pre – requisites	None
GPA/NGPA	NGPA		Lab/Assignments	40/1		

Learning Outcomes

After completing this module, the students should be able to

- explain the organizational structure and safety policies of the organization.
- work with persons of various personalities efficiently as a team.
- appreciate the application of engineering and management techniques in the real world.
- relate the theoretical concepts learnt at the University to practices in the industry.
- cultivate powers of observation and make use of the facilities provided to fulfil the needs of the industry.

Outline Syllabus

Gain experience in one or more of the following areas

1. Manufacturing technologies
2. Manufacturing systems
3. compressed air systems
4. Refrigeration & Air-Conditioning Systems
5. Steam Generating and Distributing Systems
6. Automotive Systems
7. Power Hydraulic Systems and Pneumatic Systems (PHPS)
8. Control Systems
9. Maintenance of Machinery
10. Management of organisation*
11. Electric Drive Systems and Other Electrical Equipment*

* if a student selects areas 10 and/or 11, he/she has to select a facility that cover one or many of the other areas from 1 to 9 as well.

Module Code	ME4202	Module Title	Design / Research Project			
Credits	10	Hours/Week	Lectures		Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments			

Learning Outcomes

After completing this module, the students should be able to

- carryout comprehensive design / research projects with confidence.
- work in teams to solve challenging engineering problems by putting theory and industrial exposure to practice.

Outline Syllabus

Carryout a comprehensive group project appropriate for local industry or community, preferably covering literature survey, construction & testing, analysis of test results and financial analysis.

Lectures

- Introduction to Design / Research Project
- Communication skills: Oral presentations
- Proposal writing for funding
- Project cost estimation
- Literature survey for project report writing
- Project management
- Communication skills: Technical report writing

Deliverables / Presentations

- Project Synopsis
- Presentation: Project proposal
- Project proposal for funding
- Literature Review report (Individual)
- Presentation: Literature Review
- Final Project Report
- Presentation: Final Project outcome
- Extended abstract

<table>
<tr><td>Module Code</td><td>ME4902</td><td>Module Title</td><td colspan="4">Guest Lectures and Presentations</td></tr>
<tr><td>Credits</td><td>1.0</td><td rowspan="2">Hours/Week</td><td>Lectures</td><td>1</td><td rowspan="2">Pre – requisites</td><td rowspan="2">ME1032</td></tr>
<tr><td>GPA/NGPA</td><td>NGPA</td><td>Lab/Assignments</td><td>-</td></tr>
<tr><td colspan="7"><u>Learning Outcomes</u>

After completing this module, the student should be able to
• demonstrate the ability to synthesis and summarize the contents in guest lectures and presentations,
• demonstrate the enhancement in presentation skills.</td></tr>
<tr><td colspan="7"><u>Outline Syllabus</u>

• Guest lectures and presentations by selected professionals.</td></tr>
</table>

Module Code	ME4512	Module Title	Industrial Products, Machinery & Equipment Design			
Credits	3.0	Hours/Week	Lectures	2	Pre – requisites	ME2142 ME3052
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes

After completing this module, the students should be able to

- comprehensively analyze the existing conditions and level of industry and technology in operation, and accordingly adapt the design strategy to suit the specific situations and environment.
- conduct feasibility analysis, economic and financial aspects and evaluation of related Market potential of products / machinery.
- critically analyse and design products, machinery and equipment encountered in real life.
- lead a multi-disciplinary design team, working as the team leader.
- carry out an innovative design, re-engineering, adaptation, modification.

Outline Syllabus

- *Overview of design methodologies*
  Comparison of conventional design, design by evolution, and innovative design, Adaptive and inventive innovation, Re-engineering as an effective tool for upgrading and innovative upgrading in lieu of replacement.

- *Design for functionality*

- *Design for operation and Maintenance.*

- *Human factors in design*
  Application of Ergonomics, Aesthetic aspects etc in product design.
- *Design for retirement and its impact on the environment.*

- *Design for manufacture and marketing.*

- Re-engineering, Innovative adaptation and inventive adaptation, How to develop, nurture and upgrade inventive abilities of designers, Blocks to Innovation, Idea generation etc.

- *Design optimization and analysis*: Force flow lines, Stress conversion to pure tension or compression, material optimization through webs, ribs, composites etc-, Value Analysis and Value Engineering, “buy or make?” Standardization.

- *Introduction to use and application of design standards.*

- *Case studies:* Explain above design concepts through case studies.
- *Assignments:* Appreciation of above design concepts using real life examples.

Module Code	ME4332	Module Title	Computer Aided Design & Manufacture			
Credits	4.0	Hours/Week	Lectures	3	Pre – requisites	ME3052
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes

After completing this module, the students should be able to

- apply advanced curve modelling techniques for computer graphics.
- use commercially available application software for surface and solid modelling
- use of translation, rotation, scaling, perspective transformation, projections operations etc. for mathematical modelling for computer graphics
- write part programmes for CNC machines
- use computer-aided tools and techniques for manufacturing and process planning
- implement computer networks for shop floor communication and control

Outline Syllabus

- *Revision of Mathematics of Natural Curves and Curve Manipulations:*
  Explicit and implicit representation of curves and surfaces, Parametric representation of curves such as line, circle, ellipse, parabola, hyperbola, catenary, Bicubic representation of surfaces, Parabolic blending of two curves

- *Curve and Surface Design using Cubics:* Use of Hermite Cubics for 2-D and 3-D curves, Use of Hermite cubics for surfaces, Curve and Surface Design using B-spline Method B-spline basis functions, Advantages of B-spline over other methods, Introduction to Non Uniform Rational B-Splines (NURBS)

- *Computer-Aided Design:* Mathematical Modelling of Engineering Systems, Introduction to Finite Difference Method, Introduction to Finite Element Method

- *Computer Integrated Manufacturing:* Fundamentals of Manufacturing Systems, Role of Computers in Manufacturing, CIM Models and Concepts, Flexible Manufacturing Systems

- *Computer Interfacing to Manufacturing Units:* Data Logging and Acquisition, Instrument Interconnection Standard, Integration through Information System, Computer Communication Networking

- *Computer Aided Process Planning:* Process Design and Planning, Computer Aided Process Planning, Group Technology

- *Numeric Control (NC) and Computer Numerical Control (CNC)*
  NC/CNC Systems, Control Modes of CNC, Classifications of CNC, Advantages of CNC, Part programming, CL Data, Post processing, Program verification

Module Code	ME4452	Module Title	Industrial Project Management			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	ME4042
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- describe the types of projects with their characteristics and their success & failure factors
- identify the characteristics of each phase of a project and define their scope and strategies
- apply project management tools & techniques to meet the ultimate project objective
- identify and interpret structural and leadership issues faced in managing the project team
- apply knowledge and skills to identify a problem and provide a solution to real world situation

Outline Syllabus

- *Introduction to Project Management*
  Definition of project, Project management process, Stakeholders of the project and their interests, Project management and associated success and failure factors
- *Project Formulation*
  Issues in initiation phase of the project, Inputs from stakeholders, Project life cycle
- *Feasibility Study*
  Technical, financial, market, social & ecological feasibility, Project appraisal and cash flow analysis, Project financing
- *Project Risk Management*
  Risk identification, Quantitative and qualitative risk analysis, Risk treatment strategies
- *Procurement Management*
  Plan purchases and acquisitions, Procurement cycle, Tendering and contracting
- *Project Organization*
  Team formation, Project team roles, Role of project manager and consultants, issues in managing the project team
- *Project Planning and Scheduling*
  Planning time frame, Work breakdown structure, Network analysis for project scheduling (CPM/PERT), Time, Cost & Quality trade off, Crashing projects, Scheduling resources, Gantt chart, Computer software for project scheduling
- *Monitoring and Control*
  Measuring project status, Monitoring and controlling the cost, Maintaining the schedule, Quality management of projects
- *Project Closure*
  Organising/finalising project documentation, post completion audit review and audit, suggestions for future improvements

Module Code	ME4242	Module Title	Energy Technology & Environment			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	ME1052 ME2112
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- appraise the different types of energy sources in the present context of energy and environment crises.
- characterize the appropriate energy sources and conversion technologies for different applications.
- recognize environmental impact associated with usage of different energy sources and technologies.

Outline Syllabus

- *Introduction:* Energy and economic growth, Technological structure of energy demand, use of energy, sectoral energy demand, characteristics of electricity supply and demand.

- *Fossil and Mineral Energy Resources:* Historical background, origin, reserves and future trends of fossil and mineral resources.

- *Solar Energy:* Availability, basics of solar thermal and solar photovoltaic, domestic and industrial liquid/air systems applications, solar photovoltaic for off-grid applications, socio economic aspects of promoting solar energy for off-grid applications.

- *Wind Energy:* Characteristics of wind, micro-sitting, classification and performance characteristics of wind energy converters, applications of wind energy: water pumping, battery charging and grid connected.

- *Small Hydro:* Feasibility studies and site assessment and selection, classification and performance characteristics of water turbines/generators, design and selection of turbines and related equipment, future trends.

- *Biomass Energy:* Resources, Thermo-physical and chemical properties, conversion technologies, potential of different resources and technologies in Sri Lanka, sectoral use of biomass energy.

- *Other alternative energy sources:* Status of Geothermal, OTEC, Wave, Tidal, Fuel Cell, Hydrogen.

- *Environmental Impacts:* Environmental issues associated with extraction and conversion of different sources of energy.

Module Code	ME4382	Module Title	Refrigeration & Air-conditioning			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	ME1052
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- Explain the basic heat pump cycle, identify various refrigerants used in them and explain their impact on refrigeration and the environment.
- Describe commonly used refrigeration and air-conditioning systems and related layouts
- Explain the aspects of Thermal Comfort & building indoor air quality (IAQ)
- Carry out component and system sizing of typical industrial refrigeration and air conditioning systems and assess their performance
- Use related professional codes in Designing a simple air conditioning system.

Outline Syllabus

- *Basic Refrigeration Cycles:* Reversed Carnot cycle, Simple Vapour compression cycle, Coefficient of Performance.
- *Refrigerants:* Classification, Properties, Comparison among commonly used refrigerants, Importance of of Refrigerant selection, Environmental effects, Alternative Refrigerants.
- *Vapour compression cycle:* Actual vapor compression cycle, Effects of Sub-cooling & Superheating, Flash inter-cooling, Multistage compression, Multi-evaporator and Cascade Systems, Introduction to cryogenic engineering and applications.
- *Vapor Absorption System:* Aqua-Ammonia system, Lithium Bromide-water system, Comparison with Vapour Compression cycle.
- *Refrigeration Equipment:* Compressor, Condenser, Evaporator, Expansion devices, Insulation, Cooling towers, Methods of charging and testing.
- *Psychrometry:* Moist air as a working substance, Psychrometric properties of air, Use of Psychrometric tables and charts, Air –conditioning Processes, Combinations and Calculations, ADP, Sensible heat factor, Bypass factor.
- *Thermal Comfort:* Thermal exchange between human body and environment, Factors affecting comfort, Effective temperature comfort chart, Ventilation requirement, Indoor Air Quality (IAQ), Basics aspects of Building indoor air quality
- *Heating and Cooling Load Calculation:* Load analysis RSHF, GSHF, ESHF, Factors forming the load on refrigeration and air conditioning systems, Energy requirements of different types of air conditioning systems.
- *Air Distribution System:* Principle of duct sizing, Use of friction loss and rectangular equivalent of round duct chart, Duct system, Air distribution norms, Diffusers, Dampers, Layout
- *System Layouts:* Different system layouts comprised of All-air and hydronic systems used in commercial & industrial applications, Component & System sizing, Controls used, Building Automation Systems (BAS)

Module Code	ME4462	Module Title	Automation Systems			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	ME3012
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- identify and recognize the skills required in changing manual systems to automated system
- select sensors, interface devices, motor controllers, logic controller and operator panels for a given basic design
- program a PLC to match a given user requirement
- program an operator panel and a PLC
- troubleshoot PLC based automated system

Outline Syllabus

- *Design small scale and medium scale automation systems*
  Need for automation and importance of matching the need in designing automated systems, Techniques to be used in designing small and medium level automated systems

- *Selection of components for automation*
  Selecting sensors, signal conditioning devices, interface devices, actuators and motors, conveyor for a given basic design to match the requirement, Advantages and limitations of using PLC versus microcontrollers.

- *Programming a PLC and operator panels*
  Programming a PLC for a given application using ladder diagrams, Programming techniques and methods used to satisfy the given requirements, Programming an operator panel and the PLC

- *Fault finding of PLC based automated system*
  Common faults that can occur in automated systems, Fault finding procedures, remedial actions, Stock requirement of component for minimum down time

Module Code	ME4342	Module Title	Mechatronic Systems Engineering			
Credits	4.0	Hours/Week	Lectures	3.0	Pre – requisites	ME3012
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes

After completing this module, the students should be able to

- explain the concepts in Mechatronics design
- design electronic circuits logic to match a given application
- program embedded controllers
- program interface devices for existing and newly designed Mechatronic devices
- Program motor controllers using programmable integrated circuits for an already developed motor controller circuits.
- tune a PID controllers
- use fuzzy rules for programming non-linear controller

Outline Syllabus

- *Technology Needs for Mechatronic Systems*
  Introduction to Mechatronics, Mechatronic System Technologies, Intelligent Mechatronic devices, Modelling and Design, Mechatronic Design Concepts, Evolution of Mechatronics, Application areas

- *Digital Electronic Circuit Logic Design*
  Revision of combinational and sequential logic gates, Designing finite state machines using state tables and state diagrams

- *Use of integrated circuits and program embedded controllers*
  Available integrated circuits for logic design and support. Micro-controllers and programming methods, Programming Complex Programmable Logic Devices (CPLD) and Field Programmable Gate Array (FPGA)

- *Computer control and electronic communication methods with Mechatronic Devices*
  Computer control with parallel, serial (RS 232, I^2C and RS485 standard) and USB ports (USB 2.0), Programming interface devices for serial port control and USB port control with different protocols

- *Motor Control*
  Programming a stepper controller, Programming a servo controller with closed loop control methods, Tuning of PID controller, Use of fuzzy logic and fuzzy rules for two wheeled robot

Module Code	ME4642	Module Title	Advanced Dynamics & Vibrations			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	ME3032
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- demonstrate a sound knowledge and understanding of the application of Newton – Euler methods and the methods of Analytical Dynamics to Three-dimensional Rigid Body Dynamics problems.
- demonstrate a sound knowledge and understanding of the methods of modelling the dynamics behaviour of Continuous Systems such as beams and Multi Degree of Freedom Systems.
- analysis and solve realistic problems in Three Dimensional Dynamics and Advanced Vibrations of an advanced level of difficulty, which could be taught at undergraduate level.

Outline Syllabus

- *Newton – Euler methods applied to Three Dimensional Dynamics of Rigid Bodies*.

  Computation of linear accelerations and angular accelerations of rigid bodies undergoing motion in three dimensions, Inertia Tensor, Dynamical models of non symmetrical bodies undergoing complicated forms of three dimensional motion.

- *Methods of Analytical Dynamics.*

  Lagrange's equation applied to Three Dimensional motion problems with and without damping, Hamilton's equation, Simply Constrained Systems, Independent Generalized Coordinates.

- *Vibrations of Multi Degree of Freedom Systems.*

  Mass matrix, Stiffness matrix, Matrix based methods of modeling Multi Degree of Freedom Systems, Orthogonality of modes, Vibrations of Multi Degree of Freedom Systems with damping, Rayleigh-Ritz Method, Computer based iterative techniques of estimating the natural frequencies and mode shapes.

- *Undamped Vibration of Continuous Systems.*

  Derivation of the modeling equations based on the Lagrange Equation and Newton – Euler methods, Approximate methods of estimating natural frequencies and mode shapes including the assumed modes method, Applications including vibrations of beams, etc, Computer based iterative techniques of estimating the natural frequencies and mode shapes.

- *Finite Element Modelling of Vibrations of Continuous Systems.*

  Use Finite Element Analysis packages such as ANSYS to model vibrations of continuous systems such as beams and plates.

Module Code	ME3622	Module Title	Fundamental Biomechanics			
Credits	2.0	Hours/Week	Lectures	1.5	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- describe the fundamental areas of human biomechanics such as the skeletal system, mathematical models of human tissue, orthopaedic implants, limb replacements, and human motion and methods of capturing and studying it.
- apply principles of mechanics to some of the biological systems of the human body.

Outline Syllabus

- *Introduction to module and basic definitions*
  Introduction to module, areas covered under lectures, and some basic definitions for describing anatomical planes and movement.

- *Bone and modelling of bone*
  The human skeleton, bone growth, structure and composition of bone, mechanical properties of bone and mathematical models of bone.

- *Joints in the human body*
  Classification of joints functionally, anatomically, and mechanically. Mathematical representation and calculation of joint movement.

- *Movement of the human body*
  Why and how human movement is studied. Gait analysis and force measurements.

- *Orthopaedic implants and materials used*
  Types of implants and orthopaedic interventions, principles behind materials selection, procedure followed when introducing new materials.

- *Muscle and modelling of muscle*
  Macroscopic and microscopic structure of muscle, mechanism of muscle contraction, force-length-velocity relationships, and mathematical modelling of muscle..

- *Cartilage and modelling of cartilage*
  Types of cartilage, structure function and mechanical properties of articular cartilage. Mathematical modeling of cartilage.

- *Limb replacements and orthotics*
  Types of limb replacements and orthotic devices. Existing technology in developing and developed world and current trends.

Module Code	ME4372	Module Title	Aerodynamics			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	ME1052 ME2112
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- explain the concepts of aerodynamics and associated engineering problems.
- apply analytical techniques for aerodynamics to predict the performance characteristics of number of practical systems including flow around aerofoils, ground vehicles and structures.

Outline Syllabus

- *Potential Flow Theory*
  Review of flow singularity modeling, Stream function, Potential function, Complex potential, Image theorems, Blasius theorem of forces, Conformal transformations, Joukowski Transformation, Schwaz-Christoffel Transformation.

- *Fundamental Theory of Aerofoils*
  Basic parameters characterizing an aerofoil, Lift & Drag forces, Origin of circulation around an aerofoil, Kutta-Joukowski hypothesis, Variation of force coefficients with angle of attack, Stalling, Thin-aerofoil theory.

- *Theory of Finite Span Aerofoils*
  Vortex system of a finite span wing - bound vortex, horseshoe vortices, vortex sheet wake & rolling-up vortices, Flow down-wash, Induced drag, wings with optimal planform.

- *Aerodynamics of Ground Vehicles*
  Input parameters on the aerodynamic design, Drag and Lift Coefficients, Effect of ground, Bluff bodies in tandem, Aerodynamic features of different categories of vehicles, Aerodynamic add-ons, Racing car aerodynamics

- *Aerodynamics of Structures*
  Basic characteristics of flow around bluff structures, Flow-regimes, Vortex-Wake, Steady flow around structures, Drag and Lift Coefficients, Unsteady flow, Vortex induced vibration, Oscillatory flows, Other unsteady flow phenomena and associated flow induced vibrations - Galloping, Flutter, Dynamic Stall, Gust Loading

Module Code	ME4072	Module Title	Industrial Engineering			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	ME4042
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- describe the importance and the need of industrial engineering
- design the workplace and human interface to facilitate the systems
- analyze the issues related to quality and reliability in production systems and improve their performance
- develop design, analysis and evaluation skills of industrial problems
- use theories and concepts for innovative contributions to industries & their improvement
- use the knowledge to upgrade further knowledge and skills on immerging areas relevant to subject
- demonstrate operational and leadership skills on related activities

Outline Syllabus

- *Productivity, Performance and Ethics*
  Basic concepts in industrial engineering. Productivity: concepts, measurements and improvements, Ethics: engineering and industrial engineering, Individual & Organizational competencies and responsibilities
- *Work Study and Job Design*
  Method study, Development, Principles and techniques of motion study, Work measurement, Time study, Performance-rating allowances, Synthetic basic motion times, Work sampling, Pre determined motions systems: MTM, Wage-incentive schemes
- *Ergonomics and Safety*
  Man-machine relationship, Environmental factors, Mechanization and automation, Anthropometry
- *Value Engineering*
  Functions and types, Principles of value engineering, Process and methodology, Value analysis and tools, Value control
- *Quality Control*
  Meaning of product quality, Tolerance, Process capability study, Statistical process control: control chart, variable, fraction defective, number of defects, Acceptances sampling, Operating characteristic curves, Average outgoing quality, vendor rating, quality standards, Total quality management
- *Maintenance and Reliability*
  Maintenance and replacement, Spare-parts inventory, Preventive maintenance, Replacement strategies, Basic mathematical models of reliability and maintenance, Total productive maintenance
- *New Development and Challenges*
  World class manufacturing, Lean systems, Agile manufacturing, Other productions systems

Module Code	ME4392	Module Title	Advanced Aspects of Manufacturing			
Credits	3.0	Hours/Week	Lectures	3	Pre – requisites	ME2022 ME3072
GPA/NGPA	GPA		Lab/Assignments			

Learning Outcomes

After completing this module, the students should be able to

- analyse and select best manufacturing technologies for specific applications, to introduce them and guide workers to handle such technologies.
- make decisions at a managerial level in acquiring suitable technologies.
- improve productivity and efficiency of a manufacturing organization through improvement of the existing set up and introduction of better technologies.

Outline Syllabus

- *Analysis of technological problems:* Drawbacks and remedies related to conventional manufacturing processes, their applicability and how to innovatively adapt them to Sri Lankan context.

- *Improvement of productivity and efficiency*: Design of Jigs and fixtures, Selection of appropriate materials in the local context, Design and/or selection of appropriate tooling for the technology.

- *Advanced aspects of forming processes:* Tooling Design, Compound dies and punches, use of nomograms and data sheets etc.

- *Advanced welding technologies*: weld testing and inspection, NDT, Heat Affected Zone.

- *Non-conventional and advanced machining processes and technology*: Chemical machining (CM), ECM, EDM (electrode/wire), Laser-beam and Electron-beam machining, Water-jet and Abrasive-jet machining, Ultrasonic machining, Recent advances in machining (and manufacturing processes).

- *Competitive Aspects of Manufacturing*: Design for manufacture, Group technology, JIT, Concurrent engineering, World class manufacturing.

- *Advanced metrology.*

- *Rapid Prototyping, Rapid Tooling, Rapid Manufacturing*
- *Production system design:* assembly of systems, conveying and material transportation between work stations. Assembly lines and flexible manufacturing systems.
- *Precision manufacturing and Nanotechnology*

Module Code	ME4472	Module Title	Computer Aided Engineering			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- generate 2D, 3D models for finite element analysis
- perform basic structural and thermal analysis using commercially developed software packages
- apply mathematical skills in the design and analysis of Finite Element models
- exercise analytical skills in model verifications and interpretations of FEA results

Outline Syllabus

- *Introduction to CAE*
  Application areas, software tools

- *Introduction to Finite Element Analysis*

- *Three phases in CAE*
  Pre-processing, solving, post-processing

- *Fundamentals of modelling for Finite Element Analysis*

- *Model creation and meshing*

- *Product and process optimisation*

- *Analysis methods and applications*
  Stress analysis on components and assemblies, thermal and fluid flow analysis, mechanical event simulation, process simulation for operations such as casting, moulding, die press forming, etc.

- *Case studies*
  Stress, thermal analysis problems

Module Code	ME4482	Module Title	Logistics and Supply Chain Management			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	ME4042
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- identify issues in the development of an efficient supply chain
- explain the tools and techniques for enhancing logistics operations
- use knowledge to recognize interaction of logistics & supply chain in business context
- identify the main elements of an efficient global supply chain
- analyze issues and potential solutions in a global context
- examine the importance of customers, suppliers & relationships in implementation
- plan, design, implement and manage ERP systems

Outline Syllabus

- *Supply Chain Structure and Logistics:* Definitions, Elements & activities in supply chain, Structuring, Material, Information flow, Supply chain strategies
- *Customer Accommodation:* Customer service, Customer service as a link between logistics and marketing, Customer service & customer retention, Setting customer service priorities, Competitive framework
- *Supply Chain Process:* Supply chain reference models and inks, Acquisition of goods and services, Planning process, Material planning tools, Flow of material
- *Global Supply Chain:* Impact to the supply chain from global market, Global trade requirements, Drivers & logistics implications of internationalization, Trend towards internationalization
- *Managing the Supply Chain:* Issues of managing the supply chain network and integration, Functional aggregation, Managing relationships within the enterprise
- *Procurement and Manufacturing Process:* Role of supplier, Elements of supplier selection, Bidding process, Supplier evaluation, Negotiating and contracting
- *Warehousing, Transportation and Distribution:* Material handling, Transportation, Inventories, Functions and logistics in warehousing, Types of warehouses, Primary & secondary distribution, Logistics & infrastructure.
- *Information Needs and ERP:* Segment of information, Electronic data interchange, ERP as a backbone in supply chain, Information sharing and communication
- *Partnerships in Supply Chain:* Choosing the right partnership, Partnerships in the supply chain, Supply-based rationalization, Supplier networks, Supplier development, Implementing partnerships
- *Just-In-Time, Lean & Agile in Supply Chain:* JIT, Lean, Vendor managed inventory, Quick responses, Agile practices
- *Logistics and Future Challenges:* New supply chain environment, Key management challenges, Implementation issues, Role of the internet

Module Code	ME4422	Module Title	Energy Conservation			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	ME1052
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- describe the role, current & future trends and related standards & labels related to energy conservation
- describe various aspects and best practices of energy conservation in commonly used thermal & electrical sub-systems
- conduct an energy audit for a simple system within the perspective of an overall energy management program
- evaluate the effectiveness and energy conservation project

Outline Syllabus

- *Introduction*
  , Trends & role of energy conservation in the world, Energy Intensitie for bench marking, Standards & Labels, Benefits of Energy Conservation
- *Energy Conservation in Boiler and Steam Systems.*
  Boiler heat balance, Boiler efficiency, Steam distribution, Steam traps, Waste heat and condensate recovery, Thermic fluid heaters.
- *Energy Conservation in Electrical Systems*
  Lighting systems, Power factor correction, High efficiency motors, Variable frequency drives, Load shifting.
- *Energy conservation in Fluid machinery*

  Pumps and pumping systems:
  Classification, Pump selection, Controlling the flow rate by speed variation, Pumps arrangements to meet varying demand

  Fans and blowers:
  Types of fans and blowers, Assessment of fans and blowers, Fan components, System resistance, Fan curve, Operating point, Fan laws
- *Energy Conservation in Buildings*.
  Performance evaluation of air-conditioning systems, Building envelop parameters for energy conservation, building operating strategies for energy conservation, Controllers and building automaton systems.
- *Energy Management*.
  Basics of energy management, energy auditing, evaluation of energy conservation options.
- *Economic Analysis.*
  Basic elements of economic analysis for energy conservation projects

Module Code	ME4442	Module Title	Heat Transfer			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	ME1052
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- explain the basic principles and mechanisms of heat transfer processes.
- estimate heat exchanging quantities in simple and real systems.
- apply both, analytical and numerical modeling and simulation techniques to solve real Heat transfer problems.
- evaluate the performance of a heat transfer system.

Outline Syllabus

- *Review of Thermodynamics and Introduction*
  Conservation of energy, Surface energy balance, Mechanisms of conduction, convection and radiation.

- *Conduction Analysis*
  Thermal properties of matter, Fourier's law, 1-D Steady state conduction, Introduction to transient conduction, Numerical methods applied to conduction.

- *Convection Analysis.*
  Newton's law of cooling, Thermal and velocity boundary layers, Significance of boundary layer, Forced convection, Convective heat transfer coefficient, Internal and External flow, The physical significance of dimensionless parameters, Introduction to natural Convection.

- *Boiling And Condensation*
  Boiling Heat Transfer, Pool Boiling, Flow Boiling, Condensation Heat Transfer, Film Condensation, Film Condensation inside Horizontal Tubes.

- *Thermal Radiation.*
  The electromagnetic spectrum, Black body radiation, View factors, Radiation exchange in black enclosures, absorption, reflection and transmission, Surface emission, Kirchhoff's law, diffuse and gray surface in an enclosure.

- *Heat Exchangers.*
  Classification, Temperature distribution, Overall heat transfer coefficient, Log Mean Temperature Difference, Effectiveness-Number of heat transfer units method.

Module Code	ME4492	Module Title	Advanced Automation Systems			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	ME4462
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- select the skills and expertise required in designing, developing and implementing automating systems
- program an advanced PLC with statement lists
- program PAC (Programmable Automation Controller)
- program SCADA (Supervisory Control and Data Acquisition systems)
- maintain the documents in design, development and implementing an advanced automation project
- interpret designed drawing and as-built drawings.

Outline Syllabus

- *Applications of Advanced Automated System*
  The identification and calculation of basic hardware components required for an application, Interpretation of Designed drawings and as-built drawings used in automation systems

- *Program an advanced PLC*
  Different types of blocks used in advanced PLC and programming an advanced PLC using statement lists

- *Program a PAC*
  Programming techniques of Programmable Automation Controller (PAC), Labview

- *SCADA system, communication methods and HMI devices*
  SCADA systems, Optical communication and protocols used, Master slave communication between PLC units

Module Code	ME4502	Module Title	Robotics Technology			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	ME4342
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- derive robot kinematics and dynamic
- analyze control methods of robot manipulators
- use robot sensing methods
- explain the principles used for image processing in robot vision and obtain the hardware requirements for such applications
- describe robot applications

Outline Syllabus

- *Introduction*
  Evolution of robots and robotics, Laws of robotics, Progressive advancement in robots, Robot anatomy, Human arm characteristics, Design and control issues

- *Robot kinematics*
  Coordinate Frames, Mapping and Transforms, Direct kinematics, Inverse kinematics, Manipulator differential Motion

- *Robot dynamics and control*
  Dynamic modeling, Trajectory planning, Control of Manipulators

- *Robot Sensors and Vision*
  Kinds of sensors used in robotics, Robotic vision, Architecture of Robotic vision systems, Image acquisition, Representation and processing

- *Robot Applications*
  Various industrial applications and non-industrial applications

Module Code	ME4662	Module Title	Die and Mould Design			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- select, design and fabricate different kinds of dies and moulds for various manufacturing applications
- use commercially available related computer-aided tools for die and mould design and manufacturing
- select appropriate machinery, equipment and processes for die and mould manufacturing

Outline Syllabus

- *Introduction to different dies and moulds*
- *Basic features of dies and moulds*
- *Designing of die and mould features*
  Compression / Injection / Transfer / Blow moulds, Extrusion dies, Dies and punches for sheet metal, Pressure die casting
- *Dimension calculations of moulds and dies*
- *Designing of cooling and heating channels*
- *Material selection for moulds and dies*
- *Die and mould fabricating processes*
- *Precision machining techniques*
- *Heat treatments for dies and moulds*
- *Computer aided die and mould, designing and manufacturing*
- *Economics in die and mould manufacturing*

Module Code	ME4432	Module Title	Computational Fluid Dynamics			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- demonstrate knowledge and basic understanding of CFD techniques and applications
- explain the physical principles that underpin CFD codes.
- explain the basic structure of a CFD code
- formulate, analyze, and verify a selected range of problems in Thermo-Fluid Systems using a commercial CFD software package.

Outline Syllabus

- *Introduction:* Methods of solving Fluid Dynamics problems, Elements of CFD, The role of CFD, Applications.
- *Conservation Laws of Fluid Motion and Boundary Conditions:* Governing equations of fluid flow and heat transfer, Mass momentum, energy conservation equations and equation of state, Navier-Stokes equations, Differential and integral forms of transport equations, Multi-dimensional problems, Steady-state solutions.
- *Preliminary Computational Techniques:* Overview of CFD techniques, FEM, FVM, FD and panel methods, Discretisation, Approximations to derivatives, Finite difference method.
- *Turbulence Modelling:* Introduction, Simple turbulent flows, Turbulence models incorporated into the Navier-Stokes equations.
- *Finite Volume Method for Diffusion Problems:* Discretised transport equations for diffusion problems, Steady one-dimensional diffusion problems, Two-dimensional steady state diffusion.
- *Finite Volume Method for Diffusion-Convection Problems:* Steady one-dimensional diffusion and convection problems, Differencing Schemes, Properties of discretisation schemes, Higher order schemes, QUICK algorithm.
- *Finite Volume Discretisation, Multi-dimensional Grids, Solution Algorithms:* Finite volume grids and grid generation, the staggered grid, The SIMPLE and PISO algorithms, Solution of discretised equations, TDMA for one dimensional problems and its extension for multi-dimensional problems, Other solution techniques used in CFD.
- *Finite Volume Method for Unsteady Flows:* One-dimensional unsteady flow, Explicit scheme, Crank Nicholson method, Fully implicit scheme.
- *Boundary conditions in the discretised equations of the FVM:* Implementation common boundary conditions
- *Advanced Applications of CFD – an Overview:* Combustion modeling, Multiphase Flow, Laminar flamelets, Eddy break-up, LES, PDF and DNS methods, Body-fitted grid systems.

Module Code	ME4672	Module Title	Control Systems Design			
Credits	3.0	Hours/Week	Lectures	2.5	Pre – requisites	ME3012
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to design

- closed loop controllers for continuous systems for single input and single output systems
- closed loop controllers for discrete systems for single input and single output systems
- controllers using state space analysis
- controllers using optimal control method
- a non-linear controller

Outline Syllabus

- *Design closed loop controllers for single input single output continuous systems*
  Design a control system using Root locus Method, Frequency response methods such as Nyquist stability Criterion, Bode plot, Nichol's chart
- *Design closed loop controllers for single input single output discrete systems*
  Mathematical modeling of discrete systems and Z transform, Stability criterion for discrete systems and design of discrete controllers
- *State space analysis*
  Signal flow graphs, State space models, System stability, Controllability and observability
- *Non-linear controllers*
  Characteristics if non-linear systems, Linearization using state space model, Phase plane method, Describing function method, Modified Nyquist stability criterion, Stability using Lyapunav method
- *Optimal Control*
  Application of Linear programming, Lagrange Multipliers, Calculus of Variations and dynamic programming for control system design

Module Code	ME4632	Module Title	Automotive Engineering			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	ME4632
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- derive mathematical models of basic automotive systems.
- calculate the performance of automotive systems using mathematical models.
- examine trends in automotive power plant design.
- illustrate the design considerations of automotive body and power plant.

Outline Syllabus

- *Internal combustion engines*
  Valves and cam arrangements, Engine balancing and vibration, Combustion chamber design and engine performance analysis, Induction and exhaust systems.

- *Petrol Fuel Systems*
  Basic Carbureted fuel systems, Petrol fuel injection systems.

- *Diesel Fuel System*
  In-line and rotary fuel injection pumps, Unit injectors, Phasing, calibration and testing of fuel pumps.

- *Engine Testing and Equipment and Tests*
  Dynamometer test, Load test and Wind tunnel test

- *Emission Control and Legislation*
  Sources of emissions, Legislative control, Design considerations

- *Alternative power sources*
  Sterling Cycle, Gas turbines, Electric vehicles, Hybrid cars, Solar Applications

- *Advanced Technologies in Automobile*
  This topic depends on the state of the technology e.g. Engine Modeling, Vehicle Dynamics and Simulations, Drive by wire, ABS, GPS.

- *Motor Vehicle Manufacturing*
  Assembly lines, Designing for mass production, Market trends and strategies

Module Code	ME4652	Module Title	Marine Engineering & Naval Architecture			
Credits	4.0	Hours/Week	Lectures	3.5	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- demonstrate a sound knowledge and understanding of the construction, functions, working and operational principles of Marine engines, Propulsion Systems, Auxiliary Machines and systems.
- use of ships' geometry for designing and representation.
- calculate Hydrostatic Particulars and assess stability of ships for given loading conditions.
- estimate the resistance and propulsion power of a ship.

Outline Syllabus

Part A – Marine Machinery and Systems

- *Introduction to Marine Auxiliaries:* Machinery and equipment other than Main Propulsion unit mounted on a ship, their function, constructional details, operating principles.
- *Pumps and Pumping Systems:* Types of pump, construction and operation, applications, comparison of performance of pumps. Range of pumps include centrifugal pumps.(single stage /multi stage/vertical/horizontal/high pressure/high capacity type pumps), gear and screw type pumps. Comparison and selection of the drive mechanisms of pumps.
- *Distilled water plants:* Boiling evaporation and Flash evaporation, Low pressure, heat recovery fresh water generator, Fresh water generator - reverse osmosis process
- *Heat Exchangers:* Theoretical and constructional variations of heater / cooler / condenser / evaporator, Comparison of characteristics and applications of shell and tube type heat exchanger, plate type heat exchangers.
- *Propellers & Stern tubes: C*onstruction, performance, operating characteristics and applications of Fixed pitch and Controllable pitch propellers, Ships transmission line, Construction and maintenance of oil/water lubricated stern tubes
- *Steering Gear System:* Regulations governing steering gear systems, Steering gear control systems - non follow up and follow up type systems, Hydraulic and electric steering gear systems.

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- *Marine Diesel Engines:* Introduction, Type of Marine Diesel Engines, Starting air system, Scavenge efficiency and turbo charger performance, High/Medium/Slow speed Engines, Manoeuvring of an Engine, Engine performance monitoring

Part B - Naval Architecture

- *Classification of Ship types:* Cargo ships - General cargo ships, Ro-Ro- Cargo Ships, Bulk Carriers, Liquid Carriers, Gas Carriers, Container Carriers, Car Carriers, etc, Passenger ships – Pure Passenger ships, Cargo cum Passenger ships, o-Ro Passenger Ships, Passenger Ferries, Fishing Vessels- Fishing Trawlers, Multi day fishing boats, Day Boats, Research Vessels, War Sips
- *Main Dimensional Specifications:* Definitions of Perpendiculars, Baseline, Summer Load Waterline, Length Between Perpendiculars, Length Overall, Length of Waterline, Moulded Beam, Depth and Draft, Freeboard, Freeboard deck, Chamber, Sheer, Stem, Stern, Bulbous bow, Keel etc
- *Ship Parts:* Functions and purpose of Principal bulkheads, Keel plate, Tank Top, Double bottom, Weather Deck, Intermediate Deck, Aft peak Tank, Fore Peak Tank, Double bottom Tanks, Cargo holds, Poop deck, Forecastle Deck, Superstructure etc.
- *Hullform and Representation:* Lines Plan of a ship -Stations, Waterlines, Profile Plan, Offsets, Body Plan, Waterline Plan, Buttock Planes, Parallel Middle body, Developing Lines- Straight frame lines, Methodical Lines and Use of Computer in line definitions.
- *Coefficient of Forms:* Definitions of block coefficient, Waterplane area coefficient, Midship area coefficient, Prismatic coefficient with appropriate sketches, Estimations of above coefficients for given dimensions.
- *Hydrostatics Particular:* Definitions of vertical and longitudinal center of buoyancy (KB and LCB), Centre of floatation (LCF), Tonnes Per Centimeter immersion (TPC), Metacentre and metacentric height (BM , KM and GM), Derive expression for KB, BM, and KM of a rectangular barge, Variation between draft and metacentre, minimum metacentric height.
- *Estimation of hydrostatic particulars:* Method of integration of ships lines- Trapezoidal rule, Simpson's First, Second and Third rules, Techbycheff rule, Use of Simpson's rules to estimate Waterplane area, Centre of flotation, Displacement and KB using waterplane areas, Displacement and LCB using cross-sectional areas, Second moment of area of waterplanes and BM calculations
- *Initial Stability of Ships:* Initial Stability Theory of ships and its limitation, Stable, Unstable and Neutral Equilibrium conditions, Effect of metacentric height on rolling period, Stiff and tender ship, Theory on effect of shifting small weight transversely, vertically and diagonally, Loading and unloading of a weight and inclination of the ship due to movement of centre of gravity, Effect of suspended weight to the centre of gravity of the ship and stability
- *Introduction to Ship Resistance and Propulsion:* Definition of Frictional Resistance and Residual Resistance, Model test and calculation of effective power, Transmission of power through drive system to the propeller, relevant power terms and their relationships with efficiencies of transmission, Estimation engine power from effective power.

Syllabi of Service Modules

Module Code	ME1812	Module Title	Basic Thermal Sciences			
Credits	2.0	Hours/Week	Lectures	2	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments			

Learning Outcomes

After completing this module, the students should be able to

- explain the basic thermodynamic principles.
- use Thermodynamic Property Tables.
- use the relevant properties to calculate the state of a substance/system.
- apply the laws of thermodynamics to basic processes.
- use the psychrometric property chart to do basic calculations.

Outline Syllabus

Basic Principles
Review: Boyle's law, Charles's law etc.
Forms of energy and their transformations, Heat and Work as methods of Energy transfer, the statistical nature of thermodynamics, types of systems.

Properties of Substances
The importance of Thermodynamic properties, Intensive and Extensive properties, Concept of Thermodynamic state, Thermodynamic Equilibrium
The Difference between ideal and real substances, Thermodynamic Property tables.

Fundamental laws of thermodynamics
The First Law of Thermodynamics, The first law with reference to principle system types, Internal energy as a consequence of the first law.
The meaning of a reversible process, The second law of thermodynamics, entropy as a consequence of the second law

Processes
The basic types of processes, Processes as transition of Thermodynamic states, Property Diagrams, Reversible and Irreversible processes, Cyclic Processes

Heat Transfer
Methods of heat transfer, Effects in a closed space due to heat transfer.

Psychrometrics
Humidity and Relative Humidity, Calculations using psychrometric charts.

Module Code	ME2842	Module Title	Basic Thermal Sciences and Applications			
Credits	3.0	Hours/Week	Lectures	2	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes

After completing this module, the students should be able to

- explain the basic thermodynamic principles.
- use Thermodynamic Property Tables.
- use the relevant properties to calculate non-property quantities in Thermodynamic systems
- apply the laws of thermodynamics to basic processes.
- apply basic knowledge of heat transfer to analyse simple engineering problems
- use the psychrometric property chart to do basic calculations.
- Carry out basic estimations related to power cycles

Outline Syllabus

Basic Principles
Review: Boyle's law, Charles's law etc.
Forms of energy and their transformations, Heat and Work as methods of Energy transfer, the statistical nature of thermodynamics, types of systems.

Properties of Substances
Importance of Thermodynamic properties, Intensive and Extensive properties, Concept of Thermodynamic state, Thermodynamic Equilibrium
Difference between ideal and real substances, Thermodynamic Property tables.

Fundamental laws of thermodynamics
First Law of Thermodynamics, First law with reference to principal system types, Internal energy as a consequence of the First law.
Reversible process, Second law of thermodynamics, Entropy as a consequence of the Second law

Processes
Basic types of processes, Processes as transition of Thermodynamic states, Property Diagrams, Reversible and Irreversible processes, Cyclic Processes

Heat Transfer
Mechanisms of heat transfer, Heat transfer applications in Engineering

Psychrometrics
Thermodynamic properties in Psychrometrics, Estimations using psychrometric charts

Power Cycles
Idealised gas & vapour power cycles and performance indices, Basic estimations

Module Code	ME1802	Module Title	Introduction to Manufacturing Engineering			
Credits	2.5	Hours/Week	Lectures	2.0	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- explain the mechanics of machining processes, and their applications for different operations.
- make a proper selection of manufacturing materials and tool materials for a given manufacturing process.
- select the best machining operation(s), and plan out optimum machining process(es) for same.
- use the principles of engineering metrology to assure quality of products.

Outline Syllabus

- *Overview of Manufacturing Engineering in the present context,*
- *Introduction to selected manufacturing processes*
  Casting, Fabrication, Hand tools and their importance.
- *Introduction to machining operations*
  Classification of machining operations and machine tools, Mechanics of Machining, Mechanics of chip formation, types of chips, Built-up-Edge, Tool life, Surface finish, integrity, Cutting forces and power.
- *Engineering materials and Tool materials*
  Selection of work-piece materials and tools, correlating them to process and each other.
- *Detailed study of principal Machining Processes*
  Machines and Tools used, Sawing, Drilling, Boring, Reaming, Tapping, Lathe, Shaper, Milling, Grinding, Abrasive machining, Finishing, Planing, Broaching, Gear manufacture etc
- *Introduction to Numerical Control (NC) and Computer-Aided Design & Manufacturing (CAD/CAM).*
- *Surface treatment and finishing*
  Painting, Galvanizing, Cold galvanizing, Epoxy coating, Electroplating, etc., Powder spray technology and its use as a refilling and repair technology for expensive and large items.
- *Engineering Metrology and Instrumentation*
  Basic measuring instruments in precision metrology, Tolerances, Limits and fits, Measurement of surface texture and geometric errors, Coordinate measuring machine, Advanced measuring instruments.

Module Code	ME1822	Module Title	Basic Engineering Thermodynamics			
Credits	2.0	Hours/Week	Lectures	1.5	Pre – requisites	None
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- state the First Law of Thermodynamics and define heat, work, thermal efficiency and the difference between various forms of energy.
- explain the concept of thermodynamic process and describe the different types of processes.
- recognize relationship between thermodynamics and other areas of study.

Outline Syllabus

- *Introduction to Thermodynamics*

  Historical development, Thermodynamics Concepts and Terminology, Units and Conversions.

- *Energy*

  Work and Power, Heat Transfer, Energy Transport by Mass Transport

- *Ideal gases and pure substances.*

  Introduction to ideal gases and substances, Rationale behind the definitions of ideal gases and substances

- *First Law of Thermodynamics*

  Open System, Closed System, Enthalpy, Steady state steady flow processes, Transient processes

- *Second Law of Thermodynamics*

  Reversible and Irreversible Processes, Entropy, Second Law Applications, Efficiency of real processes

Module Code	ME2832	Module Title	Mechanics of Machines			
Credits	2.0	Hours/Week	Lectures	1.5	Pre – requisites	ME1012
GPA/NGPA	GPA		Lab/Assignments	3/2		

Learning Outcomes

After completing this module, the students should be able to

- describe the important principles in Mechanics of Machines.
- analyze and solve simple but realistic problems in Engineering Mechanics.
- explain the relevance of the principles of Mechanics of Machines in the Design of Machine Elements.

Outline Syllabus

- *Planar Linkages*

  (Velocity Diagrams), Acceleration diagrams, Linkages involving sliding connections, Kinetics of plane mechanisms.

- *Gear Drives.*

  Geometry of spur gearing, External and internal gearing, Epicyclic gear trains, Speed – Torque relationships.

- *Balancing of Rotating Masses*

  Static and dynamic balancing of shaft-rotor systems

- *Single Degree of Freedom Vibrations.*

  Response of viscous damped systems to harmonic excitation, Response of viscous damped systems to ground vibration, dynamic magnification, transmissibility.

Module Code	ME3812	Module Title	Machine Design			
Credits	2.0	Hours/Week	Lectures	1	Pre – requisites	ME2122, ME2142
GPA/NGPA	GPA		Lab/Assignments	3/1		

Learning Outcomes

After completing this course module, the students should be able to

- innovatively think and look at a machine or a design with an inquiring mind, and convert an idea or a concept to a practical design.
- carryout a design task with confidence
- communicate design information through technical reports, engineering drawings, oral communication, etc.
- work as a team to manage a design project

Outline Syllabus

- Design methodology
- Design optimisation
- Conceptual design: concept generation techniques, concept selection
- Selection of materials
- Detailed design calculation: Load and stress analysis, electric motors and selection
- Production drawings
- Project: Design of a simple machine or equipment