## IESL ENGINEERING COURSE - SYLLABI

### PART I

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<td>Mathematics</td>
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<td>102</td>
<td>Presentation of Engineering Information</td>
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<td>103</td>
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<td>Thermodynamics</td>
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<td>106</td>
<td>Applied Mechanics</td>
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</table>

(Examinations for the (old) Part I syllabi will be conducted up to March, 2000)

### CURRICULA FOR THE IESL PART I

<table>
<thead>
<tr>
<th>Subjects</th>
<th>No. of Hrs</th>
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<td></td>
<td>Lectures</td>
</tr>
<tr>
<td>101 Mathematics</td>
<td>80</td>
</tr>
<tr>
<td>102 Presentation of Engineering Information</td>
<td></td>
</tr>
<tr>
<td>I Information</td>
<td>50</td>
</tr>
<tr>
<td>II Engineering Drawing</td>
<td>24</td>
</tr>
<tr>
<td>(additional work for specified category)</td>
<td>24</td>
</tr>
<tr>
<td>103 Properties and Strength of Materials</td>
<td>80</td>
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<td>106 Applied Mechanics</td>
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- Practicals for those who have had no practicals in the qualifying courses.

(Candidates for the Part I are expected to offer all six subjects listed above.)
101. Mathematics

Lectures = 80 hours

**Algebra**

Matrices: types of Matrices, algebra of matrices, inversion
Determinants: properties of determinants
Adjoint method for inversion of matrices; solution of simultaneous equations; Gauss elimination method;
Echelon form; linear dependence and consistency.
06 hrs

Vector algebra in 3-D and applications
07 hrs

Complex numbers; Argand diagram; algebra of complex numbers; De Moivre’s theorem; roots of
complex numbers Roots of algebraic equations; the remainder theorem.
08 hrs

**Analysis**

Functions: Limits, continuity; trigonometric, exponential, hyperbolic and logarithmic functions; inverse
functions; implicit functions.

Differentiation; Stationary points and curve sketching Mean value theorem; L’Hospital’s rule for limits
Leibnitz’s theorem; partial differentiation and applications Infinite series and tests for convergence.
Taylor series in one and two variables.
17 hrs

Methods of integration; reduction formulae. Applications of integrals to areas, volumes, moments etc.
08 hrs

Ordinary differential equations; formulation Methods of solution of first order differential equations,
second order differential equations with constant coefficients Use of D-operators.
08 hrs

**Numerical Methods**

Solution of equations in one variable; successive substitution method rule of false position; Newton-
Raphson method; solution of simultaneous linear equations; Jacobi method; Gauss-Seidel method
04 hrs

Finite differences and interpolation
Numerical differentiation
06 hrs

Numerical integration; trapezoidal rule; Simpson’s rule
04 hrs

Numerical methods of, solution of ordinary differential equations
Euler’s method; Euler’s modified method; difference equations
06 hrs

**RECOMMENDED BOOKS**

Advanced Mathematics for Engineers and Scientists by G S Sharma, K L Ahuja and I J S Sarma, CBS
Publishers New Delhi.

Schaum’s Outline Series books on:
- Matrices
- Linear Algebra
- Vector Analysis
102 PRESENTATION OF ENGINEERING INFORMATION

Lectures and Practical Classes – 90 hours additional Lecturers and Practical Classes 10 hrs.
**Engineering Drawing Practice**

(Lectures a, b, c, and practical class “a” are intended for those candidates, who do not possess a basic knowledge in Engineering Drawing. Each set of lectures should be followed by a take home assignment (THA) which need to be marked & given to the students. Model answer for the take home assignments should be distributed in the following session. The course will consist of lectures 12 + 3 (each of 2 hrs duration) Practical Classes 4 + 1 (each of 4 hrs duration) Take home assignments 9 + 3. (THA) (Each practical class is of 04 hours duration)

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Topic</th>
<th>Duration</th>
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<tbody>
<tr>
<td>a</td>
<td>Instruments &amp; Materials of drawing, Drawing standards, lines &amp; lettering sizes of drawings, Title blocks etc.</td>
<td>02 hrs</td>
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<tr>
<td>b</td>
<td>Simple geometrical constructions (Bisectors, perpendiculars, divided lines, areas, circles, angles and other useful constructions) (THA)</td>
<td>02 hrs</td>
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<tr>
<td>c</td>
<td>Tangency construction, the properties with the associated constructions of the common plane geometrical figures including conic sections &amp; other loci – (THA)</td>
<td>02 hrs</td>
</tr>
<tr>
<td>a</td>
<td>Class exercise base don lectures a, b and c. This all be exercise should be marked by the lecturer and the common errors can be discussed at the class to follow.</td>
<td>04 hrs</td>
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</table>

**LECTURE 01**

Revision Lecture for both categories of students. The principles of Engineering drawing including basic geometrical constructions (Drawing Standards, Instruments and materials of drawing lines & lettering, Graphic Geometry. The properties with the associated constructions of the common plane geometrical figures including conic sections and other loci) (THA) | 02 hrs  

**LECTURE 02 + 03**

Recording and sketching two dimensional drawings. Orthographic drawing and sketching (First angle and third angle projections) (THA) | 04 hrs  

**PRACTICAL CLASS 01**

Assignment based on lectures 1, 2 & 3 to be done in the classroom. | 04 hrs  

**LECTURE 04**

Sectional views and conventions (Types of Sections, Assembly Sections, Conventional Practices, Auxiliary Views and Sections) (THA) | 02 hrs  

**LECTURE 05 & 06**

The preparation of working drawing and freehand sketching in Orthographic and Pictorial Projection of Common Engineering Components and Simple Assemblies, Assembly Drawings Exploded, Exploded Orthographic, scattered orthographic views. (THA) | 04 hrs  

**PRACTICAL CLASS 02**

Assignment based on lectures 4, 5 & 6 to be done in the class room. | 04 hrs  

**LECTURE 07**
The projection line on inclined and oblique planes, Projecting plane figures, Method of revolution, coincidence and replacement of planes of projections. (THA)

**LECTURE 08 & 09**

Intersection of planes and interpenetrations of solids. The development of surfaces (THA)

**PRACTICAL CLASS 03**

Assignment based on lectures 07, 08 & 09 to be done in the class room.

**LECTURE 10**

Limits, bits and dimensional tolerances, geometrical tolerances, surface finish. (THA)

**LECTURE 11**

Screwwthreads, fasteners, keys, springs & gears. (THA)

**LECTURE 12**

The drawing system, preparation of working drawing. (THA)

**PRACTICAL CLASS 04**

Assignment based on lectures 10, 11 & 12 to be done in the class room.

**PRESENTATION OF ENGINEERING INFORMATION**

*Experimental Data*

Presentation of experimental data in graphs, monograms, etc.; curve fitting by least square method.


Flow sheets: logic diagrams and networks for process representation: critical path analysis.

*Computation*

Writing programmes in a high level language (Fortran, Basic or Pascal): simple flow charts and algorithms: the subroutine concept: data structures and data types: control flow: basic input and output: use of computer graphics. 07 hrs

Spread sheet programmes: entering data: data types: analysing data: presenting data in the form of graphs: Introduction to Computer Aided Design. 06 hrs

Analog computing: block diagrams for solution of differential equations, analog computer components.

RECOMMENDED BOOKS

ENGINEERING DRAWING PRACTICE

1. Sri Lanka standard 409
2. Engineering drawing and design
   McGraw – Hill - 1990
3. Engineering Drawing
   S. Bogolyuboy, A. Voinov
   Mir Publishers – Moscow – 1986

PRESENTATION OF ENGINEERING INFORMATION

1. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole and Raymond H. Myres, The Mcmillan Co. Ltd.,
4. Basic BASIC by James S. Coan.

103. PROPERTIES AND STRENGTH OF MATERIALS

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Stresses & Strains

Stresses (normal & shear) on an inclined plane in a 2D stress system – Formulae for normal and shear stress on inclined plane – Mohr’s circle of stress – Invariants of a Mohr’s circle – Maximum and Minimum principle stresses – pole of the Mohr’s circle – Applications of Mohr’s circle and normal/shear stress formulae in analysing stress systems.
Stress/Strain relationships of a 2D system – Young’s modulus, shear modulus and Poisson’s ratio – Normal strain and shear strain – Formulae for normal and shear strain on an inclined plane – Mohr’s circle of strain – Stresses from strain gauge data.

Springs.

Close coiled and open coiled helical springs, Flat spiral springs, Leaf springs, Conical springs.

Bending Moments & shear Forces in statically determinate beams

Definition of bending moments and shear forces as internal forces in flexural members – determination of bending moment and shear force at any given section of a beam – Relationship between load, bending moment and shear force – Bending moment and shear force diagrams – Principle of superposition.

Bending Stresses & Shear Stresses in Beams

Sectional properties of beam sections including built-up sections – Definition of neutral surface and neutral axis – classification of bending stress as a direct (normal) stress at a sections – Tensile & compressive stresses – Simple bending formula – Application of simple bending formula – Section modulus – Distribution of bending stress at a section.


Deflection of beams

Beam flexure equation for small deflections-Statistically indeterminate beams-Maculay Method in applying beam flexure equation-Moment area method.

Torsion of Circular Sections

Shear stress due to torsion – Polar moment of inertia of a hollow/solid circular section – Torsion formula – Tapering and composite shafts – Strain energy due to torsion stored in a shaft – Transmission of power through shaft/pulley systems.

Elastic Buckling of struts

Concept of Elastic stability, Euler Buckling loads for struts with different end conditions, eccentrically loaded struts, struts with initial curvature, stuts with lateral loads, struts with eccentric axial loads.

Atomic Structure and Molecular Structure


Electronic Structure of Elements: Bohr theory, quantum numbers, energy levels, excitation, ionisation, periodic table.

Interatomic Bonding: Ionic, covalent, metallic, van der waals, and hydrogen bonds. Directionality and polarity of bonds, Relationship between type of bond and basic physical and mechanical properties of materials.

Crystal Structure

Crystallography Crystal systems, unit cell, density, packing factor, Miller indices.
Crystal Structure Analysis: Production of X-rays, X-ray diffraction, Bragg's Law.

Crystal Defects: Point, line, interfacial, and bulk defects. 10 hrs

**Equilibrium Phase diagrams**

Alloy Systems Solid solutions, intermetallic compounds.

Phase Equilibria Single component systems, multi-component systems, phase rule, interpretation of phase diagrams, equilibrium and non-equilibrium microstructures. 06 hrs

**Introduction to Properties of Materials**


Mechanical Testing Methods Tensile, impact, compression, and hardness tests.

Physical Properties of Materials Ductile to brittle transition temperature fatigue and creep.


Radioactivity Nuclear materials, Kinetics of radioactivity, detection and measurement of radioactivity, fission and fusion.

Physical properties of Materials Thermal properties; Thermal Conductivity, thermal expansion, melting point, Electrical and Electronic Characteristics: Ionisation, thermionic emission ...... 12 hrs

**Laboratory Experiments**

1. Tensile Testing of Metals
2. Impact Testing of Steel (at different temperatures)
3. Hardness Testing
4. Microstructure Examination

**Recommended Books**

2. Strength of Materials, G.A. Ryder (Publisher – William Clowes & Sons Ltd.)
4. The Elements of Materials Science, L.H. Van Vlack, Addison – Wesley
104. ELECTROTECHNIQUES

<table>
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<th>Lectures</th>
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**SI System of Units**

- Electric charge: description of the Electric field of charges at rest;
- Colombo’s law, Gauss’s law.
- Permittivity, Field Energy, dielectrics, insulation.
- Determination of capacitance.

- 02 Hours

- Effects of Electric and Magnetic Fields on charged particles
- Election beam deflection.

- 06 hrs

- Elements of plane radiation field in free space

- 03 hrs

- Conduction current as the movement of charge Electric and Magnetic fields of charges in motion.
- Ampere’s law, left hand rule, Biot-Savart law.

- 04 hrs
Conductivity, conduction loss, continuity resistance, ohm’s law, Kirchoff’s laws Ideal energy dissipating and energy storage parameters. Energy sources and loads; constant current and constant voltage sources.  
Induced emfs – Faraday’s and Lenz’s laws Electromagnetic systems.  
Magnetic field of simple linear current configurations. Permeability, field energy, inductance. Simple magnetic circuits,  
Transient responses of ideal network elements to step, ramp and sine stimuli. Mechanical and thermal analogues.  
Cyclic repetitions; qualitative analysis of periodic waveforms as harmonic sums.  
Network theorems – superposition, equivalent voltage, current sources, etc. Networks with mutual inductance: coefficient of coupling. Transfer functions of simple RC and LC two-ports.  
Resonant circuits, Q-value, bandwidth, selectivity  
Logic Systems – combinational systems using or, AND, NOR and NAND gates. Truth tables and Karnaugh maps in the design of simple systems.  
Electricity Distribution practices in Sri Lanka. Basics of electricity distribution, including system earthing. Basic wiring circuits in households and in industry.  
Basic feedback principles, effects of closed loop systems.  
Basic principles of balanced three-phase systems. Power factor improvement; load addition.  
Operation principles of simple instruments used for measuring voltage, current and power.  
The ideal transformer Deviations from the ideal; Analysis of simple single phase transformers under steady loads.  
The ideal rotating machine Conditions for force and torque production.  
The laboratory classes in ELECTROTECHNIQUES should consist of five experiments taken from the following:-
1. Insulation and Continuity Testing, and Measurement of earth resistance, earth loop impedance.  
2. Study of simple ac circuits (including series and parallel circuits comprising R,L and C elements)  
3. A study of non-linear devices (to include non-linear resistances such as tungsten filament lamps, diodes etc)  
4. Measurement of power and energy (use of the wattmeter and/or energy meter)  
5. Current ratings of fuses and MCBs.
6. Use of bridges for measurement
   (experiment to consist of the use of one bridge circuit, such as Kelvin’ Double bridge, Hay’s
   bridge, etc.)

7. Calibration of a meter
   (Calibration of a moving coil meter, moving iron meter or an energy meter)

**RECOMMENDED BOOKS**

Advanced Electrical Engineering by H Cotton
(Wheeler Publishers, India)
(alternatively – ELBS Edition)

or

Electrical Technology by H Cotton 7th Edition (MKS Units)

Or

Advanced Electrical Engineering by Morton

Suggested supplementary texts –

1. Electromagnetism for Engineers by Hammond
2. Electrical Technology by Edward Hughes
   7th Edition ELBS Longmans
3. Basic Electrical Engineering Science by McKenzie Smith and Hosie, ELBS
4. Networks and Systems by D R Choudhury
   Wiley Eastern.

**105. THERMODYNAMICS**

Lectures  =  80 hours

*Fundamental concepts*

Units and dimensions. Definition of thermodynamic terms such as properties, process, path cycle
process, state etc. Boundaries of a system and the interaction between the system and its surroundings.

04 hours

*First Law of thermodynamics*

Definition of work; calculation of work involved in reversible processes. Heat and work as interactions.
Application of First Law of thermodynamic systems. Internal Energy and Enthalpy. Energy equation
applied to non – flow processes. Kinetic Energy and Potential Energy. Energy equation applied to flow
process. Introduction to simple flow and non – flow process.

12 hrs

*Second Law of thermodynamics*

Second Law and its corollaries. Reversible and irreversible processes. The efficiency of reversible heat
engines. Thermodynamic scale of temperature. Entropy as a property and its relation with other
properties. The Clausius Inequality. Isentropic efficiency.

10 hrs
Properties of ideal gases and vapours

Three phases of matter; solid, liquid and vapour. Equilibrium between phases, phase changes, triple and critical points. Tabular and graphical properties of real gases. 10 hrs

Flow and non – flow processes

Flow and non – flow processes undergone by ideal gases and vapours. Equation of state, specific gas constant. Universal gas constant. Relations of specific heats. Relations between entropy changes and changes in other thermodynamic properties. 10 hrs

Vapour power cycles


Gas power cycles

Carnot cycle for ideal gas. Otto cycle and Diesel cycle. Thermal efficiency and power output. Correlation with actual four stroke cycle. Cycle efficiency and mean effective pressure as criteria of performance. Practical working of reciprocating internal combustion engines. 12 hrs

Refrigeration


LABORATORY EXPERIMENTS

i. Compulsory practicals

1. Redwood viscometer
2. Flash point
3. Thomson’s calorimeter
4. Boy’s Calorimeter

ii. Optional practicals

1. Calibration of indicator spring
2. Calibration of pressure gauge
3. Valve timing
4. Marcet’s boiler

It is recommended to perform at least five (05) practicals. IESL may select practicals from the optional list.

RECOMMENDED TEXTS

1. Engineering Thermodynamics – Work and Heat transfer
   - by G F C Rogers & Y R Mayhew

2. Applied Thermodynamics – for Engineering Technologists
   - by T D Eastop & A McConkey
3. Thermal Environmental Engineering
   - by James L Threlkeld

4. Basic Engineering Thermodynamics in SI units
   - by Rayner Joel

106 APPLIED MECHANICS

Lectures = 80 hours

**FLUID MECHANICS**

*General Properties of Fluids*

Differences between liquids and gasses, ideal and real fluids; Density – Specific Weight – Specific Volume – Pressure Exerted by a fluid – Bulk Modulus – Viscosity – Surface Tension – Units of Measurement.  
02 hrs.

*Fluids at Rest*

Thrusts on vertical and inclined plane immersed surfaces and on curved immersed surfaces – Thrusts on immersed bodies – Centre of Pressure – Lock Gates – Thrusts on Dams.  
04 hrs.

*Fluids in Equilibrium*

Measurement of Pressure – Different types of Manometers and Pressure Gauges – Buoyancy – Centre of Buoyancy – Stability of Submerged and Floating Bodies – Meta Centre Experimental and Analytical determination of Metacentric Height – Floating Bodies containing water – Anchored Floating Bodies – Oscillation of Floating Bodies – Pitching and Rolling – Equilibrium of Moving Fluids.  
06 hrs

*Dynamics of Fluids*

Flow to a Line Sink – Combination of Basic Flow Patterns: Uniform Rectilinear Flow and Line Source; Source and Sink of numerically equal strength, Source and Sink of numerically equal strength combined with Uniform Rectilinear Flow.

12 hrs

Principles of Fluid Motion


16 hrs

MECHANICS

Kinematics

8 hrs

Dynamics

The impulse – momentum relation for a particle and a system of particles. The moment of momentum of a system. Torque and work done by a torque.

06 hrs

Turning Moment Diagram and Flywheel

06 hrs

Balancing of Rotors
Static and dynamic balancing of rigid rotors. Resolution method and force and couple polygon method.

06 hrs

Friction
Laws of friction between unlubricated surfaces. Friction formulae for square and V-threads. Plate clutches, cone clutches and centrifugal clutches under uniform pressure and uniform wear conditions.

06 hrs

Vibrations
Free vibration of one degree of freedom systems without damping and systems with viscous damping. Analytical solutions and phase-plane diagrams.
Forced vibration of viscous damped one degree of freedom systems.

LABORATORY EXPERIMENTS

List of suggested experiments

Section I
1. Experimental determination of the Hydrostatic Thrust on Immersed surfaces using the Centre of Pressure apparatus. 03 hrs
2. Measurement of Frictional Loss in a pipe for Reynold’s Numbers in the Laminar and Turbulent ranges 03 hrs
3. Measurement of Discharge in a pipe using Veturimeter and Orifice meter 03 hrs
4. Measurement of Discharge using Notches and Weirs 03 hrs
5. Determination of Cv, Cc, and Cd for orifices 03 hrs

Section II
1. Static and Dynamic Balancing 03 hrs
2. Hook’s Joint 03 hrs
3. Equivalent Moment of Inertia 03 hrs
4. Velocity Diagrams 03 hrs

RECOMMENDED BOOKS

4. Engineering Fluid Mechanics, J.A. Fox, Macmillan
5. Solution of Problems in Fluid Mechanics parts I & II, J.F. Douglas, Pitman
6. Hydraulics and Fluid Mechanics, Lewitt E.H., ELBS/Pitman
7. Applied Mechanics
   J Hannah & M J Miller (Longmans)
8. Mechanics of Machines – Advanced Theory and Examples
   J Hannah & R C Stephes (Edward Arnold Publishers Ltd.)
   R S Khurmi
10. A Text Book of Applied Mechanics
     R S Khurmi (S Chand & Co. Ltd., India)
11. Theory of Machines
    R S Khurmi & Gupta

12. Theory of Machines
    P L Ballaney (Khanna Publishers, India)

13. Mechanical Technology
    D H Bacon & R C Stephens (Butterworth – Heinemann Ltd., U.K.)