

## **Courses and Course Learning Outcomes**

Level: 300 Semester: 1 Credits: 1 Lecture Hours: 15 Practical Hours: 0

Prerequisite: N/A

### Course Learning Outcomes

At the end of the course, students should be able to:

1. Understand the concepts of Engineering investment decisions, compounding, discounting, and economic equivalence.
2. Demonstrate cash flow analysis and inflation.
3. Apply various methods to evaluate investments and choose between alternatives.
4. Apply decisions and cost analysis concepts to evaluate public projects

## **EGR3102: TECHNICAL WRITING AND PRESENTATION**

Level: 300 Semester: 2 Credits: 2 Lecture Hours: 15 Practical Hours: 0

Prerequisite: N/A

### Course Learning Outcomes

At the end of the course, students should be able to:

1. Demonstrate the concept of clear writing, common pitfalls and unambiguous language in engineering communication.
2. Demonstrate the skills of language flexibility, formatting, logic, data presentation styles, referencing.
3. Use of available aids, intellectual property rights, their protection, and problems in engineering communication and presentation.
4. Demonstrate good interpersonal communication skills through hands-on and constant practice on real-life communication issues for engineers.

## **EGR3311: COMPUTER APPLICATIONS**

Level: 300 Semester: 1 Credits: 3 Lecture Hours: 30 Practical Hours: 15

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Identify different software packages and their uses
2. Demonstrate understanding and use different data capture techniques
3. Identify different programming languages and understand programming in at least one programming language
4. Use word processing, spreadsheets, and some application software in engineering

#### EGR3203/GET299: SIWES I

Level: 300 Semester: 2 Credits: 2 Lecture Hours: Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. demonstrate proficiency in at least any three softwares in their chosen career choices;
2. demonstrate proficiency in some animation videos (some of which are free on YouTube) in their chosen careers;
3. carry out outdoor hands-on construction activities to sharpen their skills in their chosen careers;,,
4. demonstrate proficiency in generating data from laboratory analysis and develop empirical models;
5. demonstrate proficiency in how to write engineering reports from lab work;
6. fill logbooks of all experience gained in their chosen careers;
7. write a general report at the end of the training.

#### EGR3301 - ENGINEERING MATHEMATICS

Level: 300 Semester: 1 Credits: 3 Lecture Hours: 45 Practical Hours: 0

Prerequisite: N/A

Aim: The aim of this course is to provide students with the tools necessary to solve differential equations and application problems modeled by them.

Course Learning Outcomes

At the end of the course, students should be able to:

1. Solve linear differential equations of higher-order.
2. Solve application problems modeled by a second-order differential equation.
3. Use Laplace transform methods to solve differential equations.
4. Solve systems of differential equations.
5. Solve linear Partial Differential equations of both first and second order with different methods

#### EGR3302: COMPUTATIONAL TECHNIQUES

Level: 300 Semester: 2 Credits: 3 Lecture Hours: 45 Practical Hours: 0

Prerequisite: N/A

Aim: To provide students with the knowledge of how to employ various numerical analyses methods in solving simple and complex engineering problems.

Course Learning Outcomes

At the end of the course, students should be able to:

1. Understand the basics principle of numerical differentiation and integration.
2. Understand various methods of performing numerical differentiation and integration (Newton Coates formulae).
3. Understand the basics of expressing physical engineering phenomena as mathematical equation (linear and non-linear).
4. Apply the techniques learned and solve the system of linear and non-linear equations
5. Understand the fundamental principle of engineering modelling.
6. Understand the basic principle behind differential equations and the difference between ordinary and partial differential equations

7. Understand the basis of methods of solving ordinary differential equations i.e. Maclaurin's and Taylor's series.
8. Understand the application of methods of solving both 1st and 2nd order ordinary differential equations i.e. Euler's, Runge-Kutta's and Predictor Corrector methods including their accuracy levels.
9. Understand how to express some physical engineering phenomena as a system or couple of ordinary differential equations.
10. Understand how to apply Eigen values and Eigen Vectors in solving a system or couple of ordinary differential equations.
11. Develop algorithm for solving problems using computer software.

#### EGR4101: ENGINEER IN SOCIETY

Level: 400 Semester: 1 Credits: 1 Lecture Hours: 15 Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. describe and explain the basic concept, sources and aspects of law;
2. describe and explain the major differences between the various categories of law, courts and legal jurisdictions;
3. describe and explain legal principles and their application in professional engineering design and management services and their professional liability implications; and
4. develop reasoned analysis of real-life or hypothetical engineering scenarios using the legal principles to undertake critical analysis of reliable information to develop, and practically present technical reports for use in varying judicial/quasi-judicial settings including as an expert witness.

#### EGR4201: ENGINEERING STATISTICS

Level:400 Semester: 1 Credits: 2 Lecture Hours: 30 Practical Hours:

Prerequisite: N/A

### Course Learning Outcomes

At the end of the course, students should be able to:

1. Apply knowledge of statistics and probability in solving engineering problems.
2. Identify various distributions and how the spread in the distributions affect variability.
3. Assess the strength and direction of linear relationship between variables.
4. construct appropriate graphical displays of data and highlight the roles of such displays in data analysis, particularly the use of statistical software packages;
5. plan and execute experimental programmes to determine the performance of programme-relevant industrial engineering systems, and evaluate the accuracy of the measurements undertaken;

### EGR4401: SIWES II

Level:400 Semester: 2 Credits: 4 Lecture Hours: Practical Hours:

Prerequisite: N/A

### Course Learning Outcomes

At the end of the course, students should be able to:

1. be exposed and prepared for the Industrial work situation they are likely to meet after graduation, by developing their occupational competencies;
2. bridge the existing gap between theory and practice of programmes through exposure to real-life situations, including machines and equipment handling, professional work methods and ethics, human relations, key performance assessment methods, and ways of safeguarding the work environment – human and materials;
3. experience/simulate the transition phase of students from school to the world of work and the environment seamlessly, and expose them to contacts for eventual job placements after graduation;
4. be motivated to identify the industrial and practice engineering challenges of their place of engagement and the larger society and creatively devise impactful solutions to them; and

5. exploit the opportunity to improve and utilise their acquired critical thinking and innate creativity skills, during the program and SIWES Seminar presentation respectively.

### **CLOs for CORE Mechanical Engineering Courses**

#### **MEE101: INTRODUCTION TO MECHANICAL ENGINEERING**

Level: 100 Semester: 1 Credits: 1 Lecture Hours: 30 Practical Hours:0

#### **Course Learning Outcomes:**

At the end of this course, the students should be able to:

1. differentiate between science, engineering and technology, and relate them to innovation;
2. identify the various branches of mechanical engineering discipline and their applications to the solution of societal problems;
3. demonstrate appreciation of the problem of climate change; and
4. demonstrate appreciation of the role of energy systems to environmental sustainability.

#### **MEC3201: THERMODYNAMICS II**

Level: 300 Semester: 1 Credits: 2 Lecture Hours: 30 Practical Hours:

Prerequisite: N/A

Aim: To provide students with the techniques required for the design, analysis and performance evaluation of various power generation systems and determine properties and perform energy analysis of non-reacting gas mixtures.

#### **Course Learning Outcomes**

At the end of the course, students should be able to:

5. Draw any power cycle on a chart (either T-S, P-V and e.t.c)
6. Apply the first law of thermodynamics to analyse and evaluate the performance of various steady flow energy devices such as heat exchangers, nozzle, diffuser, boiler, turbine, compressor and pump.

7. Analyse vapour power cycles (Rankine cycles) and determine how the thermal efficiency can be improved by modifying the basic Rankine cycle
8. Evaluate the performance of re-heat, regenerative, combined and binary power cycles.
9. Analyse and determine the performance of cycles in which the working fluid remains gas throughout the cycle (gas power cycles)
10. Classify gas power cycles and make simplifying assumptions in the analysis of gas power cycles
11. Carry out performance analysis on gas power cycles based on the Otto, Diesel and Brayton cycles
12. Classify IC engines based on the fuel or stroke and Explain their principle of operation
13. Explain how super and turbo charging effects engine performance
14. Compare the practical IC engine cycle with an air standard cycle
15. Obtain the properties of a mixture of gases (both ideal and real) from the properties of the individual gases
16. Apply the Dalton's law and Amagat's law to predict the P-V-T behaviour of gas mixtures.
17. Conduct energy analysis on a mixing process
18. Differentiate between atmospheric and dry air
19. Calculate relative humidity, specific humidity and dew point temperatures of atmospheric air
20. Relate adiabatic saturation temperature and wet bulb temperature
21. Use psychrometric chart as a tool to determine the properties of atmospheric air

MEC 3202: MATERIALS SCIENCE II

Level: 300 Semester: 1 Credits: 2 Lecture Hours: Practical Hours:

Prerequisite: N/A

Course Learning Outcomes

At the end of the course, students should be able to:

1. Understand how Iron and Steels are produced and classified; charges, processing, product types; pig, wrought and cast irons, killed, semi-killed and rimmed steels, and shapes; slabs, blooms and billets.
2. Appreciate the role of the iron-carbon equilibrium diagram (the iron-iron-carbide phase diagram) in determining the structure/property relationship of iron and steel.
3. Identify the limitations of plain carbon steels (unalloyed steels) and how to mitigate these limitations.
4. Know the common non-ferrous metals, their alloys and engineering applications.
5. Differentiate between the non-equilibrium condition; strengthening/hardening and equilibrium conditions; softening/stress relieving; e.g. tempering, annealing, spheroidising, surface hardening and normalising in heat treatable carbon and alloy steels.
6. Acquaint with various isothermal transformation processes and the effect the rate of cooling of steels on their structures and properties.
7. Acknowledge the inevitability of corrosion as a process in engineering materials (especially metals), types of corrosions and preventions/methods of conditioning.
8. Classify and understand the engineering applications of polymers, ceramics and glasses.
9. Categorise and know the various techniques of production of composite and nano-composite materials with proposed strengthening/toughening mechanisms.
10. Familiarise with the advantages of high surface area volume ratio obtainable in nano-materials; specifically graphene and carbon nanotube.

## MEC 3203: ENGINEERING DRAWING II

Level: 300 Semester: 1 Credits: 2 Lecture Hours: 15 Practical Hours: 30

Prerequisite: N/A

### Course Learning Outcomes

At the end of the course, students should be able to:

1. draw objects in 1st and 3rd angle projections.
2. draw various conic sections
3. use freehand sketching to represent engineering ideas.
4. draw bearing and lubrication arrangement.
5. draw different mechanical parts used for joining.
6. appreciate the use of computer aided design tools.

### MEC 3204: FLUID MECHANICS II

Level: 300 Semester: 1 Credits: 2 Lecture Hours: 30 Practical Hours:

Prerequisite: N/A

Aim: To learn how to analyse the flow of a constant density viscous fluid (incompressible) through bounded systems such as pipes.

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. determine various kinematic elements of the flow given the velocity field,
2. differentiate between a closed and open system (control volume),
3. analyse fluid flow systems based differential and control volume approaches,
4. derive the general formulation for the conservation of mass and conservation of momentum for an infinitesimal control volume from that of a finite control volume and be able to explain the meaning of each term,
5. apply correct assumptions to the Navier-Stokes equation to solve various hydrostatic problems,
6. apply the concepts of stream function and velocity potential,
7. characterize simple potential flow fields,
8. identify various characteristics of flow in pipes,
9. discuss the main properties of laminar and turbulent pipe flow and appreciate their differences,
10. calculate losses in straight portions of pipes (both smooth and rough) as well as those in various pipe system components,

11. apply appropriate equations and principles to analyze a variety of pipe flow situations,
12. predict the flowrate in a pipe by use of common flowmeters,
13. apply Darcy's equation to determine the frictional factors for laminar and turbulent flow in pipes
14. design a pipe network system and select the appropriate pump.

### MEC3205: MACHINE TOOLS

Level: 300 Semester: 2 Credits: 2 Lecture Hours: 30 Practical Hours:

Prerequisite: N/A

Aim: To expose the student to the fundamental knowledge of machining processes and machine tools by providing them with fundamental knowledge and principles of material removal (machining) processes using lathes, milling machine tools, grinding machine tools, drill presses and CNC machine tools.

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Understand the cutting tool geometry, mechanism of chip formation and mechanics of orthogonal cutting
2. Identify basic parts and operations of conventional machine tools including lathe, drilling, milling, grinding machine tools etc.
3. Select a machining operation and corresponding machine tool for a specific application
4. Understanding the principles and operation of CNC machine tools

### MEC3206: METROLOGY

Level: 300 Semester: 2 Credits: 2 Lecture Hours: 30 Practical Hours:

Prerequisite: N/A

Aim: To understand measurement standards and the concepts of various measurement systems in mechanical engineering.

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Explain the standards of lengths and angles.
2. Use precision instruments to inspect engineering components
3. Explain the principles and applications of measuring instruments and gauges
4. Design tolerances and fits for a selected product quality
5. Determine surface roughness
6. Select appropriate methods and instruments for gear and thread measurements.
7. Design comparators.
8. Design inspection gauges and calibrate measuring instruments

#### MEC3207: MECHANICS OF MACHINES I

Level: 300 Semester: 2 Credits: 2 Lecture Hours: 30 Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Determine the no. of degrees of freedom of a planar mechanisms
2. Determine the velocities and accelerations of various points/links in a planar mechanism including members with sliding and rotation using either vector method, analytical or graphical methods
3. Apply D'Alemberts principle in the force analysis of planar mechanisms and machines using either the vector method or graphical method
4. Determine input torques required to operate a mechanism
5. Calculate and represent dynamic forces acting on a link in a mechanism
6. Carry out force analysis on a piston and cylinder engine to determine the various forces/torques acting on an engine
7. Interpret Torque diagrams and use them to design a suitable flywheel

8. Analyse cams and Governors
9. Determine characteristics of different governors and Select a Governor suitable for an application
10. Classify and analyse cams based on shape and motion of follower.
11. Determine max. velocities and acceleration of basic CAMS and those with specified contours (circular arc, tangent, rigid eccentric CAMS
12. Carry-out dynamic analysis of various power transmission mechanisms such as Hooke's Universal Joint, Gearing systems and Friction Clutch

### MEC 3301: SOLID MECHANICS II

Level: 300 Semester: 1 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

Aim: To enable students to develop the technical knowledge and skills required to analyse the behaviour of structural and machine components subjected to various loading and support conditions.

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Apply the principles of equilibrium and material constitutional relationship to determine the behaviour of structural and machine components subjected to various loading and support conditions.
2. Apply the concept of stress and strain to analyze structural members and machine parts under axial load, shear load, bending moment and torsion.
3. Solve practical problems through evaluating the relationship between stress and strain.
4. Determine the thermal effects.
2. Calculate stresses due to combine stresses in a structural machine component.
3. Analyse a structural member and machine part when loaded beyond its elastic limit (inelastic and plastic cases).
4. Analyse the forces in a statically indeterminate beams.

ELE3300: ELECTRICAL ENG. FOR MECH. ENGRS.

Level: 300 Semester: 1 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

Aim: To acquaint students with the principles of electrical engineering for the measurement of physical parameters, design of sensors and actuators for data acquisition and selection of electrical machines for mechanical applications.

Course Learning Outcomes

At the end of the course, students should be able to:

1. Explain the working principles of measuring instruments
2. Identify and select measuring instruments for a specific application
3. Carryout error analysis and calibrate a measuring instrument
4. Model fundamental physical and technical base of sensors and DC motors.
5. Classify/select AC motors for mechanical applications such as lifts e.t.c.
6. Identify various components of a Data Acquisition System
7. Use a Data Acquisition System to acquire and log input/output data from a system or an experimental set-up

MEC 3401/MEC 3402: LABORATORY A/B

Level: 300 Semester: 1&2 Credits: 4 Lecture Hours: Practical Hours:

60/semester

Course Learning Outcomes

At the end of the course, students should be able to:

1. carry out experiments practically demonstrate what is taught in theory
2. learn how to use data acquisition system for measurements using different sensors
3. to develop the necessary skills to implement what is learnt during the two semesters
4. prepare and present practical reports.

## MEC4201: INNOVATIVE DESIGN

Level:400 Semester: 1 Credits: 2 Lecture Hours: 30 Practical Hours:

Prerequisite: N/A

### Course Learning Outcomes

At the end of the course, students should be able to:

1. Understand the basic aspects of the product development process
2. Use the product design process to develop idea into product concept.
3. Be able to gather data from customers and establish technical specifications of a product
4. Apply creative processes and techniques in problem-solving and critical thinking in product design process
5. Understand and use safety, ergonomic, maintainability, environment, aesthetic, manufacture, assembly issues in product development.
6. Participate in real product design problem solving through the execution of mini project.

## MEC4202: MANUFACTURING PROCESSES

Level:400 Semester: 1 Credits: 2 Lecture Hours: 30 Practical Hours:

Prerequisite: N/A

### Course Learning Outcomes

At the end of the course, students should be able to:

1. Explain the various techniques of manufacturing machine parts using metals and plastics;
2. Select appropriate processes for manufacturing industrial products/machine components;
3. Identify routings of the operations and equipment involved in changing raw materials into useable products;

4. Explain the mechanics involved in the various manufacturing processes.

#### MEC4203: FLUID MECHANICS III

Level:400 Semester: 1 Credits: 2 Lecture Hours: 30 Practical Hours:

Prerequisite: N/A

Aim: To learn how to analyse external flow past a variety of objects and compressible (variable density) flow through or over bodies

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. identify and discuss the features of external flow.
2. explain the fundamental characteristics of a boundary layer, including laminar, transitional, and turbulent regimes.
3. calculate boundary layer parameters for flow past a flat plate.
4. explain the concept of boundary layer separation.
5. calculate the lift and drag forces for various objects.
6. distinguish between incompressible and compressible flows, and know when the approximations associated with assuming fluid incompressibility are acceptable.
7. identify the features of different categories of compressible flows of ideal gases.
8. explain speed of sound and Mach number and their practical significance.
9. apply fluid dynamic principles to solve problems involving isentropic and nonisentropic flows including flows across normal shock waves.
10. appreciate the compelling similarities between compressible flows of gases and open channel flows of liquids.
11. determine the temperature and pressure of high speed gas flows

#### MEC4301: DESIGN OF MACHINE ELEMENTS

Level:400 Semester: 1 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. understand the basic design procedures.
2. demonstrate the ability to apply the fundamentals of stress analysis, theories of failure and material science in the design of machine elements.
3. demonstrate specifically design abilities by performing correctly the design, analysis and sizing of shafts, springs, power screw, couplings, brakes and other machine elements.
4. display the ability to seek and learn new material in addition to the class topics through the completion of an open-ended project.

#### Course 56: MEC4302 - MECHANICS OF MACHINES II

Level:400 Semester: 1 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

Aim: To learn the process of designing or modifying a machine to reduce unbalance to acceptable limits and develop models for vibrating systems.

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Apply mechanics principles to balance static masses in the same or different planes
2. Apply force analysis principles to dynamically balance rotating systems with masses in different planes
3. Dynamically balance forces on a linkage, and systems with reciprocating masses
4. Balance locomotives, V-engines, and radial engines
5. Use balancing machines to determine static and dynamic unbalance in systems
6. Identify various types of vibrations
7. Determine natural frequencies, displacements, velocities and accelerations of vibrating systems by using either Equilibrium method, Energy method or Rayleigh's method.
8. Analyse Damping applied to vibrating systems
9. Classify various ways of forcing a system to vibrate

10. Analyse forced vibrations in systems to determine vibration parameters such as amplitude, resonance and e.t.c
11. Determine the whirling speeds for shafts
12. Determine vibration parameters for a system undergoing torsional vibration

### MEC4303: THERMODYNAMICS III

Level:400 Semester: 1 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Apply the principles of the laws of conservation of mass and energy to various air-conditioning processes.
2. Classify various types of fuel
3. Identify and determine parameters used in combustion analysis: air-fuel ratio, percent theoretical air, and dew point temperatures
4. Balance combustion equations by applying the principle of mass conservation
5. Determine the air-fuel ratio of an actual combustion process using the exhaust gas analysis
6. Apply energy balance to steady-flow and closed reacting (Combustion) systems to determine the amount of heat obtainable from these systems
7. Determine the enthalpies of reaction and combustion and heating values of fuels and the adiabatic flame temperature for reacting systems
8. Design combustion systems
9. Develop the Maxwell's relations
10. Determine the enthalpy of vaporization of a substance using P, V and T measurements by applying the Clapeyron equation.
11. Apply the Maxwell's equation to develop general relations for Specific heats, internal energy, enthalpy and entropy changes for pure substances.
12. Determine the performance of refrigerators and heat pumps

13. Perform the analysis of ideal and actual vapour compression refrigeration cycles
14. Analyse gas cycle refrigeration systems and liquefaction of gases
15. Determine the performance of absorption refrigeration system
16. Use psychrometric chart as a tool to determine the properties of atmospheric air
17. Determine refrigeration and air-conditioning load for refrigeration and air-conditioning systems.
18. Use the psychrometric chart to analyse air conditioning processes.
19. Design an air-conditioning system for a particular application.
20. Understand the principle of solar energy.

#### MEC 4304 LABORATORY

Level:400 Semester: 1 Credits: 3 Lecture Hours: Practical Hours: 45

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. carry out experiments practically demonstrate what is taught in theory
2. learn how to use data acquisition system for measurements using different sensors
3. to develop the necessary skills to implement what is learnt during the semester
4. prepare and present practical reports.

#### MEC5301: DESIGN OF MACHINE ELEMENTS II

Level: 500 Semester: 1 Credits: 2 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. design and analyze mechanical systems such as gear systems, belt, rope, and chain drives. Sliding and rolling contact bearings, Cam design

2. use computer-based techniques and algorithms such as FEM for the analysis, selection, and synthesis of mechanical components/systems, in particular with respect to those components and systems defined in the topical areas.
3. explore and learn new material in addition to the class topics through the completion of an open-ended project.

#### MEC 5312 LABORATORY

Level: 500 Semester: 2 Credits: 3 Lecture Hours: Practical Hours: 45

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. carry out experiments practically demonstrate what is taught in theory
2. learn how to use data acquisition system for measurements using different sensors
3. to develop the necessary skills to implement what is learnt during the two semesters
4. prepare and present practical reports.

#### MEC5401: THERMODYNAMICS IV

Level: 500 Semester: 1 Credits: 4 Lecture Hours: 60 Practical Hours:

Prerequisite: N/A

Aim: To learn the principles required for the design of various work transfer devices such as steam and gas turbines, axial compressors and reciprocating compressors.

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. To apply the moment of momentum balance to develop the Euler's equation of turbomachinery
2. Draw the blade velocity diagram of a turbomachine stage (impulse or reaction) and determine the power or work transfer for the stage and the efficiency.
3. Differentiate between pressure and velocity compounding in steam turbines

4. Determine the overall efficiency, stage efficiency and re-heat factor (RF) of a single and multi-stage axial compressor or turbine
5. Determine the power required to drive a centrifugal compressor with specific configurations
6. Explain the principle of operation of positive displacement machines (compressors and internal combustion engines)
7. Identify various types of positive displacement machines
8. Determine the power required by a reciprocating compressor and how to minimize it
9. Analyse multi-stage compression with intercooling using reciprocating air compressors

#### MEC5402: SOLID MECHANICS IV

Level: 500 Semester: 2 Credits: 4 Lecture Hours: 60 Practical Hours:

Prerequisite: N/A

##### Course Learning Outcomes

At the end of the course, students should be able to:

1. Gain knowledge of basic concepts and analytically approach the strength and deformation of mechanical components
2. Deal with elastic deformation problems for homogeneous isotropic materials and anisotropic materials

#### MEC5403: CONTROL SYSTEM ENGINEERING

Level: 500 Semester: 1 Credits: 4 Lecture Hours: 60 Practical Hours:

Prerequisite: N/A

##### Course Learning Outcomes

At the end of the course, students should be able to:

1. explain the purpose of control systems and define basic control system features and configurations

2. understand systems representations in time and s-domains, obtain Transfer Function, classify and draw block diagrams, and obtain overall transfer functions from block diagrams
3. represent systems using block diagram, s-plane
4. derive mathematical models of electrical, mechanical, fluid, thermal and electromechanical systems and draw their block diagrams
5. understand the working principles of basic control systems components, and obtain their transfer functions
6. simulate mathematical models using computer programs like MATLAB/Simulink.
7. identify and understand the characteristics of basic control system components, and obtain their transfer functions
8. analyse and obtain quantitative measures of steady and transient responses of systems from transfer functions.
9. determine the stability of simple control systems from transfer function, and determine the range of a parameter required for stability
10. draw root locus and design cascade compensators and feedback compensators using root locus technique
11. implement control algorithms in microcontroller

#### MEC5404: FLUID MECHANICS IV

Level: 500 Semester: 1 Credits: 4 Lecture Hours: 60 Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. explain how and why a turbomachine works.
2. differentiate between a turbine and a pump.
3. recognize the importance of minimizing loss in a turbomachine.
4. Draw velocity diagram of a turbomachine and determine the power required or produced
5. select an appropriate class of turbomachine for a particular application.

6. Explain why turbomachine blades are shaped like they are.
7. Apply principles of scaling to sensibly scale turbomachines from prototypes to larger ones
8. Design a turbomachine for a particular application.
9. apply strategies of avoiding cavitation in pump design

#### MEC5405: ENGINEERING MANAGEMENT

Level: 500 Semester: 1 Credits: 4 Lecture Hours: 60 Practical Hours:

Prerequisite: N/A

##### Course Learning Outcomes

At the end of the course, students should be able to:

1. Explain and evaluate key performance indicators in the industry such as productivity
2. Explain wage incentive systems
3. Explain production planning and control and to use tools such as CPM and PERT
4. Use statistical control tools for quality control in the industry
5. Use financial management tools for decision making

#### MEC5313: COMPUTER AIDED DESIGN AND COMPUTER AIDED MANUFACTURING

Level: 500 Semester: 2 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

##### Course Learning Outcomes

At the end of the course, students should be able to:

1. Explain the concepts and theory of modeling and the usage of models in different engineering applications.
2. Create geometry of complex mechanical engineering systems and use the geometric models in different engineering applications.

3. Explain the basic concepts of CNC programming and machining and write CNC programmes using Manual part programming, computer assisted programming and CAD/CAM programming.
4. Explain concept of PLC and programming of PLCs
5. Explain basic concept of Robotics and Robot programming
6. Create 3D models for rapid prototyping and process files for 3D printing.

#### MEC5309: AUTOMOTIVE ENGINEERING

Level: 500 Semester: 2 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

##### Course Learning Outcomes

At the end of the course, students should be able to:

1. Demonstrate technical knowledge of the function and operation of each of the sub systems of a power train
2. Determine vehicle performance
3. Demonstrate technical knowledge of air-conditioning, fuel supply and safety systems in an automotive system
4. Troubleshoot and diagnose faults in automotive systems

#### MEC5601: PROJECT

Level: 500 Semester: 2 Credits: 6 Lecture Hours: Practical Hours: 90

Prerequisite: N/A

##### Course Learning Outcomes

At the end of the course, students should be able to:

1. identify an engineering research problem;
2. demonstrate proficiency in PowerPoint presentation in a seminar;
3. demonstrate a methodology for actualising aims and objectives of a research project;

4. partake in a group research project efficiently; and
5. submit report comprising a topic, abstract, problem statement, aims and objectives, methodology, experimentation and/or analysis, results and analysis, conclusion and recommendation.

### **CLOs for OPTIONAL Mechanical Engineering Courses**

#### **OPTION I – THERMOFLUIDS/ENERGY**

##### **MEC5301: REFRIGERATION AND AIRCONDITIONING**

Level: 500 Semester: 1 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

#### **Course Learning Outcomes**

At the end of the course, students should be able to:

1. Determine the performance of refrigerators and heat pumps
2. Perform the analysis of ideal and actual vapour compression refrigeration cycles
3. Evaluate the performance of Innovative vapour compression refrigeration systems
4. Analyse gas cycle refrigeration systems and liquefaction of gases
5. Determine the performance of absorption refrigeration system
6. Use psychrometric chart as a tool to determine the properties of atmospheric air
7. Determine refrigeration and air-conditioning load for refrigeration and air-conditioning systems
8. Select suitable refrigerant and compressor for particular application
9. Use the psychrometric chart to analyse air conditioning processes
10. Explain the various factors that determine human comfort.
11. Design an air-conditioning system for a particular application

##### **MEC5302: HEAT AND MASS TRANSFER**

Level: 500 Semester: 2 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

#### **Course Learning Outcomes**

At the end of the course, students should be able to:

1. Identify and calculate the three different modes of heat transfer (conduction, convection and radiation) in a simple system.
2. Apply the concept of thermal resistance in the determination of heat transfer interactions in multi-layered systems in both rectangular and cylindrical co-ordinates.
3. Determine heat transfer rates by conduction in 2D steady systems and 1D transient systems
4. Differentiate between forced and natural convection and explain their mechanism
5. Apply empirical correlations to determine heat transfer coefficients in forced and natural convection in bounded and unbounded systems
6. Apply conduction and convection principle in the analysis of extended surfaces (heat transfer enhancement)
7. Apply heat transfer principles to the design of heat exchangers
8. Determine heat transfer rates by thermal radiation in black and grey bodies.

### MEC5303: ALTERNATIVE ENERGY SOURCES

Level: 500 Semester: Credits: Lecture Hours: Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Explain the energy obtained from the sun and classify solar radiation
2. Determine the performance of low temperature solar collectors, concentrators and receivers
3. Identify various thermal energy storage methods and select appropriate storage technologies for a system
4. Explain solar thermal power generation
5. Conduct performance analysis on a low temperature Rankine cycle and Stirling cycles
6. Design a solar collector for domestic applications (low temperature)

7. Identify various applications of solar energy
8. Identify and classify various types of nuclear reactors
9. Explain the principle of nuclear fission and determine the amount of energy obtainable from a nuclear fission reaction
10. Determine the wind energy potential of a location from weather data
11. Select wind turbines for a particular location and determine turbine performance from the turbine performance characteristics
12. Design a wind farm for a particular location
13. Classify various hydro power systems
14. Explain the principles of various direct energy conversion systems
15. Explain principles of energy extraction from Geothermal and Tidal sources

## OPTION II – PRODUCTION

### MEC5304: OPERATIONAL RESEARCH

Level: 500 Semester: 2 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Apply ergonomic principles to the creation of safer, healthier and more efficient and effective activities in the workplace
2. Conduct ergonomic risk assessments
3. Develop appropriate control measures for ergonomic risk factors;
4. Describe work-related causes of musculo-skeletal disorders;
5. Design a workplace according to good ergonomic principles
6. Assess ergonomic aspects of the working environment and work organisation

### MEC5305: MANUFACTURING AND INDUSTRIAL FINISHING

Level: 500 Semester: 2 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Principles of coating deposition and surface modification methods
2. Fundamental coating properties and their relationship
3. Introduction to corrosion and wear protection, and various functionalities obtainable by coatings and surface treatments
4. Fundamentals of industrial application of coatings and surface treatments including capability to propose appropriate coating solutions for these
5. Pros and cons of different approaches in surface engineering.

#### MEC5306: THEORY OF METAL CUTTING

Level: 500 Semester: 2 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Know the working principles and processing characteristics of ultra-precision machining, high-speed machining methods, and non-traditional machining to the production of components;
2. Understand the advanced casting processes suitable for processing materials
3. Know the advanced welding processes and techniques of joining materials
4. Understand the basic principles and operations of advanced metal forming processes
5. Know the working principle of rapid prototyping technology, microwave processing of materials and other advanced manufacturing processes

#### Course Content

Detailed geometry of cutting tool angles. Cutting forces and temperatures. The variables of metal cutting (speed, feed rake angle, energy power, tool wear and life). Cutting - tool materials. Cutting fluids (coolants). Economics of metal cutting (cutting speed, feed and depth of cut and their effect on tool life, criteria of selection of suitable machine tool, example). Machine tool acceptance test. Machine tool foundation. Vibration in machine tools.

### OPTION III – APPLIED MECHANICS

#### MEC 5307: FRACTURE MECHANICS

Level: 500 Semester: 2 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Understand the concept of Fracture Mechanics
2. Describe Griffith - or wan-Irwin concept
3. Predict crack growth rate using empirical expression
4. Apply different crack detection techniques to identify the presence of cracks and initial flaw sizes.

#### MEC5308 - MECHANICS OF METAL FORMING

Level: 500 Semester: 2 Credits: 3 Lecture Hours: 45 Practical Hours:

Prerequisite: N/A

#### Course Learning Outcomes

At the end of the course, students should be able to:

1. Provide an overview of the essential concepts in metal forming, focusing on stress, strain, the way metals behave when flowing, and work hardening.
2. Examine various metal forming methods, including bulk and sheet metal forming techniques like forging, rolling, drawing, extrusion, deep drawing, and bending, considering their mechanics, material behavior, and operating conditions.

3. Analyze how friction, lubrication, temperature, deformation processes, and die geometry affect the results of metal forming.
4. Evaluate forming defects (cracking, wrinkling, springback, etc.) and provide methods to lessen their impact.
5. Create fundamental forming processes (die design, process sequence) for a product based on specifications, while also considering material and tooling limitations.