

Institution of Engineers, Sri Lanka
Engineering Certificate Course Stage 1
Syllabuses

MA1001 Engineering Mathematics I

Subject Code	CC1001	Subject Title	Engineering Mathematics I			
Credits	4.0	Total Hours	Lectures	60 hrs	Pre-requisites	None
GPA/NGPA	GPA		MCQ	2 Tests		
Aims:						
To provide the students with fundamental mathematical concepts and tools to analyse and solve a range of engineering problems.						
Learning outcomes:						
At the successful completion of this subject course, learner will be able to :						
<ul style="list-style-type: none"> • Use matrix algebra to solve linear system of equations with reference to linear dependency, consistency • Use different methods of solution of linear systems of equations. • Apply eigen value methods in engineering applications. • Apply techniques of vector algebra in engineering analysis. • Use concepts of solid geometry and 3D coordinate geometry. • Identify number systems culminating in complex numbers. • Solve polynomial equations with real coefficients using complex numbers. • Use polar representation of complex numbers. • Apply advanced calculus techniques of a function of a single variable, such as limits, differentiation, integration, sum of series for the solution of engineering problems. • Work with hyperbolic functions and relations to trigonometric functions. • Solve differential equations of 1st order and linear differential equations of higher order. • Use advanced integration methods. • Use theories on partial derivatives, in Cartesian and polar co-ordinate systems. • Solve simple partial differential equations. 						
Syllabus:						
Algebra						
Matrices: types of matrices, algebra of matrices, inversion determinants: properties of determinants. Inverse of matrices; solution of simultaneous equations; Gauss elimination method; Echelon form; linear dependence and consistency. Rank of a matrix and its use. Eigen values and vectors, characteristic equation and its uses. Applications of eigen values in Engineering.						
						[12 hrs]
Vector Algebra						
Vector algebra in 3-D and applications. Vector operations and applications.						
						[08 hrs]
Solid Geometry						
Geometry of 3D figures. Theorems on lines and planes Elements of 3D Coordinate Geometry. Transformations						
						[08 hrs]

Complex Numbers

Number systems leading to complex numbers.

De Moivre's theorem; roots of complex numbers Roots of algebraic equations; Solution of polynomial equations with real coefficients. [09 hrs]

Analysis**Function of a single variable**

Limits, continuous functions, L'Hospital's rule for limits , inverse functions; implicit functions. Stationary points and curve sketching. Mean value theorem; Leibnitz's theorem; Infinite series and tests for convergence. Taylor series in one independent variable.

Trigonometric, exponential, hyperbolic and logarithmic functions, Euler's equation. Methods of integration; reduction formulae. Applications of integrals to areas, volumes, moments etc. Ordinary differential equations; formulation Methods of solution of first order differential equations, second order differential equations with constant coefficients. Use of D-operators. Applications in engineering. [13 hrs]

Function of many variables

Partial differentiation and application in error analysis. Higher order partial derivatives. Taylor's expansion of function of two independent variables. Cartesian and polar forms, applications in 3 D. Solution of simple partial differential equations [10 hrs]

Assessment:

MCQ – 30%

Final Exam 70%

Recommended Texts:

(Will be included in the subject outlines given to students)

HM1001 – Language Skills Development

Subject Code	HM1001	Subject Title	Language Skills Development			
Credits	4.0	Total Hours	Lectures	45hrs.	Pre-Requisites	None
GPA/NGPA	GPA		Lab/Assignt	30 hrs.		
Aims:						
<ol style="list-style-type: none"> 1. To make students interact with others confidently 2. To make them do a short presentation with confidence 3. To make them respond to and interact with a written text intelligently 4. To make them write with reasonable fluency and grammatical accuracy on subject related topics 						
Learning Outcomes:						
<p>At the successful completion of this subject course, learner will be able to :</p> <ul style="list-style-type: none"> • Participate in a group discussion with a fair degree of confidence • Make a short formal presentation • Read and comprehend a fairly complex subject-related text • Summarize a short text on a familiar topic with a fair degree of accuracy. • Write assignment reports, methodically answer tutorials, short passages etc. with minimum errors. 						
Syllabus:						
<u>Speech</u> (through pair/group activities)						
<ul style="list-style-type: none"> ▪ Group activities, language games, puzzles ▪ Presentation skills 						
<u>Reading</u>						
Suitable reading texts from various sources including the internet						
<u>Writing</u>						
<ul style="list-style-type: none"> ▪ Paraphrase/Précis ▪ Descriptive writing i.e. describing phenomena / processes ▪ Evaluative writing i.e. commenting on a passage, merits and demerits of a system 						
<u>Grammar</u>						
Based on errors occurring in students' writing (Active/passive, tense, prepositions etc.)						
Assessment:						
Home assignments, Class tests, group interaction, presentation, writing (30%)						
Final examination: written test and presentation (70%)						
References:						
(Will be included in the subject outlines given to students)						

GE1001 – Mechanics and Properties of Materials

Subject Code	GE1001	Subject Title	Engineering Properties of Materials			
Credits	4.0	Total Hours	Lectures	55hrs	Pre-Requisites	None
GPA/NGPA	GPA		Lab/Assignt	10hrs		
<p>Aims: The aim of this unit is to introduce structural mechanics principles and engineering properties related to deformable solids.</p>						
<p>Learning Outcomes: At the successful completion of this subject course, learner will be able to:</p> <ul style="list-style-type: none"> • Understand internal and external forces, equilibrium and free body diagrams • Determine stresses and strains and deformations due to force and displacement induced loads • Determine properties of various engineering materials. • Predict failure of structural components 						
<p>Syllabus:</p> <p>Mechanics</p> <ol style="list-style-type: none"> 1. Analysis of stress and strain (6hr). 2. Bending moments, shear forces and action diagrams (4hr) 3. Bending and shear stresses in beams (8hr) 4. Deflection of beams and simple frames (6hr) 5. Torsion of circular sections (3hr) <p>Properties</p> <ol style="list-style-type: none"> 1. Atomic structure 2. Crystal Structures 3. Mechanical properties 4. Failures 5. Testing methods 6. Phase diagrams and heat treatment 7. Electrical properties 8. Introduction to nano materials 						
<p>Assessment:</p> <p>5 laboratory assignments, each 2hr duration (30%)</p> <ol style="list-style-type: none"> 1. Tensile testing 2. Impact testing 3. Hardness Test 4. Microstructure Examination 5. To be decided <p>End of stage examination of 3hr duration (70%)</p>						
<p>References:</p> <p>(Will be included in the subject outlines given to students)</p>						

GE1002 – Basic Electrical Engineering

Subject Code	GE1002	Subject Title	Electrical and Electronic Engineering			
Credits	4.0	Total Hours	Lectures	55 hrs	Pre-requisites	None
GPA/NGPA	GPA		Lab/Assign.	10 hrs		
Aims:						
The aim of this unit is to develop ac and dc electrical principles relating to electrical circuits and to use of measuring and instrumentation techniques.						
Learning outcomes:						
At the successful completion of this subject course, learner will be able to:						
<ul style="list-style-type: none"> • Apply safety in electrical wiring <ul style="list-style-type: none"> ○ Use electricity safely in the home and workplace ○ Know the body current characteristics for electric shock ○ Select fuses, MCBs and RCDs in simple installations • Perform basic calculations on dc and ac circuits <ul style="list-style-type: none"> ○ Analyse dc circuits ○ Identify steady-state and transient responses in simple RLC circuits ○ Analyse single phase ac circuits using phasors and complex numbers ○ Analyse dc and ac circuits using network theorems ○ Calculate active power, reactive power and power factor in ac circuits ○ Determine conditions for resonance and Q-factor in simple RLC circuits ○ Analyse balanced three-phase circuits • Apply basic principles to transformers and rotating machines <ul style="list-style-type: none"> ○ Derive equivalent circuit of transformer from circuit theory ○ Analyse single phase transformers under steady load conditions ○ Derive conditions for force and torque production in simple rotating machines • Analyse the performance of diode, transistor and operational-amplifier circuits <ul style="list-style-type: none"> ○ Review diode characteristics and employ diode circuits for rectification, limiting and clamping ○ Review transistor characteristics and ascertain small-signal parameters ○ Determine current and voltage gain, input and output impedances, and matching ○ Analyse simple operational amplifier circuits • Use measuring instruments and analyse instrumentation systems <ul style="list-style-type: none"> ○ Understand the principles of different types of meters for electrical measurements ○ Select and use measuring instruments to dc circuits, single-phase and three-phase ac circuits, diode circuits and transistor circuits • Understand the electricity distribution practice in Sri Lanka <ul style="list-style-type: none"> ○ Understand the structure of a low voltage distribution network ○ Calculate voltage drops in a radial distribution network 						
Syllabus:						
1. Preliminaries					[4 hrs]	
Use of SI Units, Analysis of dc circuits. Electrical Safety – Fuses, MCBs, electric shock, RCCBs, earthing						
2. Circuit analysis					[10 hrs]	
Response to a unit step, natural behaviour of RLC circuits. Network Theorems: Ohm's Law, Kirchoff's Law, Superposition theorem, Thevenin's theorem, Millmann's theorem. Star-Delta transformations. Application to circuits.						

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| 3. Electromagnetic and Electrostatic theory
Basic Electrostatic and Electromagnetic theory.
Force and torque development in magnetic circuits. Application to rotating machines. | [8 hrs] |
| 4. Alternating Current theory
Phasor and complex representation. Impedance, Active and reactive power, Power factor.
Analysis of simple R, L, C circuits using alternating current.
Magnetically coupled circuits. Mutual Inductance. Application to transformers.
Solution of simple network problems by phasor and complex number representation. | [12 hrs] |
| 5. Balanced three phase systems, Power factor correction. | [4 hrs] |
| 6. Resonance, Q-factor, bandwidth. | [2 hrs] |
| 7. Diode, transistor and operational-amplifier circuits.
Basic feedback principles, closed loop systems. | [8 hrs] |
| 8. Electrical Measurements
Direct deflection and null deflection methods. Ammeters, Voltmeters, Wattmeters, Energy meters.
Extension of ranges. | [4 hrs] |
| 9. Electricity Distribution Practice in Sri Lanka | [4 hrs] |

Assessment:

5 laboratory assignments, each of 2hr duration (30%)
End of stage examination of 3hr duration (70%)

Recommended Texts:

(Will be included in the subject outlines given to students)

GE1003 – Thermodynamics and Fluid Mechanics

Subject Code	GE1003	Subject Title	Thermodynamics and Fluid Mechanics			
Credits	4.0	Total Hours	Lectures	55hrs	Pre-Requisites	None
GPA/NGPA	GPA		Lab/Assignt	10hrs		
Aims:						
<p>The Aim of this subject is to provide the knowledge and skill necessary for the design and analysis of simple engineering thermodynamic processes involving energy transfer and to teach basic principles of Fluid Mechanics and application to problems associated with fluid at rest and in motion.</p>						
Learning Outcomes:						
<p>At the end of the subject students should be able to:</p> <ul style="list-style-type: none"> ▪ Apply the basic principles of thermodynamics to explain performance of a thermodynamic system ▪ Analyze and solve engineering problems involving thermodynamic phenomena ▪ Understand the basic principles governing the dynamics of non-viscous fluid ▪ Analyze and solve engineering problems associated with fluid at rest and in motion 						
Syllabus:						
<u>Thermodynamics</u>			[27 Hours]			
1. Fundamental Concepts			[02 Hours]			
<p>Thermodynamics and Energy, Illustration of the use of the knowledge of Thermodynamics with real life applications, Unit and Dimensions, Definition of Thermodynamic Terms such as System, Property, State, Path, Process, Cycle, etc.</p>						
2. Pure substances and Ideal Gases			[04 Hours]			
<p>Pure Substance: Properties of Pure Substances, Physics of Phase Changes, Phase Diagrams, Independent Properties, Development of Property Tables.</p> <p>Ideal Gas: Ideal Gas Behaviour, Ideal Gas Equation.</p>						
3. First Law of Thermodynamics			[06 Hours]			
<p>Forms of Energy, Internal Energy, Comparison of Work and Heat, Conservation of Mass and Energy, Adiabatic Work, Enthalpy, Non-Flow Processes, Irreversible Processes, Flow Processes and Control Volume, Throttle Process, Steady and Unsteady Flow Processes.</p>						
4. Second Law of Thermodynamics			[06 Hours]			
<p>Limitation of First Law and a need for a Second Law for Thermodynamic Analysis, Thermal Energy Reservoir, Reversible and Irreversible Processes, Heat Engine and Thermal Efficiency or Coefficient of Performance of Heat Pump, Different Statements of Second law, Perpetual-Motion Machines, Absolute and Thermodynamic Temperature Scales, Carnot Cycle and Carnot Efficiency.</p>						
5. Gas Power and Refrigeration Cycles			[09 Hours]			
<p>Carnot Cycle for Ideal Gas, Otto Cycle, Diesel Cycle, Dual Cycle, Thermal Efficiency and Power Output, Principle of Vapor Compression Refrigeration, Properties of Refrigerant, Refrigeration Effect, Coefficient of Performance.</p>						

Fluid Mechanics

[28 Hours]

6. Description of Fluids

[02 Hours]

Classification of fluids, Properties of fluids, Units of Measurements, Measuring Instruments

7. Static Fluid Systems

[06 Hours]

Forces on Planar Bodies, Hydrostatic forces on curved bodies, Buoyant forces on Submerged bodies, Initial stability of floating and submerged ships

8. Dynamics of Fluids

[06 Hours]

The Continuity Equation, The Euler Equation, The Navier-Stokes Equation, The Velocity Potential Function, The Stream Function, Circulation and Vorticity, The Source and the Sink, The Doublet Flow, Combined Flows – Uniform flow past a source and a sink, uniform flow past a Doublet.

9. Flow of Real Fluids

[10 Hours]

Bernoulli's Equation, Reynolds' Number – Transition from Laminar to Turbulent Flow in pipes, Frictional Losses in pipes (Darcy Formula), Minor Losses in pipes, Simple Pipeline problems with reservoir, Pump combinations with pipes in series and in parallel, Viscous drag – Skin friction drag and Pressure Drag, Pitot Tube Venturi meter, Orifices and Orifice Meter, Triangular and rectangular Notches, Time of emptying a reservoir with a sharp crested rectangular weir.

10. Fluid Machineries

[04 Hours]

Operating principles of pumps, Impact of a jet, Operating principles of turbines.

Assessment:

Five Practicals of each 2 hr duration (15%)

1. Marcet's Boiler
2. Calibration of Pressure Gauge
3. Determination of "Friction Factor" for Laminar and Turbulent flow through pipes
4. Redwood's Viscometer
5. Stability of a Rectangular Pontoon

Quiz(s) (10%)

Attendance or any other (5%)

Final Written Examination (70%)

References:

(Will be included in the subject outlines given to students)

GE1004 – Engineering Mechanics

Subject Code	GE1004	Subject Title	Engineering Mechanics			
Credits	4.0	Total Hours	Lectures	50 hrs	Pre-Requisites	None
GPA/NGPA	GPA		Lab/Assignt	20 hrs		
Aims:						
Understand the principles of statics (deals with the bodies that are at rest or are moving with constant velocity) and dynamics (deals with the bodies, which may possess any type of motion) with roots in physics and mathematics, and applications of such principles to study analyse solve engineering problems.						
Learning Outcomes:						
At the end of the subject students should be able to:						
<ul style="list-style-type: none"> • Develop the ability to apply the fundamentals of physical sciences and mechanics using mathematics as a tool to quantitatively analyze and solve engineering problems with development of analytical skills. • Conceive principles in statics and dynamics which is a prerequisite for studying further the core engineering subjects, mechanics of machines, strength of materials, structural engineering, stress analysis, mechanical engineering design and analysis, etc. 						
Syllabus:						
Section 1 – Statics						
<ol style="list-style-type: none"> 1. Introduction: Revision of Basic Units of Mechanics; Force and Mass. Revision of Vectors, fundamental concepts and definitions, Scalar and vector quantities, Vector Additions, operations with unit vectors; Use and application of vector Dot product and Cross product for determine several other quantities in engineering. [02 hrs] 2. Operation with forces: Addition of forces to find resultant force, Vector addition and subtraction of forces. Rectangular components (2D and 3D) of a force. [01 hr] 3. Operations with Moments, Couples and Torques: Fundamental definition of moment as a vector Cross Product, moment of a force, moment as the sum of moments, Resultant moment in a two-dimensional force system; The couple and Torque; Replacement of a force by a force and a couple, or by a force with two couples; Moment in three dimensional force system and components of moments. [02 hrs] 4. Force Analysis: Physical interpretation of force, body and surface forces, tensile and compressive forces, types of force systems; Free body diagramme, Newton’s Laws of Motion, Equilibrium, construction of free body diagramme [02 hrs] Analysis of two dimensional force systems: Resultant force and equilibrium requirements with respect to collinear, concurrent, parallel force systems and general two dimensional force system. [01 hr] 5. Force analysis of plane trusses: Forces in truss members, stability, force transmission through a joint, method of support of trusses; Method of joints using force equilibrium; Requirement for a concurrent force system, Pulleys connected to trusses; Method of joints using force equilibrium requirement for a closed force triangle polygon; method of sections, connected 						

trusses.

[02 hrs]

6. **Force analysis of plane frames and machines:** Geometry and loading of frames, comparison of truss and frame solutions, multi-force and two-force members in a frame, general method of solution; pin connection of several members, and load applied at a pin; geometry and loading machines, force analysis of machines using the method for force analysis of frames. [02 hrs]
7. **Analysis of friction forces:** Characteristics of friction forces coefficient of friction, angle of repose, impending motion; criteria for sliding or tipping, friction force analysis for connected bodies; Multiple sliding surfaces (eg. wedge); Belt friction, friction braking, friction forces in plane machines. [02 hrs]
8. **Centroids of plane areas and curves:** Centroids of composite areas, first moment of area, centroids of patterns of hole areas, tabular forms of solution for centroidal coordinates, centroids of simple and composite plane curves; Theorem of Pappus; solutions using the integral definitions of the centroidal coordinates. [02 hrs]
9. **Moments and products of inertial of plane areas and curves:** Moment of inertia of plane areas, polar moment of inertia, radius of gyration,; parallel axis theorem, theorem of area moments of inertia, tabular forms of solution; moment of inertia of hole areas, properties of typical structural member cross sections, moment of inertia of plane curves, product of inertia of plane areas and curves, solutions using integral definitions of moment and product of inertia of areas. [02 hrs]
10. **Analysis of three dimensional force systems:** Direction of force and moment, sense of moment, methods of support of body, equilibrium requirements; concurrent and parallel force systems; general three dimensional force system with cable, hinge, and ball supports; general three dimensional force systems with clamped supports and with friction. [02 hrs]

Section 2 – Dynamics

11. **Kinematics of Particles:** Rectilinear motion, displacement, velocity of acceleration; Motion with constant acceleration, motion with gravitational acceleration; Plane curve linear motion, velocity and normal and tangential components of acceleration, plane projectile motion; absolute and relative displacement, velocity and acceleration. [02 hrs]
12. **Dynamics of particles:** Newton's Second Law, dynamics of particles in rectilinear translation; motion with friction forces; dynamics of connected particles; dynamics of particles in plane curvilinear translation, normal and tangential component motions; The D'Alembert principal. [02 hrs]
13. **Kinematics of plane motion of a rigid body:** Rectilinear and curvilinear translation of a rigid body, rotation of a rigid body, angular displacement, velocity and acceleration; angular rotation with constant acceleration, relationship with rotational and translational motions, rotational and translational motions of connected bodies; general plane motion of a body, instant centre of rotation; pure rolling of rigid bodies. [03 hrs]
14. **Centroids and mass moments and products of inertia of rigid bodies:** Centroid of volume, centre of mass of a rigid body, centre of mass of a composite rigid body; radius of gyration, parallel axis theorem for mass moment of inertia; Computation of mass moment of inertia using the transfer theorem and single integration, mass moment inertia of composite body; Mass moment inertia of homogeneous, thin plane, rigid bodies, relationship between area moments of inertia and mass moment of inertia; center of mass and mass moment of inertia of plane bodies formed of thin rod shapes, mass product of inertia. [02 hrs]
15. **Dynamics of rigid bodies in plane motion:** Dynamic motion of a rigid body about a fixed point; dynamic motion described by translation of the centre of mass and rotation about this point; pure rolling of a cylindrical body; dynamic motion of connected rigid bodies; solutions using D'Alembert principle; forces and moments, criteria for sliding or tipping, centre of percussion. [03hrs]

16. **Work Energy methods for particles and rigid bodies:** Work and force; couple or torque, or moment, energy of a mass particle due to position of motion, potential and kinetic energies; Conservation of Energy, Work-Energy method for a particle; Potential energy and kinetic energy of a rigid body in plane motion, the work-energy method for a rigid body in plane motion; The work-energy method for connected bodies, the work-energy method to find normal acceleration of a particle; power as the work done or energy expended per unit time. [03 hrs]
17. **Impulse momentum for particles and rigid bodies:** Impulse of a force and linear momentum of a particle; Impact, Conservation of Linear Momentum, coefficient of restitution; Direct and oblique central impact, impulsive forces; Angular momentum and impulse momentum of a rigid body in plane motion, impact of rigid bodies in plane motion, impact at the centre of percussion. [03 hrs]
18. **Rectilinear motion of a body with resisting or drag forces:** Constant drag force, drag force directly proportional to velocity, Linear Resistance Law; Drag force proportional to velocity squared, quadratic resistance law with applied constant force with same, and with opposite sense as velocity. [02 hrs]
19. **Rigid bodies in three dimensional motion, and introduction to Dynamic unbalance and Gyroscopic moments:** Dynamic forces caused by rotating off-centre masses, solutions by direct use of inertia forces and by integration of the inertia forces acting on the mass elements; dynamic forces caused by rotating unbalance, general solutions for unbalanced bodies of arbitrary shape, Independence of dynamic forces and angular acceleration of the body; Derivative of a vector with constant magnitude and changing direction, moment effects due to change of an axis of rotation; Gyroscopic moment. [04 hrs]

Notes:

1. *Wherever relevant vector representation of quantities should be taught and meaningfully demonstrated, and vector mathematics and operations be used.*
2. *Wherever relevant consider both 2D and 3D situations.*
3. *After each and every section: Work problems relevant to engineering application, which should demonstrate the application of theory learned at the lecture.*

A tutorial with 10 questions should be given after every lecture to be attempted by students on their own. This would be the THA.

Assessment:

Class Room Assignments (3 Assignments two hours each, the best two to be considered)) (15%)
 Take Home Assignments (5 best Assignments and practicals to be considered) (15%)
 Final Examination (70%)

References:

(Will be included in the subject outlines given to students)