| Module Code | Module Title | Modular Credits [MC] | Semester | Module Description | Learning Outcomes | Pre-requisites | Co-requisites | Preclusions | Cross Listing | Syllabus | Assessment | Illustrative Reading List |
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| ME2102 | Engineering Innovation and Modelling | 4 | 2 | This module introduces the students to the various standards and techniques of sketching, prepare engineering drawings and specifications, and interpreting drawings. Students also get to use advanced commercial CAD software to do 3D solid modeling. Above all, this module expands the students' creative talent and enhances their ability to communicate their ideas in a meaningful manner. Major topics include: Principles of projections; Isometric; Orthographic and Isometric sketching; 3D solid modeling; Sectioning and Dimensioning; Welding representations, Drawing standards; Limits, Fits and Geometrical Tolerances.<br><br>This module also provides the student with the fundamental knowledge to do calculations on design components like bolts, screws, fasteners, weld joints, springs, gears, material selection, fatigue, bearings and shafts.<br><br>This is a 100% CA core module for all Mechanical Engineering students. | On successful completion of this module, the student will:<br><br>1. Have acquired the basic knowledge in engineering drawing principles, tolerance, engineering conventions and representations.<br>2. Be able to use advanced 3D modeling software in solid modeling.<br>3. Be able to do calculations on design components | Nil | Nil | **Nil** | Nil | Introduction to engineering drawing, scale, title-block<br>Principles of projection; 1st and 3rd angles.<br>Isometric views.<br>Sectioning and Dimensioning of parts.<br>Isometric & orthographic sketching,<br>Limits, Fits and Geometrical Tolerances,<br>Symbols for machine elements, Conventions, Keys, coupling & Locking Devices, Welding symbols & representation.<br>Screws, bolts and fasteners, Weld joints, Springs, Gears, Selection of materials, Design against fatigue; Selection of rolling bearings; Design of shafts | CA, Final Examination | **Compulsory reading:**<br>K.S.Lee, "Introduction to 3D Solid Modeling with SolidWorks (Third edition)", McGraw-Hill Education (Asia), 2008.<br><br>"Shigley's Mechanical Engineering Design" by Richard G Budynas and J Keith Nisbett (10th edition in SI units) ISBN 978-981-4595-28-5 McGraw Hill<br>**Supplementary reading:**<br>A.W. Boundy, "Engineering Drawing" Third edition, McGraw Hill, 2007.<br><br>Pickup and Parker, "Engineering Drawing with Worked examples. Vol. I & II", Third edition, Hutchinson & Co. Ltd, 1985.<br><br>Cecil Jansen, Jay D. Helsel & Dennis R. Short, "Engineering Drawing and Design", 6 edition, McGraw Hill, 2002<br><br>Frederick E. Giesecke, Alva Mitchell et. al., "Principles of Engineering Graphics", second edition, Macmillan Publishing Company, 1994.<br><br>William P. Spence, "Engineering Graphics", Prentice Hall, 1984. |
| ME2112 | Strength of Materials | 4 | 1 | This course provides basic mechanical engineering knowledge and theory of mechanics of materials, and how they are used to solve practical engineering problems. The course includes introduction to statics, concept of stress and strain, analysis of stresses and deflections in a loaded beam, torsion of a circular bar as well as analysis of frames and machines. | Students will be able to<br>1. Understand the concepts of statics, equilibrium of a rigid body, forces and moments.<br>2. Understand frames and machines in a structural component.<br>3. Understand and analyze two dimensional stress system.<br>4. Understand and analyze beam deflection.<br>5. Understand and analyze stresses in a loaded beam.<br>6. Understand and analyze torsion of a circular bar. | EG1111 | Nil | Nil | Nil | • Introduction to Statics, Equilibrium of Rigid Bodies, Frames and machines.<br>• Deformable Bodies; Stress and Strain and Sign Convention; Linear Elastic Stress-Strain Relationships.<br>• Two -dimensional stress and strain systems.<br>• Shear Force and Bending Moment in Beams.<br>• Deflection of Laterally Loaded Symmetrical Beams. Statically Indeterminate Beams<br>• Bending and Shear Stresses in Laterally Loaded Symmetrical Beams. Second moment of area. The flexure formula.<br>• Torsion of Cylindrical Shafts. | Lab, Quiz, Final Examination | • C. Ugural, Mechanics of Materials, McGraw-Hill, Current edition<br>• R. C. Hibbeler,Mechanics of Materials, Prentice Hall, SI 2nd Ed., 2005.<br>• F. P. Beer, E. R. Johnston, Jr. and J. T. DeWolf, Mechanics of Materials, McGraw-Hiil, SI 3rd Ed., 2004.<br>• J. M. Gere and S. P. Timoshenko, Mechanics of Materials, PWS Publishing Company, 4th ed., 1997.<br>• R. R. Craig, Jr., Mechanics of Materials, McGraw-Hill, 2nd ed., 2000. |

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| ME2114 | Mechanics of Materials II (Core for cohort AY1516 & earlier) | 3 | 2 | The topics covered are: inelastic behavior, columns, experimental stress analysis, energy methods and finite element analysis. | 1. Students will learn the limit loads concept and able to determine the first yield as well as ultimate bending and torsional loads on a structure.<br>2. Students will have knowledge of buckling formulas and able to solve column buckling problems.<br>3. Students will know the strain gauge technique in experimental stress analysis.<br>4. Students will know how to apply energy methods to determine the deformation of structures beyond basic structural members like beams, rods and trusses.<br>5. Students will know how to appreciate how energy methods can form the basis of commercial software | ME2113 | Nil | Nil | Nil | Inelastic Behavior (4 hrs)<br>Columns (4 hrs)<br>Experimental Stress Analysis (4 hrs)<br>Energy Methods (8 hrs)<br>Introduction the Finite Element Method (6 hrs) | Lab, Quiz, Final Examination | • C. Ugural, Mechanics of Materials, McGraw-Hill, Current edition<br>• R. C. Hibbeler,Mechanics of Materials, Prentice Hall, SI 2nd Ed., 2005.<br>• F. P. Beer, E. R. Johnston, Jr. and J. T. DeWolf, Mechanics of Materials, McGraw-Hiil, SI 3rd Ed., 2004.<br>• J. M. Gere and S. P. Timoshenko, Mechanics of Materials, PWS Publishing Company, 4th ed., 1997.<br>• R. R. Craig, Jr., Mechanics of Materials, McGraw-Hiil, 2nd ed., 2000. |
| ME2121 | Engineering Thermodynamics | 4 | 2 | This module develops a good understanding of the basic concepts and application of thermodynamics, required for the analysis, modeling and design of processes and thermal-fluid systems in engineering practice. Major topics include a review and the application of the First and Second Laws of Thermodynamics, reversible and irreversible processes, entropy, non-flow and flow processes, cycles involving entropy changes, power and refrigeration cycles, ideal gas mixtures, psychrometry and its applications. | On successful completion of this module, the student will be able to:<br>1. Apply principles of thermodynamics in analyzing non-flow and flow processes.<br>2. Analyze, model and design power plants using water or air as working fluids.<br>3. Analyze, model and design vapour compression refrigeration systems.<br>4. Analyze processes involving non-reacting gaseous and gas-vapour mixtures. | PC1431 | Nil | Nil | Nil | Properties of pure substances, steam tables (4 hrs)<br>Review and Applications of First Law: First Law applied to non-flow, flow processes and cycles. Ideal gas and condensible substances. (4 hrs)<br>Second Law of Thermodynamics: Direct and reversed heat engines. Reversibility, processes and cycles. Carnot cycle. Clausius inequality. Absolute temperature. Entropy of substances. (5 hrs)<br>Application to processes and cycles: Entropy changes for pure substances in non-flow, flow processes and cycles. P-v and T-s diagrams. Isentropic efficiency. (4 hrs)<br>Power and refrigeration cycles: Water as working fluid for power cycles. Rankine cycle, superheating and reheating. Vapour compression cycle. (3 hrs)<br>Air standard cycles: Analysis of Otto, Diesel and Mixed cycles. Gas turbine cycle. (4 hrs)<br>Mixtures: Dalton's law. Ideal gas and vapour mixtures. (2 hrs) | Lab, Quiz, Final Examination | **Compulsory reading:**<br>Cengel Y.A. and Boles, M.A., "Thermodynamics: an engineering approach", 6th edition in S.I. units, McGraw-Hill Book Company, 2007.<br>**Supplementary reading:**<br>Van Wylen, G.J. and Sonntag, R.E., "Fundamentals of Classical Thermodynamics", 6th edition, John Wiley & Sons, Inc, 2003.<br><br>Rogers, G.F.C. and Mayhew, Y.R., "Engineering Thermodynamics", 4th edition, Longman Group Ltd, 1992.<br><br>Jones, J. B. and Dugan, R.E., "Engineering Thermodynamics", Prentice-Hall International, Inc., 1996. |

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| ME2134 | Fluid Mechanics I | 4 | 1 | This is an introductory course to fluid mechanics as applied to engineering. After introducing the basic terminology and a classification of fluid and flow, students are taught fluid statics, which cover hydrostatic forces on submerged bodies, surface tension forces, buoyancy, metacentric height and stability of floating bodies. Numerous examples of engineering applications pertaining to each aspect of fluid statics are presented. In the section on fluid dynamics, basic principles of fluid motion are<br>introduced. This covers the continuity equation, Bernoulli and energy equations. The momentum equation and its engineering application using the control volume approach are included. In the analysis of fluid-mechanics problems, dimensional analysis and similitude are taught with engineering examples. On viscous flow in pipes, laminar and turbulent pipe flows, Hagen-Poiseuille law, friction factor, losses in pipe fittings and use of Moody's Chart will be covered. This module ends with an introduction to pumps, their elementary theory and matching pump and system. | On successful completion of this module, the student will be able to:<br><br>1. classify different types of fluid, identify different types of flow regimes, define stress and rate of strain in a fluid, and understand the phenomenon of surface tension.<br><br>2. analyze hydrostatic forces on submerged plane or curved surfaces, evaluate stability of floating bodies and identify the states of equilibrium of floating bodies.<br><br>3. define streamlines and establish energy equation and derive Bernoulli equation from it.<br><br>4. analyze equilibrium of moving fluid in translation and rotation, and apply continuity, linear and angular momentum equations to analyze fluid mechanics problems.<br><br>5. formulate dimensional groups using Rayleigh techniques and Buckingham Pi Theorem, and analyze fluid mechanics problems using the concept of modelling and similitude. | PC1431,<br>PC1431FC,<br>PC1431X | Nil | Nil | Nil | 1. Introduction to Fluid Mechanics.<br><br>2. Classification of Fluid and Flow: Real and ideal; Newtonian and non-Newtonian; Uniform and non-uniform; Steady and unsteady; Laminar and turbulent; Incompressible and compressible.<br><br>3. Fluid Statics: Hydrostatic forces on submerged body, buoyancy, metacentric height, stability of floating bodies.<br><br>4. Principles of Fluid Motion: Definition of streamline. Continuity equation, Bernoulli equation and Energy equations. Equilibrium of moving fluid (in translation and rotation). Momentum equation and its applications.<br><br>5. Dimensional Analysis and Similitude: Rayleigh's method, Buckingham's Π theorem, Dimensionless numbers. Type of physical similarities: geometric, kinematic and dynamic. Reynolds number, Froude number, etc and their simple applications.<br><br>6. Laminar and Turbulent Pipe Flows: Hagen-Poiseuille equation, Darcy friction factor, Darcy-Weisbach equation, turbulent flow in smooth and rough pipes, application of Moody's chart and minor losses in pipe system. | Lab reports/Assignment, Final Examination | **Compulsory reading:**<br>1. "Fluid Mechanics" by F.M. White, 7th edition (McGraw Hill) 2011.<br>2. "Fundamentals of Fluid Mechanics" by B. R. Munson, D. F. Young, T. H. Okiishi & W. W. Huebsch,, John Wiley & Sons, Inc., 7th Edition, 2013.<br>**Supplementary reading:**<br>3. "Introduction to Fluid Mechanics" by R. W. Fox, A. T. McDonald & P. J. Pritchard, John Wiley & Sons, 8th Edition, 2012.<br>4. "Fluid Mechanics: Fundamentals and Applications" by Y. A. Cengel and J. M. Cimbala, Mcgraw-Hill, 3rd Edition, 2014.<br>5. "Mechanics of Fluids" by M. C. Potter, D. C. Wiggert & M. Hondzo, Prentice Hall, 4th Edition, 2012.<br>6. "A Physical Introduction to Fluid Mechanics" by A. J. Smits, John Wiley & Sons, 1st Edition, 2000.<br>7. "Mechanics of Fluids" by I. H. Shames, McGraw-Hill, 4th Edition, 2003.<br>8. "Engineering Fluid Mechanics" by C. T. Crowe, D. F. Elger, J. A. Roberson & B. C. Williams, John Wiley & Sons, 9th Edition, 2010.<br>9. "Fluid Mechanics" by J. F. Douglas, J. M. Gasiorek, J. A. Swaffield & L. B. Jack, Prentice Hall, 5th Edition, 2005.<br>10. "Fluid Mechanics with Engineering Applications" by J. B. Franzini & E. J. Finnemore, McGraw-Hill, 10th Edition, 2002.<br>11. "Mechanics of Fluids" by B. S. Massey, Taylor & Francis, 9th Edition, 2012.<br>12. "Applied Fluid Mechanics" by R. L. Mott, Prentice Hall, 6th Edition, 2006.<br>13. "Elementary Fluid Mechanics" by R. L. Street, G. Z. Watters & J. K. Vennard, John Wiley & Sons, 7th Edition, 1996.<br>14. "Fluid Mechanics" by V. L. Streeter, E. B. Wylie & K. W. Bedford, McGraw-Hill, 9th Edition, 1997 |
| ME2135 | Fluid Mechanics II<br>(Core for cohort AY1516 & earlier) | 4 | 2 | This module builds upon the concepts learnt in ME2134, with emphasis on Fluid Mechanics concepts and applications including turbomachinery, potential flow, viscous fluid flow and boundary layers. | Apply angular momentum principle and dimensional analysis to analyze the performance of pumps, perform pump-system matching and assess the likelihood of cavitation occurrence; Understand the concepts of vorticity, circulation, irrotationality, stream function and velocity potential function, and apply these concepts to solve simple potential flow problems involving the superposition of elementary flows; Identify and discuss the features of external flow past immersed bodies and calculate the lift and drag forces for typical body shapes; Describe and explain the phenomenon of boundary layer on a body (at this stage, a flat plate) and estimate the drag force exerted; Analyze and design an aerodynamic body with minimum drag force | ME2134 | Nil | Nil | Nil | **Fluid Machinery:** Pump classification for dynamic and positive- displacement pumps. Basic velocity triangles and rotordynamics of centrifugal and axial-flow pumps. Use of dimensional analysis to simplify pump characteristic curves. Specific speed and pump selection. Matching of pump and system requirements. Physical phenomenon of cavitation in pumps and quantification of cavitation risk and damage.; **Potential Flow**: Ideal and irrotational flow. Continuity equation. Rotation, vorticity and circulation. Streamfunction and velocity potential of basic flows, such as a uniform flow, source, sink, vortex and doublet. Linearity of potential flow. Flow past a circular cylinder and the lift on a rotating cylinder. D'Alembert's<br>paradox, Kutta Joukowski Theorem and Magnus Effect. Method of images.;<br>**Viscous Flow:** Comparison between inviscid and viscous flow, description of fluid motion and substantive derivative. Navier-Stokes equations and some exact solutions. Boundary layer flows. Comparison between laminar and turbulent boundary layers. Boundary layer thickness, displacement and momentum thicknesses | Laboratories Experiments, Quizzes, Final Examination | **Compulsory Reading:**<br>"Fluid Mechanics" by F. M. White, McGraw-Hill, 7th Edition, 2011.;<br>"Fundamentals of Fluid Mechanics" by B. R. Munson, D. F. Young, T. H. Okiishi & W. W. Huebsch,, John Wiley & Sons, Inc., 7th Edition, 2013.<br>**Supplementary Reading:**<br>"Introduction to Fluid Mechanics" by R. W. Fox, A. T. McDonald & P. J. Pritchard, John Wiley & Sons,<br>8th Edition, 2012.;<br>"Fluid Mechanics: Fundamentals and Applications" by Y. A. Cengel and J. M. Cimbala, Mcgraw-Hill,3rd Edition, 2014.;<br>"Mechanics of Fluids" by M. C. Potter, D. C. Wiggert & M. Hondzo, Prentice Hall, 4th Edition, 2012.;<br>"A Physical Introduction to Fluid Mechanics" by A. J. Smits, John Wiley & Sons, 1st Edition, 2000.;<br>"Mechanics of Fluids" by I. H. Shames, McGraw-Hill, 4th Edition, 2003.;<br>"Engineering Fluid Mechanics" by C. T. Crowe, D. F. Elger, J. A. Roberson & B. C. Williams, John Wiley & Sons, 9th Edition, 2010.;<br>"Fluid Mechanics" by J. F. Douglas, J. M. Gasiorek, J. A. Swaffield & L. B. Jack, Prentice Hall, 5th Edition, 2005.; "Fluid Mechanics with Engineering Applications" by J. B. Franzini & E. J. Finnemore, McGraw-Hill, 10th Edition, 2002.;<br>"Mechanics of Fluids" by B. S. Massey, Taylor & Francis, 9th Edition, 2012.;<br>"Applied Fluid Mechanics" by R. L. Mott, Prentice Hall, 6th Edition, 2006.;<br>"Elementary Fluid Mechanics" by R. L. Street, G. Z. Watters & J. K. Vennard, John |

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| | | | | | | | | | | displacement and momentum thicknesses. Laminar boundary layer equations (Prandtl's equations), drag on flat plate (von Karman integral equation), solution of laminar boundary layer flow on a flat plate (Blasius solution). Boundary layer separation and control. Turbulent flow and time averaging, equations of motion for turbulent flow, turbulent boundary layer's structure and equations, turbulence models, velocity profiles in turbulent boundary layer and parameters of turbulent boundary layer. Boundary layer with transition. Flow around bluff and streamlined bodies: their flow patterns, drag and lift. | | "Elementary Fluid Mechanics" by R. L. Street, G. Z. Watters & J. K. Vennard, John Wiley & Sons, 7th Edition, 1996.; "Fluid Mechanics" by V. L. Streeter, E. B. Wylie & K. W. Bedford, McGraw-Hill, 9th Edition, 1997. |
| ME2142 | Feedback Control Systems | 4 | 1 & 2 | This module introduces students to fundamental concepts in control system analysis and design. Topics include mathematical modeling of dynamical systems, time responses of first and second-order systems, steady-state error analysis, frequency response analysis of systems and design methodologies in both the time and the frequency domains. | **On successful completion of this module, the student will be able to:**<br>1. Obtain the dynamic models of simple physical systems, particularly mechanical and electrical systems and obtain the transfer functions of these systems.<br>2. Determine the transient response of first and second order systems.<br>3. Determine the stability characteristics of a system using Routh's stability criterion and the root locus method.<br>4. Determine the steady state error characteristics of systems.<br>5. Determine the steady state frequency response of physical systems and represent the frequency response graphically in terms of Bode and Nyquist plots.<br>6. Determine the stability of physical systems through the frequency response using the Nyquist stability criterion.<br>7. To determine also the relative stability measures such as gain and phase margins and to translate these values in terms of transient response.<br>8. To conduct simple experiments determining performance of control systems | MA1512+ MA1513 | Nil | ME2142E, EE2010 and EE2010E | Nil | **1. General Introduction to Automatic Control:** Definitions. Closed-loop and Open-loop Control. Examples<br>**2. Review of Mathematical Background:** Review of Laplace Transformation. Inverse Laplace Transformation. Solution of Differential Equations.<br>**3. Mathematical Model of Physical Systems:** Transfer functions. Block diagrams. Modeling of mechanical systems, electrical systems, motors.<br>**4. Transient Response Analysis:** Standard time response test functions. Time responses of first-order, second-order and higher-order systems.<br>**5. System Stability and Steady State Characteristics:** Routh's stability criterion. Root locus Method. System Types. Steady state error analysis<br>**6. Frequency Response Analysis:** Forced sinusoidal response. Graphical frequency response methods – Bode and Nyquist plots. Nyquist stability criterion. Gain and phase margins. Closed-loop frequency response. | Lab, Final Examination | 1. Course Notes.<br>2. R.C.Dorf and R.H. Bishop, "Modern Control Systems," Prentice Hall Inc., 2008<br>3. K. Ogata, "Modern Control Engineering," Prentice-Hall, Inc., 2002.<br>4. B.C. Kuo, "Automatic Control Systems," Prentice Hall, Inc., 1995 |

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| ME2143 | Sensors and Actuators (Core for cohort AY1516 & earlier) | 4 | 2 | This module introduces various components that are useful in the analysis, design and synthesis of mechatronic systems. The components include electronic circuits (analog and digital), sensors, actuators, power supplies, etc. For the sensors part, the basic principles and characteristics of various sensors for the measurement of physical quantities such as position, strain, temperature, etc will be introduced. The actuators section mainly covers the electric motors which include DC motors, stepper motors and AC motors. | Apply operational amplifiers circuits for analog signal processing.; Analyze circuit involving diodes, BJT transistors; Design and implement digital circuits.; Understand the basic principles and characteristics of DC, AC, and stepper motors.; Understand the basic principles and applications of various sensors. | EG1108 and PC1431 | Nil | Nil | Nil | Operational Amplifiers and Applications: Ideal Op-amp model. Inverting and non-inverting amplifier. Summer. Integrator. Voltage follower. Differential amplifier. Practical op-amp characteristics; Semiconductor Electronics: Junction Diode. Zener diodes. Rectifiers. Voltage regulators. Transistors.; Introduction to Digital Electronics: Boolean Algebra. Truth tables. Logic Gates. Combinational logic. Karnaugh Maps. Flip-flops and counters. Sequential logic.; DC Motors: Magnetic field and circuits. DC motor principle. Types of DC motors. Torque-speed characteristics. Speed regulations.; Review of AC Power: Single and three phase systems. Star and delta configurations. Line and phase quantities.; AC Motors and Stepper Motors: Principle of operation. Torque-speed characteristics. Induction motors and stepper motors.; Sensors and Transducers: Bridges and their applications. Variable resistance elements: potentiometers, strain gauges, thermistors, RTDs. Variable reluctance elements: differential transformers, variable reluctance transducers. Capacitive transducers. | Laboratories: Motor characteristics, linear circuits, Online assignments/forum participation, Final Examinations | **Compulsory Reading:**<br>David G. Alciatore and Michael B. Histand, "Introduction to Mechatronics and Measurement Systems", McGraw-Hill, 2007.; Allan R Hambley, "Electrical Engineering, Principles & Application", Prentice Hall, 2005.<br>**Supplementary Reading**:<br>R. Pallas-areny and J. Webster, "Sensors and Signal Conditioning", John Wiley & Sons, 2001.; Ernest O. Doebelin, "Measurement Systems Application and Design", McGraw Hill, 2004.; W. Bolton, "Mechatronics", Prentice Hall, 2003.; Nitaigour Premchand Mahalik, "Mechatronics: Principles, concepts and applications", McGraw Hill, 2003.; D. Shetty and R. A. Kolk, "Mechatronics System Design", PWS Publishing Company, 1997. |
| ME2151 | Principles of Mechanical Engineering Materials | 4 | 1 | This module provides the foundation for understanding the structure-property-processing relationship in materials common in mechanical engineering. Topics explore the mechanical properties of metals and their alloys, the means of modifying such properties, as well as the failure and environmental degradation of materials. Practical applications are demonstrated through laboratory experiments to illustrate the concepts taught during lectures. | Describe the mechanical properties of metals and their alloys and how they are tested; Correlate the microstructures of metals to mechanical properties; Explain the mechanics of failure in metals, including environmental degradation; Apply the knowledge of phase transformations to predict microstructures and desired properties. | Nil | Nil | MLE1101 | Nil | Mechanical properties: stiffness, strength, hardness; testing methods: tensile test, indentation. Material structures: atomic bonding; crystal structures; imperfections. Deformation mechanisms in metals: dislocation motion, slip; strengthening/hardening mechanisms. Failure: fracture, crack propagation, ductile-to-brittle transitions, impact testing; fatigue, fatigue testing. Environmental degradation: oxidation; corrosion. Phase equilibria; phase diagrams; invariant reactions; development of microstructures. Kinetics of phase transformations: nucleation and growth; time-temperature transformation diagrams; continuous-cooling-transformation diagrams. | Laboratory, Final Examination | **Compulsory Reading:**<br>Donald R Askeland Pradeep P Fulay and Wendelin J Wright, The Science and Engineering of Materials, 6th Edition, SI Edition, Cengage Learning, 2011;<br>**Supplementary Reading:**<br>William D Callister Jr. and David G. Rethwisch, Materials Science and Engineering, 8th Edition, SI Version, John Wiley and Sons, 2011.; James F. Shackelford, Introduction to Materials Science for Engineers, 7th Edition, Pearson Prentice Hall, 2009.; William F. Smith and Javad Hashemi, Foundations of Materials Science and Engineering,<br>5th Edition in SI Units, Mc-Graw Hill, 2011 |

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| ME3103 | Mechanical Systems Design | 6 | 1 & 2 | This module consists of a project which is either (i) an industry-sponsored project, (ii) an in-house project linked to external competitions, or, (iii) a project according to a prescribed theme proposed by a group of students. The students will work in groups to complete the design of a mechanical product/system in the first half of the semester to be followed by the fabrication/testing of prototype(s) in the second half. In the course of project work, students will be exposed to the working of team dynamics, the engineering design process, report writing, oral presentation and project management. | 1. Students have been exposed to technical proposal preparation, problem solving, the design process, the use of computer-based tools in the design and preparation of design documentation.<br><br>2. Students have been exposed to the non-technical issues in a group project such as time management, scheduling, costing, team co-ordination, team dynamics, and informal communication.<br><br>3. Students are able to present the design concepts and final design technically (in drawings and CAD models) through reports and oral presentations.<br><br>4. Students have been exposed to the verification of designs through the building of a workable prototype that involves hands-on fabrication, prototyping, outsourcing, assembly and testing.<br><br>5. Students are able to present the proof-of-concept prototypes through demonstrations, reports and oral presentations. | ME2101 Fundamentals of Mechanical Design<br>ME2103 Engineering Visualisation and Modelling | NA | ME3101 Mechanical Systems Design I<br>ME3102 Mechanical Systems Design II | NA | Team dynamics<br>The design process, comprising:<br>identifying requirements,<br>conceptual design and evaluation,<br>embodiment design and designing for X,<br>analysis/simulation and detailed design.<br>The prototyping process, comprising:<br>experiments,<br>machining,<br>rapid prototyping,<br>outsourcing of specialised fabrication works,<br>sourcing of off-the-shelf components,<br>assembly and integration of components/subsystems,<br>testing and refinement to verify workability.<br>Report writing and oral presentation skills<br>Project planning and management | Tutorials/Seminars, IVLE quizzes, Final report, others (quality of project and its execution, peer review) | **Compulsory reading:**<br>E-learning courseware on ME3103 IVLE<br><br>Engineering Design Process, Cengage Learning 2nd International Ed., Yousef Haik & Tamer M. Shahin, 2011 |
| ME3112 | Mechanics of Machines (Core for cohort AY1516 & earlier) | 4 | 2 | This course covers the fundamental engineering principles on kinematics and kinetics. The topics of rigid body dynamics and vibration will be covered, including the theoretical development and practical application to mechanisms and machinery. The salient features of dynamics to be applied for each instance will be clearly explained and the interpretation of the results obtained will be highlighted. | 1. Understand the principles of kinematics and kinetics of rigid body motion.<br>2. Apply the knowledge of dynamics to solve mechanical vibration problems.<br>3. Apply the knowledge of kinematics and kinetics to the analysis of machines and mechanisms. | PC1431 | Nil | Nil | Nil | 1. Revision for kinematics and dynamics of particles<br>2. Kinematics for rigid bodies<br>3. Kinetics for rigid bodies<br>4. Work and energy principle for rigid bodies<br>5. Vibration of single degree of freedom system<br>6. Analysis of mechanisms and linkages. | Lab, Final Examination | **Compulsory reading:**<br>Beer, Johnston and Clausen, "Vector mechanics for Engineers - dynamics", McGraw-Hill.<br>**Supplementary reading:**<br>J.L. Meriam and L.G. Kraige, “Engineering Mechaics, Vol 2, Dynamics”, John Wiley & Sons.<br><br>R.C. Hibbler, “Engineering Mechanics, Dynamics”, Prentice Hall. |

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| ME3122 | Heat Transfer | 4 | 1 | This course covers the key concepts related to the different modes of heat transfer (conduction, convection and radiation) and principles of heat exchangers. It develops the students' proficiency in applying these heat transfer concepts and principles, to analyse and solve practical engineering problems involving heat transfer processes. Topics include introduction to heat transfer; steady state heat conduction; transient heat conduction; lumped capacitance; introduction to convective heat transfer; external forced convection; internal forced convection; natural/free convection; blackbody radiation and radiative properties; radiative exchange between surfaces; introduction to heat exchangers and basic calculation of overall heat transfer coefficient. | Identify, formulate and solve problems involving different heat transfer processes; Analyse, model heat conduction in one-dimensional cases and describe two- and three-dimensional heat conduction and be able to apply them to simple heat conduction problems; Analyse, model and apply appropriate empirical correlations for convection heat transfer in both internal and external flows; Identify, model and calculate heat transfer through radiation and between irradiated surfaces; and Understand principles and different types of heat exchangers and perform basic calculation of overall rate of heat exchange. | PC1431 | Nil | Nil | Nil | **Conduction:** Fourier's law of conduction, one dimensional heat conduction through composite wall, tubes and spheres. Derivation of general transient conduction equation with a heat source. Steady state 1D conduction with and without energy generation; overall heat transfer coefficient, critical and economic thickness of insulation. Extended surfaces: derivation of equation for simpler cases, fin efficiency and effectiveness. Unsteady heat conduction: lumped system analyses.; **Convection**: Newton's law of cooling. Laminar flow over a flat plate, Reynolds number and its interpretation, Blasius solution, velocity profile, boundary layer thickness, wall shear stress. Momentum integral equation, similar velocity profile, boundary layer thickness. Thermal boundary layer, energy equation, energy integral equation and its solution. The Reynolds analogy between fluid friction and heat transfer. Laminar flow through a circular tube, constant heat flux, constant wall temperature conditions, concept of bulk temperature, Nusselt number for these cases. Turbulent flow through circular tubes, use of Reynolds analogy, empirical relations, Dittus-Boelter equation. Empirical relations for internal and external flows, Reynolds number, circular and non-circular geometries, hydraulic diameter. Natural convection on a vertical plate, energy integral approach to the problem, Grashof number. Use of empirical correlations for laminar and turbulent flows and for standard geometries to determine natural convection heat transfer.; **Radiation:** Laws of blackbody and gray body radiation; semi-transparent and opaque materials. Intensity, emissive power, emittance, absorptance, reflectance, transmittance; shape factor. Radiation exchange between blackbody and gray surfaces; radiation shields.; **Heat Exchangers:** Types of heat exchangers, overall heat transfer coefficients, influence of hi/o on U values. Log mean temperature method, extension to non-counter flow arrangement, correction factor charts. Effectiveness-NTU method. Application to sensible heat exchangers and condensers. | Laboratory Sessions, Mid-term Quizzes/ Project Assignment, Final Examination | Fundamentals of Heat and Mass Transfer by Incropera and DeWitt; Heat Transfer – a practical approach by Y.A. Cengel; Heat Transfer by J. P. Holman **Compulsory Reading**: Lecture Notes |

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| ME3162 | Manufacturing Processes | 4 | 1 | Manufacturing processes: cold and hot working, rolling, extrusion, forgoing, sheet and metal blanking and forming, cold forming, welding, brazing, soldering, casting, powder metallurgy, plastics technology.<br>Machine tools: RP, 3-D printing, Lathes, Milling, Drill press, Grinding and laser machining, etc. | On successful completion of this module, the student will be able to:<br><br>1. The student will know the principles and applications of various manufacturing processes, and be able to compare them<br>2. The student will know the principles and applications of plastics manufacture<br>3. The student will know the principles and applications of metal machining | Nil | Nil | Nil | Nil | A) Manufacturing processes:<br>• Introduction to cold and hot working.<br>• Rolling - 2, 3 and 4-high rolls, cluster and planetary rolls, manufacture of blooms, billets and slabs.<br>• Extrusion - Direct and indirect extrusion, hollow extrusion, hydrostatic extrusion.<br>• Forging - Hammer, press, roll forging, open and closed die forging.<br>• Sheet metal bending and deep-drawing, punch load, drawability, Crane's constants.<br>• Shearing of sheet metal - types of shearing operation, punch and die clearance, punch force.<br>• Cold forming processes - Marforming, Guerin process, hydroforming.<br>• Welding, brazing, soldering - Arc and gas welding, pressure welding, MIG, TIG, submerged-arc, friction, resistance, laser and electron-beam welding.<br>• Casting - Sand casting, patterns, defects, die-casting, centrifugal casting, investment casting, continuous casting.<br>• Powder metallurgy - Production of powders, fabrication processes, sintering, comparison with other processes.<br>• Electro-discharge machining.<br>• Plastics technology - Properties of plastics, thermoplastics and thermosets, manufacturing of plastics<br>B) Machine tools:<br>• Introduction to machine tools and machining operations, Saws (band, abrasive and toothed circular), Drill presses, Lathes, Milling machines and machining centres, Grinders, Single point, multi-point and abrasive material removal<br>Generating motions of machine tools<br>• Cutting tool materials<br>Major tool material types.<br>• Introduction to rapid prototyping<br>Additive manufacturing technologies (fused filament deposition, photo-curing, powder fusing/binding, polymer jetting)<br>• Introduction to laser cutting<br>Laser cutting of sheet material (metal and polymer) | Lab, Final Examination | |

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| ME4101A | B.Eng. Dissertation | 8 | 1 & 2 | This module consists mainly of an industrial or research-based project carried out under the supervision of one or more faculty members. It introduces students to the basic methodology of research in the context of a problem of current research interest. The module is normally taken over two consecutive semesters, and is a core requirement of the B.Eng. (Mech) program. | On successful completion of this module, the student will be able to:<br><br>(1) Undertake research projects in a methodological manner including literature search, formulation of problems, conduct experiments, and analysis.<br><br>(2) Think critically and acquire independent research skills that are vital for life life-long learning.<br><br>(3) Communicate effectively through technical report writing on the achievements of the final year project.<br><br>(4) Achieve confidence in communication skills through various project oral presentations. | Stage 4 standing | Nil | Nil | Nil | NA | 100% CA | Dependent on project selected. |