



General Qualifying Examination Syllabus for AMIESL

Contents

Paper A: Syllabus of IESL General Qualifying Examination for AMIESL	3
Paper B: Syllabus of IESL General Qualifying Examination for AMIESL	10
Paper C: Syllabus of IESL General Qualifying Examination for AMIESL	15
Paper D: Syllabus of IESL General Qualifying Examination for AMIESL	20
Paper E: Syllabus of IESL General Qualifying Examination for AMIESL.....	25
Paper F: Syllabus of IESL General Qualifying Examination for AMIESL.....	31
Management, Law & Ethics Syllabus	37
Assessment Strategy.....	38
Assessment Mode 1	38
Assessment Mode 2	38

Paper A: Syllabus of IESL General Qualifying Examination for AMIESL

1. Circuit Analysis (10)

- Network Theorems, Superposition, Thevenin's, Norton's, Millman's, Reciprocity, maximum power transfer theorems
- DC circuit analysis, Transient solution of simple RLC circuits
- AC Theory, AC circuit calculations, analysis of coupled circuits, resonant circuits
- Three-phase AC circuits, three phase balanced and unbalanced circuits, symmetrical components
- Two-port network calculations using ABCD, Z, Y and H parameters
- Network functions of LC, RC and RLC networks, Pole-zero patterns, energy functions.
- Synthesis of LC, RC, & RLC networks using Cauer, Foster and other methods
- Design of classical and active filters of low pass, high pass and band pass types
- State-space representation of circuits
- Non-sinusoidal waveforms and parameters, Fourier analysis
- Laplace-transform methods in circuits

2. Fields and measurements (12)

- Electrostatic fields due to charge distributions, Coulomb's law, Gauss's theorem, method of images
- Capacitance calculations, Energy and force calculations
- Magnetic field calculations using, Biot-Savart and Ampere laws
- Magnetic circuits, Amperes-circuital law, flux leakage
- Electromagnetic induction, Faraday's law, Energy in magnetic fields, Calculation of mechanical forces/torques
- Motion of charged particles in the presence of electrostatic and electromagnetic fields
- Maxwell's equations in differential and integral forms, Maxwell's equations in sinusoidal variations
- Wave equation, plane waves in media with and without losses, wave impedance, power flow, Poynting's theorem
- Electromagnetic waves at boundaries, Electromagnetic waves in conductors.
- Electrical Measurement: Moving coil, moving iron and rectifier type meters, bridge methods, power and energy meters, current and potential transformers
- Sampled data systems: Nyquist's sampling theorem, encoding, modulation, quantising, resolution, dynamic range, quantisation noise; Fourier analysis of sampled data, aliasing, anti-aliasing filters.
- Digital instrumentation: Analogue-to-digital conversion (ADC), digital-to-analogue conversion (DAC), real-time data acquisition, hardware and software for data acquisition, digital multimeters, data loggers
- Analogue oscilloscope: electron deflection, time base generation, focusing, modes of operation
- Digital oscilloscope: sample rate and bandwidth, data storage, display, on-screen measurements.
- Statistical basis of measurements, Statistical signal analysis, correlation, convolution, Kalman filtering.

3. Electrical Machines and drives (12)

- Properties of iron, permanent magnets, conductors, superconductors, insulation materials, atomic magnetism, magnetization curve, magnetic hysteresis, magnetic losses, ferro-fluids
- Stationary and rotating magnetic fields, relationship between machine dimensions and power, specific electric and magnetic loading
- DC motors: separate, shunt, series and compound excited motors, steady state equivalent circuit, torque/speed characteristic, starting, braking, speed control, dynamic modeling, motor drives with one, two and four quadrant converters of transistor and thyristor types, transient over current limiting, implementation of dynamic and regenerative braking, motor-converter coordination, applications
- Single-phase transformers: construction, equivalent circuit, testing, characteristic, parallel operation, autotransformers, pulse transformers, high frequency equivalent circuit
- Three-phase transformers: Construction of different types, vector group, vector diagrams, per-unit equivalent circuit, characteristic, losses and efficiency, magnetization phenomena, unbalanced loading, parallel operation, tap changing, inrush current
- Synchronous generators: cylindrical rotor and salient pole rotor types, constructional features, windings, cooling, excitation, equivalent circuit, phasor diagram, power-angle characteristic, safe operation, turbine-governor characteristic, real power control, reactive power control, AVR, parallel operation, synchronizing, earthing, current transient due to sudden short circuit faults, subtransient, transient, and steady state reactance and time constants, parameter estimation using short circuit current waveform, sudden open circuit performance, slip test
- Synchronous motor drives: large synchronous motor drives using load commutated inverters, self-controlled synchronous motor drives, Permanent magnet synchronous motor drives (AC servomotors)
- Brushless DC motor drives: trapezoidal and sinusoidal types of motors, construction, principle of operation, drive system, performance calculation, open and closed loop control, multi-quadrant operation
- Three-phase induction motors: squirrel cage rotor and wound rotor types, equivalent circuits, torque-speed characteristics, losses and efficiency, NEMA classes, testing, starting, braking, methods of speed control, operation as a generator, scalar control drives using variable voltage variable frequency inverters, initial voltage boosting, slip regulation and direct current limiting type drives, open loop drives, constant torque and constant horsepower regions, high speed region of control, current controlled drives
- Single-phase motors: single phase induction motors of different types, equivalent circuit calculations, torque-speed characteristic, speed control, applications, AC commutator motor (universal motor)
- Stepper motor drives: types of stepper motors and their constructions, stepping sequence, torque characteristic, dynamic performance, operational constraints, drive systems, unipolar and bipolar excitation, switch reluctance motor
- Operational aspects: rating plate data, safe operation, temperature rise calculations, sizing of motors for given load cycles, general and special purpose motors, cooling of motors, protection of motors

4. Power Systems (12)

- Development, structure and management of the electric power system in Sri Lanka
- Power generation technologies: coal steam, oil steam, diesel, gas turbine, combined cycle, combined heat and power, nuclear steam, hydroelectric, run-of-river, micro/mini, pumped storage, renewable energy systems, environmental and ecological considerations, safety issues, nuclear fuel cycle, types of reactors
- Power transmission systems: overhead conductors and underground cables, types of towers, conductor spacing and configuration, choice of route, line profile, Sag and span calculations, sag templates, stringing charts. insulating materials, insulator string voltage distribution, transmission line parameter calculations, transposition, transmission line models, long line performance calculations, Ferranti effects, shunt and series compensation, line power limits
- Power distribution: feeders and distributors, ring and radial systems, principles of electricity tariff, tariffs in Sri Lanka, end use equipment, introduction to demand management and conservation of electricity
- Load flow analysis: mathematical techniques of load flow analysis, active and reactive power flow calculations, tightly/loosely coupled networks, contingency analysis
- Fault analysis: causes and effects of faults, per unit system and symmetrical components, symmetrical

three-phase faults, asymmetrical faults, short circuit and open circuit conditions, simultaneous faults

- Power system stability: steady state stability, power angle characteristics, swing equation, effect of AVR and governor on stability, transient stability, equal area criterion, stability under fault conditions, step by step solution of swing equation, voltage stability
- Power system protection: necessity and historical development, general requirements of protective relaying, unit and non-unit protection, primary and backup protection, current and voltage transformer, accuracy limits and classes of CTs and VTs., electro-mechanical, static and numeric relays, basic structure of protection systems, rated current, voltage and setting of relays, over current protection, discrimination by time and current, inverse characteristics, discriminative grading, earth fault detection, sensitive earth fault protection, directional over current, earth fault relays and their applications
- Distance protection: general principles, relationship between primary and secondary impedance, zones, distance relay performance, distance relay inputs, switched and non-switched distance relays, numeric distance relays, distance relay schemes with co-ordination of communication facilities
- Transformer and Generator protection: transformer faults, principles of transformer protection, generator faults, principles of generator protection
- Busbar and feeder differential protection: application of Merz-Price principle, current balance and voltage balance schemes, summation current transformers, differential relay performance, numeric feeder differential relays, basic requirements and types of busbar protection schemes, introduction to slow and high speed auto reclosing, failure analysis
- Power system control: load control & frequency stability, automatic load frequency control, AVR and voltage control, reactive power control, dynamic model of a governor, different governors in power plants, primary load frequency control, concept of control area, voltage profile & power transfer, voltage control of generators and droop settings, step up transformers and voltage injection
- Power system modelling: dynamic model of power system, ALFC control, control techniques (PI, PID, Modern control), synchronous and asynchronous interconnections
- System stability and load shedding: effect on system stability by adding generators and loads, load shedding criterion and design of load shedding scheme.
- HVDC Transmission: high voltage direct current transmission over long distances.
- Power system planning and reliability: introduction to long term planning, reliability, probabilistic production costing
- Power system economics: economic operation of power systems: load dispatch with power system constraints, merit order dispatch, use of Lagrange multipliers and penalty factors
- Power sector restructuring, regulation and competition: restructuring of the electricity industry, alternative structures, types of regulation, relationship between competition and regulation, International and local experience

5. Control systems (12)

- Modelling of systems: transfer functions and block diagrams, block diagram simplification, state variable models
- Time response techniques: transient response, disturbances, steady state errors, cost of feedback, test input signals, performance of a second order systems, rise-time, peak-overshoot, settling time, stability, sketching of root loci, controller design via root loci
- Frequency response techniques: Bode Plots, Nyquist plots, Nichols plots, stability criteria in frequency domain, controller designs, bandwidth, gain-margin, phase-margin, incorporation of time delays
- State-Space Methods: solution of the state equation, state-transition matrix, characteristic equation and the eigenvalues, stability, canonical forms, controllability and observability, observer design, state feedback control, state feedback with integral control, pole-placement designs
- Digital control: analog versus digital control, mathematical methods of discrete systems, the z-transform, discrete time transfer function, stability, modified Routh's criterion, design of digital control systems, time response calculations
- Nonlinear control: nonlinear systems, linearized systems, Lyapunov-based methods, stability using Lyapunov method, phase-plane method, feedback linearizing control

- Intelligent and adaptive control: Neural networks of RBF (radial basis function) and MLP (multi-layer perceptron) types, identification-based indirect control, designs, fuzzy Logic Control (FLC), three-step process of generating FLCs, Fuzzy PID control, designs, conventional adaptive control, adaptive PID control, neuro-adaptive control
- Automation components: Coils, Contactors, Timers, Counters, Servo Valves, Pneumatic Control Systems, encoders, Sensors and Actuators, integration of Sensors, actuators and Controllers
- Process Control: PID control, controller tuning, special control structures, feed forward and ratio control, predictive control, control of systems with inverse response, cascade control
- Sequence and digital Control: PLCs and relay ladder logic, scan cycle, RLL Syntax, structured design approach, hardware environment, DSPs

6. Electrical Installations (12)

- Wiring Regulations: structure of the 17th Edition of the IEE Wiring Regulations (BS 7671: 2008), its importance and applicability to Sri Lanka
- Types of electrical earthing systems: TT, TN, IT systems and their features, commonly used grounding arrangements
- Electrical safety and protective measures: protection against electric shock, protective equipment and conductors. Protection systems adopted in wiring systems, electrical safety measures
- Design criteria of electrical installations: assessment of general characteristics of an electrical installation, demand calculation and diversity, Sizing and selection of cables, accessories, current rating of cables, voltage drop, temperature dependence, steps in the design of a small electrical installation
- Wiring design using CAD: use of a software package for electrical wiring design
- Technical documents: preparation and use of tender documents, technical specifications and drawings, bill of quantities, contract documents
- Inspection, testing and certification: earth resistivity measurements, ground resistance calculations, continuity and insulation testing, polarity checking, basic testing and commissioning of electrical installations, preparation of test reports
- Engineering Acoustics: Sound power, measurement, sound level estimation, sound pollution, noise control
- Artificial lighting and lighting design: physics of illumination, vision and perception of colour, lamps and luminaires, lighting design by manual methods, lighting design software, lighting control and automation
- Lighting protection for structures: lightning parameters, effects of lightning and protection principles, lightning protection of equipment
- Air conditioning, ventilation, fire detection and alarm systems: HVAC and fire safety, air conditioning, load calculations and design, ventilation systems, fire detection systems, alarm systems
- Switchgear: types of switchgear, fault clearing and interruption of currents, making and breaking capacities, arc formation, methods of quenching, re-striking and recovery voltage transients, principle of operation, indoor and outdoor types, miniature circuit breakers, oil, air, vacuum, Sulphur hexafluoride and air blast circuit breakers, use of GIS package
- System grounding: ungrounded, effectively grounded, resistance grounded and resonant grounded systems, neutral earthing, step and touch potentials, grounding of delta connected systems, design of grounding systems
- Building management systems: introduction to building management systems (BMS), hardware and software for BMS, communication networks in BMS designs

7. High Voltage Engineering (05)

- Dielectric Materials: polarization of a medium, free charges and bound charges in a capacitor, thermal classification of dielectrics, properties and selection of dielectric materials

- Breakdown of gaseous insulation: ionisation and breakdown processes in gases, time lags of spark breakdown, mechanism of corona formation and power Loss
- Breakdown of liquid and solid insulation: breakdown of commercial liquids, breakdown due to gaseous inclusions, liquid globules, solid particles, purification of a liquid for testing, breakdown of solid insulating materials, breakdown of composite insulation
- Lightning phenomena: mechanism of lighting, frequency of occurrence of lightning flashes, lightning problem for transmission lines, shielding by overhead ground wires, effects of lightning on a transmission line
- High Voltage Cables: power loss in cables, insulation resistance, capacitance, copper space factor, dielectric stress in a single core cable, cable grading for uniform stress distribution, pressurised high voltage cables, thermal design of cables, high voltage bushings
- High Voltage transients: surges on transmission lines, surge impedance and velocity of propagation, reflection and transmission of travelling waves, Bewley lattice diagram, representation of lumped parameters, digital computer implementation, transform methods of solving transients
- Measurement of High Voltage: electrostatic voltmeters, sphere gaps, transformer and potential divider methods of measurement, matching of potential dividers, measurement of surges, general measurements, oscilloscope for measurement of fast transients, measurements of capacitance permittivity and dissipation factor, detection of internal discharges
- High Voltage generators for testing: generation of high AC voltages, cascade arrangement of transformers, resonant transformers, generation of high DC voltages, rectifier circuits, voltage multiplier circuits, electrostatic generators
- High Voltage impulse generators: single exponential waveform, double exponential waveform, calculation of coefficients from resistance and capacitance values, definition of wave-front and wave-tail, practical waveforms, operation of the Marx impulse generator, generation of chopped impulse waveforms
- High Voltage testing: general tests carried out on high voltage equipment, testing of solid dielectric materials, type tests, sample tests, routine tests, tests on typical high voltage equipment

8. Power Electronics and Applications (12)

- Power semiconductor switching devices: Power Diodes Thyristors, BJTs, MOSFETs, IGBTs and other hybrid devices, switching characteristics, ratings, drive circuits
- AC to DC converters: single and three phase converters using diodes and /or thyristors, effects of smoothing capacitor, operation with inductive loads, control of output voltage, line-voltage notching at the PCC due to thyristor converters, inverter operation, margin-angle, bidirectional AC to DC converters
- DC to AC inverters: single and three-phase voltage source inverters, square-wave switching, PWM switching schemes (square-wave, sinusoidal, regular sampled, harmonic elimination, distortion minimization, current control ed, and voltage vector control types), implementation, harmonics, output filtering, voltage and frequency control, applications
- AC voltage regulators: static ac voltage regulators for low and high power applications
- DC to DC converters: non-isolated converters of different types (buck, boost, and buck-boost types), uni-directional and bidirectional converters, isolated converters of different types (forward, fly back, push-pul , half-bridge, and ful -bridge types), output voltage regulation, steady state analysis, switch mode power supplies
- Design of power electronic converters: selection of voltage and current ratings, deciding on switching frequency, protection of power devices against over voltage, over current, thermal build up, switching stresses (snubber protection), spurious triggering, shoot-through fault etc., circuit protection, design of drive circuits, isolation of control signals, component selection, testing, circuit fabricating ethics, control circuit interface, power integrated circuits, application specific integrated circuits, product architecture, documentation
- Power electronics in renewable energy harvesting and grid connecting
- Multilevel converters

9. Energy Systems (08)

- Energy Resources: major hydro, coal, oil, natural gas, uranium, major reserves, depletion rates, non-

conventional energy resources, small hydro, solar, wind, biomass, tidal, geothermal, limitations, barriers for commercial deployment

- Energy Conversion Processes: primary conversion processes, oil refining, gasification of coal and bio fuels, energy conversion processes at end use, their efficiencies, costs of conversion
- Energy Consumption/Demand: energy consumption in developed and developing countries, regional consumption patterns, sectoral consumption, per capita consumption, global/Sri Lanka demand for energy, demand growth patterns and forecasts, energy and the economy
- Energy Policy in Sri Lanka: energy policy by world energy council, energy policy in Sri Lanka
- Energy Planning/Energy Management: energy data bases, development of an energy balance, Integrated energy planning, supply side and demand side energy management
- Energy Economics: economic comparison of energy supply systems, energy pricing, financial and economic cost-benefit analysis of energy sector projects
- Environmental Concerns: environmental impacts of energy projects and related costs, regulatory requirements, International protocols, carbon trading, global warming, extreme weather
- Sustainable energy supplies: sustainable and renewable energy sources and projects, impacts on the environment
- Present status of renewable energy development: global status of renewable energy technology development, targets set by government energy policies and initiatives
- Renewable energy technologies: present day technologies used in harnessing small hydro, wind, solar, biomass, geothermal, tidal power etc., resource assessment, the efficiencies of energy conversions, costs of development and operation.
- Battery technologies: types of batteries, capacities, specific energy densities, fuel cells, battery technologies for renewable options
- Regulatory structure: regulatory structure for developing renewable energy projects for electricity generation, tariffs available for developers, net metering

10. Nuclear Power Engineering (03)

- Basic Nuclear Physics: atomic structure and radioactive decay, nuclear reactions and cross sections, mass defect and binding energies
- Radiation Measurements: gas-filled and scintillation detectors, single channel and multi-channel analysers, counting statistics
- Radiation Protection: sources of radiation, biological effects, dose estimation, and principles of radiation protection
- Nuclear Power Plants: main components of nuclear power plants, pressurized water reactors, boiling water reactors, pressurized heavy water reactors
- Nuclear Safety: Things that can go wrong, levels of safety, physical barriers, past accidents
- Nuclear Power in Sri Lankan Context: constraints, factors to be considered, phases and milestones of nuclear power projects

11. Microelectronics (12)

- Single-stage BJT/FET amplifier configurations, small-signal models, small signal equivalent circuits, low frequency and high frequency equivalent circuits, multistage amplifiers
- Operational amplifiers, applications, analysis with ideal and practical operational amplifiers
- Power amplifiers, applications, amplifier classes and their efficiencies
- Astable, mono-stable, and bi-stable multi-vibrators, Schmitt triggers
- Phase locked loops (PLL), types, frequency synthesis
- Linear power supplies: voltage regulators and protection circuits

- Analog-to-digital and digital-to-analog conversion, frequency ranges and bandwidth, signal reflection in cables, noise and interference, noise reduction methods
- Logic gates, Boolean algebra, minimization of logic expressions, Karnaugh maps up to 5 variables, combinational logic circuits, design of simple logic circuits
- Sequential logic circuits, latches, flip-flops, counters, registers and other MSI devices, design of finite state machines
- Logic families (DTL, TTL, ECL, CMOS), logic levels and noise margins, dynamic response of logic gates, fan-in, fan-out
- Programmable logic devices, PLAs, PALs, GALs, RAM and ROM chips, microcontrollers
- Timing analysis of digital circuit, gate delays, propagation delays, hazards, operating frequency, stability
- Asynchronous circuit design, asynchronous structure, analysis of bistable circuits, flow tables, flow table reduction, hazards, stability
- Embedded systems: System specifications and constraints, systems architectures, soft and hard processors, microcontrollers and peripherals, programmable system on chip (PSoCs), real time operating systems (RTOS), device drivers and resource ware programming, hardware-software co-design, debugging and testing, interfacing memory and peripherals, buses, interrupts, timers, and analog inputs, power management, system robustness, optimizations and security concerns

12. Management, Law & Ethics (10) – Refer page 31

Assessment Strategy

Assessment mode 1

Paper B: Syllabus of IESL General Qualifying Examination for AMIESL

1. Electronic Properties of Materials (02)

- Materials used for electronic engineering; atomic bondings; crystal line structures
- Basic quantum mechanics; Schrodinger equation; Fermi energy
- Electrical properties of metals, insulators and semiconductors; conductance and resistance; electrons in metals, insulators and semiconductors; band theory
- Magnetic properties of materials; basic concepts: diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism; Soft and hard magnetic materials; permanent magnets; Curie temperature and hysteresis loop
- Optical properties of materials; light emission and detection

2. Linear Circuits (04)

- Resistors, sources, Kirchhoff's voltage and current laws.
- Linearity, superposition, Thevenin's and Norton's theorems; node and mesh analysis
- Capacitors and inductors, series and parallel connections, stored energies
- Analysis of first- and second-order circuits consisting of resistors, capacitors and inductors; forced and natural responses; series and parallel resonance
- Phasors, impedance and admittance
- RMS quantities; complex power; maximum power transfer
- Three-phase circuits, Y- and Delta-loads

3. Electromagnetic Theory (05)

- Static Electric & Magnetic Fields: Poisson's and Laplace's equations and their applications, Integral and differential forms of Gauss's and Ampere's law. Capacitance and inductance.
- Dynamic Fields: Faraday's Law and Maxwell's equations.
- Plane Wave Propagation: Uniform plane wave propagation, intrinsic impedance, phase velocity, group velocity, propagation constant, Poynting's theorem, skin depth, boundary conditions, reflection and transmission coefficients, polarization.
- Transmission Lines: Characteristic impedance, propagation characteristics, reflection, voltage standing waves, Smith chart and impedance matching.
- Guided Wave Propagation: Wave propagation through a rectangular and circular metal waveguide, TE and TM modes.
- Antenna Basics: Isotropic and anisotropic radiators, antenna radiation patterns, directivity, gain, antenna aperture, Dipoles, monopoles, antenna arrays

4. Continuous-Time Signals and Systems (04)

- Elementary signals: impulse, step, real and complex exponentials and real and complex sinusoids; signal representations using elementary signals; basic signal transformations; signal properties: periodic, energy and power signals
- System properties: linearity, time invariance, causality, memory, and stability (BIBO); linear time-invariant (LTI) systems; impulse response of an LTI system; convolution; properties of convolution; properties of LTI systems; response of LTI systems to complex exponential signals
- Fourier series definition; finding Fourier series representations of signals; convergence of Fourier series; properties of Fourier series; Fourier series and frequency spectra; Fourier series and LTI systems

- Fourier transform definition; convergence of Fourier transform; Fourier transform properties; Fourier transform of periodic signals; frequency spectra of signals; frequency response of LTI systems; frequency responses of ideal low pass, high pass, bandpass and band stop analog filters
- Laplace transform definition; relationship between Laplace transform and Fourier transform; region of convergence; finding the inverse Laplace transform; properties of the Laplace transform; analysis of systems using the Laplace transform; BIBO stability of LTI systems in the Laplace domain

5. Control Theory and Systems (04)

- Introduction to open-loop and closed-loop control; modelling of electrical and mechanical systems; properties of systems: linearity, time invariance, causality and stability; Laplace transform; transfer function of a linear and time-invariant (LTI) system
- Transient and steady-state responses of first- and second-order systems; step response: rise time, peak time, peak overshoot, settling time; transient response of higher-order systems
- Bode plots; polar (Nyquist) plots, Routh-Hurwitz stability test, Nyquist stability criterion; root locus diagrams
- Introduction to state-space analysis of LTI systems; concepts of controllability and observability
- PID controller design; gain margin and phase margin; design of lead, lag and lead-lag compensators; Implementation of analog controllers using operational amplifiers
- Sensors and transducers: performance characteristics of transducers: dynamic range, sensitivity, resolution, input/output impedance, useful frequency range, resistance transducers, opto-conductive transducers, capacitive transducers, inductive transducers, thermocouples, piezoelectric transducers
- Introduction to digital control systems; discretization, analysis using z-transform and bilinear transform; implementation using digital circuits, e.g., microcontrollers and programmable logic controllers (PLCs)

6. Analog Electronics (08)

- Diodes and diode-characteristics, bipolar junction transistors, field effect transistors, microwave devices.
- Analysis of transistor circuits: analysis of transistor circuits at DC, biasing circuits for BJTs and FETs, transistor as an amplifier, single-stage BJT/FET amplifier configurations, small-signal models, small signal mid-frequency equivalent circuits and analysis, low frequency and high frequency equivalent circuits of BJT/FET circuits, h-parameter model, pole zero analysis, Bode plots, frequency response of amplifiers, multistage amplifiers
- Differential amplifiers: the BJT differential pair, small-signal operation of the BJT differential amplifier, characteristics of a differential amplifier, differential amplifier with active load
- Operational amplifiers: ideal opamp, negative feedback in opamp circuits, operational amplifier specifications, op-amp applications, practical behavior of op-amps, instrumentation amplifiers
- Data converters: analog-to-digital and digital-to-analog conversion, frequency ranges and bandwidth, signal reflection in cables, noise and interference, noise reduction methods
- Power amplifiers: definitions, applications and types of power amplifiers, power transistors, transistor power dissipation, amplifier classes and their efficiency, push-pull amplifiers, harmonic distortion and feedback, heat generation of power transistors and heat sinks
- Oscillators: astable, mono-stable, and bi-stable multi-vibrators, Schmitt triggers
- Phase locked loops: operating principles, PLL types, and frequency synthesis
- Linear power supplies: voltage regulators and protection circuits

7. Digital Electronics (08)

- Logic gates and Boolean algebra, minimization of logic expressions, five variable Karnaugh maps, combinational logic circuits, design of simple logic circuits
- Introduction to sequential logic circuits, latches, flip-flops, counters, registers and other MSI devices, design of finite state machines

- Logic families: ideal logic gates, logic levels and noise margins, dynamic response of logic gates, Analysis of logic families (fan-in, fan-out), diode logic, logic families (DTL, TTL, ECL, CMOS)
- Programmable devices: programmable logic devices, PLAs, PALs, GALs, RAM and ROM chips, microcontrollers
- Timing analysis of digital circuit: gate delays, propagation delays, hazards, operating frequency, stability, case study simple RS232 communication link.
- Asynchronous circuit design: asynchronous structure, analysis of bistable circuits, flow tables, flow table reduction, hazards, stability
- Microcontrollers: introduction, programming and applications of microcontrollers

8. Analog and Digital VLSI Systems (04)

- Electronic product manufacturing process: manufacturing process design and engineering, translation of product design information to manufacturing information, Product fabrication, assembly, testing, repair and quality control
- RTL design, implementation and verification: sequential system design using RTL based approach and its HDL implementation, introduction to functional and logic verification
- Digital design concepts: introduction to digital IC design, Digital design basics, RTL to netlist mapping, synthesis, high fan-out synthesis, clock tree synthesis
- IP development: analog & digital IP design flow, IO definition, test methodologies, characterization of IPs
- Design for test (DfT): define test modes, DfT insertion techniques

9. Electronic Instrumentation (04)

- Introduction to sensor-based measurement systems; static characteristics: accuracy, precision, repeatability, reproducibility, sensitivity, drift, linearity, resolution; dynamic characteristics: dynamic error, speed of response; measurements with zero-, first- and second-order systems.
- Sensors: temperature, light, force, pressure and motion
- Signal acquisition and signal conditioning circuits
- Operation principles of instruments: voltmeters and ammeters (analog and digital), signal sources and function generators, oscilloscopes, spectrum analyzers, network analyzers and logic analyzers

10. Computer Architecture (05)

- Introduction: computer as a data processing system, functional blocks of a computer system.
- Performance metrics of a computer system: throughput, speed, response time, Amdahl law, quantitative principles of computer design.
- Processor architecture: Von-Neumann model, instruction set architecture, evolution of architecture – RISC, VLIW, EPIC.
- Processor design: micro-architectures and programming.
- Memory: principles of DRAM, SRAM and their construction, organization of memory, principle of cache memory and its design considerations, specification of memory, interfacing and performance issues
- Interfacing: low and high-speed peripherals, internal and external bus architectures: AMBA, Wishbone, USB, and PCI.
- Operating systems: processes and threads, memory management, virtual memory, scheduling, concurrency

11. Introduction to Telecommunications (04)

- Overview of the history and evolution of telecommunication and current trends.
- Basic Elements of Telecommunication Systems: Information Source, transmitter, transmission medium, receiver and information destination.
- Use of decibels in power measurements.
- Communication Channels: Bandwidth, noise and other impairments, Signal-to-Noise ratio, information-carrying capacity of a channel.
- Overview of transmission media: Copper, fibre, radio, Twin lines, coaxial lines, waveguides. The radio spectrum. Overview of noise and channel bandwidth.
- Multiplexing: Frequency division, time division, code division and their hybrids. Standard multiplexing hierarchies.
- Circuit switching and packet switching and their applications.

12. Signals and Systems (04)

- Classification of signals: continuous/ discrete, analog/digital, periodic/apperiodic, deterministic/ stochastic, energy/power.
- The Fourier series representation of periodic signals and the Fourier transform for the representation of non-periodic energy signals. Properties of the Fourier series and the Fourier transform.
- Frequency domain representation of sampling. The sampling theorem and aliasing. Reconstruction of a bandlimited signal from its samples. Discrete-time processing of continuous-time signals using discrete-time Fourier analysis techniques.
- Linear Time Invariant (LTI) Systems: Characteristics of LTI systems. Characterizing the input-output relationship of continuous- and discrete-time LTI systems in the time domain. The convolution theorem and its application to LTI systems. Discrete-time LTI systems.
- Laplace and Z-transforms for continuous- and discrete-time signals and systems. Properties of the Laplace and Z-transforms.

13. Digital Signal Processing (03)

- Filter Design: Specifications, Structures, Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters. Design of FIR filters using windowing methods. IIR filter design: Butterworth, Chebyshev.
- Stability and Performance of Filters: Frequency and Z-domain analysis of filters.
- Finite Precision Arithmetic: Design decisions, impact on filter stability and performance.
- Platforms for Hardware Implementation of Digital Filters.
- Fast Fourier Transform.

14. Random Variables and Processes (03)

- Random Variables: Probability density/mass function, the cumulative distribution function, mean and variance. Functions of random variables. Uniform, Binomial and Poisson random variables. The Gaussian (normal) random variable.
- Multivariate Random Variables: Joint and conditional distributions, correlation, independence and covariance matrices. Characterization of jointly Gaussian random variables and Gaussian random vectors.
- Random Processes: Mean function, auto/cross-correlation, auto/cross-covariance, classification as stationary, wide sense stationary and ergodic, power spectral density.

15. Communication Systems and Networks (08)

- Layered structure of communication protocols and reference models, network elements and their roles. OSI seven layer model.
- The Physical Layer: Functions of the physical layer (encoding, synchronization, modulation, multiplexing, encryption), standards such as RS232, USB, FDDI, Ethernet, Bluetooth, WiFi, HDMI, FireWire.
- The Data Link Layer: Flow control techniques, Forward error control and automatic repeat request techniques, Error detection and error correction codes. The High Level Data Link (HDLC) protocol. Medium access mechanisms: Token-based, CSMA/CD, CSMA/CA and ALOHA.
- Network and Transport Layers.
- The role of access networks. The PSTN, ADSL, wireless LANs and cellular networks.
- The role of core networks. Core network infrastructure. SONET, DWDM, ATM, IP.
- Radio wave propagation in the microwave region and signal propagation over optical fibers. Simple power budgets for optical and microwave links.

16. Analog and Digital Communication Systems (10)

- Reasons for carrier modulation. Modulation and demodulation of double sideband suppressed carrier and conventional AM. Asymmetric sideband signals: single sideband, vestigial sideband.
- Generation and demodulation of frequency modulated and phase modulated signals. Bandwidth of angle modulated signals.
- Digitization of analog signals: Sampling theorem, Nyquist rate, quantization (Uniform and non-uniform), encoding. Pulse amplitude/width/position/code modulation.
- Baseband Digital Transmission: PAM signals and their power spectra, line codes and their spectra, geometric space representation of signals and noise.
- Performance analysis in AWGN channels: optimum detectors for binary polar signaling and general binary signaling.
- Digital Carrier Modulation Techniques: Signal-space representation of signals, ASK, PSK, QAM, QPSK, FSK, minimum shift keying, GMSK. Coherent receivers.
- Signal Design for Bandwidth-Constrained Channels: Inter symbol interference, Nyquist criterion, eye diagrams.
- Receiver Design for AWGN Channel and Performance: Correlation detector, matched-filter detector.
- Broadband Technologies: Principles of multicarrier modulation and spread spectrum communications.

17. Management, Law & Ethics (10) – Refer page 31

Assessment Strategy

Assessment mode 2

Paper C: Syllabus of IESL General Qualifying Examination for AMIESL

1. Basic Structural Design (12)

- Introduction to structural design
- Types of structural forms, loads, load paths and support conditions
- Structural Design Philosophies and Properties of structural materials: Concrete, steel, timber and masonry
- Design aspects related to tension members, compression members and bending members
- Members subjected to combined effects such as tension and flexure, compression and flexure.
- Design of connections and simple structures

2. Reinforced Concrete and Masonry Design (12)

- Behavior in flexure, shear and torsion
- Selection of initial member sizes for basic concrete elements
- Methods for performing structural idealization and modeling for analysis
- Design of beams, slabs, columns (short and slender), bases, staircases, walls, flat slabs, redistribution of moments for low rise buildings with extension to medium rise buildings
- Design of load bearing masonry for vertical, lateral and in-plane loads, Design of infill masonry panels
- Standard method of detailing for reinforced concrete members

3. Structural Steel and Pre-Stressed Concrete Design (8)

- Design of axially loaded tension members
- Design of axially loaded compression members
- Design of tension members subjected to moments
- Design of compression members subjected to moments
- Design of beams
- Design of steel frames
- Design of welded and bolted connections
- Introduction to prestressed concrete
- Basic principles and methods of pre-stressing
- Materials for pre-stressing
- Design of flexural members for serviceability and ultimate limit states
- Pre-stress losses

4. Analysis and Modeling of structures (8)

- Fundamentals of Structural Analysis - Equilibrium, Compatibility and Material Law
- Introduction to Lower Bound and Upper Bound Theorems
- General structural analysis methods
 - Three moments equation, Methods to calculate deflections (including Mohr's Theorem and Macaulay's Method), Virtual work and energy theorems, Moment Distribution method, Slope Deflection Equations, Plastic analysis of beams and frames, Introduction to structural dynamics
- Force matrix method - Displacement Matrix method and Stiffness matrices for basic structural elements
- Modeling Structures using computer programs and validating the output

5. Soil Mechanics and Engineering Geology (12)

- Earth's place in the space, history of the Earth, structure of the Earth, geological processes of the Earth's crust
- Process of weathering, erosion transportation and deposition, Nature distribution and engineering characteristics of sediments deposited in different environments, deltaic, desert, fluvial, glacial, periglacial, residual soils, common rock forming minerals
- Deformational features of the Earth crust and deformational features of rocks (foliation, folds, faults, lineations and joints), Intra-formational shears, Nature and origin in relation to stress fields, Formation and classification of sediments and sedimentary rocks
- Metamorphism, metamorphic grades and classification of metamorphic rocks
- Igneous activity, formation of igneous rocks and classification of igneous rocks
- Theory of plate tectonics and associated activities
- Geological time scale, Principles of stratigraphy

- Introduction to Sri Lankan geology
- Geological and geotechnical maps, their interpretation and mapping. Measurement of planar structures in the field. Rose diagrams and stereographic nets
- Basic soil properties - Mass, Volume, void ratio, moisture content definitions, specific gravity and density relationships. Particle size distribution (Sieve Analysis and Hydrometer Analysis), plasticity of soils (Atterberg Limits)
- Classification of Soils - Classification of Soils for engineering purposes, purpose of Classification, different systems, Unified Classification System
- Compaction of Soils - Proctor compaction test, AASHTO test, air voids ratio, Compaction in the field, Compaction control, field testing of density, principles of soil stabilization
- Permeability of Soils - Darcy's law, hydraulic gradient, coefficient of permeability, laboratory and field measurement of permeability, steady seepage
- Flow nets for confined and unconfined flow, isotropic and anisotropic conditions, critical hydraulic gradient and piping

6. Fluid Mechanics (10)

- Fluids and Fluid Properties: Characteristics of fluids, Continuum concept, Density, Specific weight, Relative density, Viscosity, Bulk modulus, Vapour pressure, Surface tension, Significance of fluid properties in engineering applications
- Hydrostatic Pressure: Variation of hydrostatic pressure, Pressure and Piezometric head, Absolute and Gauge pressure, Centre of pressure, Measurement of pressure
- Buoyancy: Up thrust on submerged bodies, Archimedes principle, Centre of buoyancy, Equilibrium and stability of fully submerged and floating bodies, Concept of metacenter
- Boundary Layers: Viscosity of fluids, Definition of boundary layer, Displacement thickness and Momentum thickness, Distribution of shear stress and velocity and Computation of drag force in Laminar/Turbulent boundary layers, Drag coefficient, Dynamic pressure, Form drag and Skin friction drag, Wakes, Streamlining of shapes/bodies, Lift and Drag of aero foils
- Pipe Systems and Networks: Equations for frictional loss, Darcy-Weisbach/Manning's/Hazen Williams formulae, Relationships between the coefficients, Moody diagram, Iterative methods for pipe network analysis (Hardy Cross Method)
- Transient Flow in Pipes: Incompressible water column theory, Elastic theory of water hammer, Sudden/gradual closure & valve opening, Strain energy water hammer theory, Fundamental differential equation of water hammer, Velocity of propagation, End conditions, Reflection at a reservoir, Surge tanks (Purpose, Type, Frictional effect, Theory of mass), Oscillation (Simple finite difference methods of solution, Solutions using scale models)
- Dimensional and hydraulic model Analysis: Dimensionless numbers, Buckingham's theorem, Hydraulic similarity, Hydraulic models of different types of structures, Distorted models
- Hydraulic Machinery: Introduction, Types of Pumps and Turbines, Total head, Reciprocating pumps (Components and mechanisms, SHM of piston, Single/Double acting pumps, Slip, Inertia pressure, Friction in Suction/Delivery pipes, Cavitation, Practical applications and limitations), Centrifugal pumps (General equation for head generated, Velocity triangles, Efficiencies, Specific speed, Performance at Constant/Variable speed, Guide vanes, Volute casing, Priming/Self priming, Deep-well pumps, Components and installation), Turbines (Impulse/Reaction types, General equation for power generated, Velocity triangles, Pelton turbine and Velocity ratio/speed regulation, Francis turbines, Specific speed, Efficiencies, Characteristic curves, Guide vanes, Volute casing, Draft tubes, Selection of turbines, Introduction to hydropower installations in Sri Lanka)
- Uniform Flow in Open Channels: Equations, Normal depth and Economic/optimum section

7. Construction Technology (10)

- Sustainable construction techniques - Implementation of sustainable design concept into construction, how to incorporate sustainable concepts in construction projects
- Planning and Setting out - Techniques of setting out of buildings and major civil engineering work
- Concreting Material handling on sites and access scaffolds
- Material handling equipment on site: Hoists, Forklifts, Tower cranes; other cranes, Dumpers, site layout of material handling equipment; concreting equipment and methods, Erection of scaffolds
- Temporary works for the concreting; formwork, false work and scaffolding (This should include conventional and advanced new system formwork)
- Tunneling Rock Blasting and Aggregate Production
- Tunneling equipment and methods, blasting of rock and use of explosives, quarrying and production of aggregates including new techniques used in Sri Lanka and other countries
- Road and Bridge construction

- Road Construction techniques, earthmoving plant selection; Bridge construction methods, cofferdams and work over water; Pile driving and Caisson sinking
- Construction Safety, Health and Safety at work
- Safe construction practices and checklists
- Land clearing and Earthworks
- Equipment used for Land clearing and earthworks: Bul dozer, Backhoe, Grab, Scraper, Grader, Wheel Loader, Dredger, Dump Truck; Land clearing techniques; Large excavations, dredging, Trench excavation, Pipe laying, Sheet piling and Shoring Systems
- Compaction of Earth with necessary equipment
- Deep excavations including dewatering and method of ground water control
- Quality assurance process - application of quality assurance processes and ISO 9000 for heavy construction work

8. Surveying (4)

- Classifications and basic principles of surveying
- Setting out of Buildings
- Level ing, Principles and theory of Level ing, Datum, Bench Marks, Temporary and Permanent Adjustments, Methods of Level ing, Sources of errors in Level ing, Curvature and refraction
- Curve Ranging
- Tacheometry and Subtense Bar Methods, Horizontal and vertical angle measurements, Tacheometry surveying, Contouring, Uses of contour plans and maps
- Electromagnetic Distance Measurement (EDM) and Global Positioning Systems (GPS)
- Total Station: Advantages, Fundamental quantities measured, Parts and accessories, working principle, on-site calculations, Field procedures, Errors and Good practices in using Total Station, GPS Surveying, Traversing and triangulation
- Use of Surveying Software
- Astronomy and Sun Observation
- Theory of Errors

9. Hydraulic Engineering and Water Resources, Coastal Engineering (8)

- Non-Uniform Flow in Open Channels: Specific Energy (Variation of specific energy with depth at constant discharge and with discharge at constant head), Critical Depth, Super critical and Sub-critical depths, Alternate depths, Determination of Surface Profiles by Numerical, Graphical and Analytical methods, Hydraulic jump on horizontal bed, Initial depth, sequent depth, Loss of energy in a hydraulic jump, Length of jump, Practical applications of hydraulic jump, Flow from a reservoir to a channel, Flow between two reservoirs, Branching channels, Flow at a clear overfall
- Hydraulic Structures: Introductory description and calculation of discharge for flumes, Sluices (with free flow and submerged flow), Weirs (sharp crested, ogee type and Broad crested), Spill ways (Weir type, Morning glory and Siphon types), Energy dissipaters
- Sediment Transportation: Modes of sediment movement, Suspended load, Bed load, Stable channels
- Design of Channels: Design of channels in erodible and non-erodible material, Criteria for Design, Economic section, Maximum and minimum permissible velocities, Maximum permissible unit tractive force, Cohesive and Granular materials
- Surface water Hydrology and Water Resource Management
- Hydrology and Water Resource Management: Hydrologic cycle (Precipitation, Infiltration, Evaporation and Runoff), Water balance concept, Water resource development and management, Regional/Global water related issues
- Surface Water Hydrology: Components of hydrologic cycle, Precipitation (Measurement of precipitation, Estimation of missing data, Tests for consistency, Hyetograph, Pluviograph, Computation of Mean Precipitation over a given area from gauge measurements using Simple Average, Thiessen Polygon and Isohyetal Method, Intensity/Frequency/Duration Curves), Runoff (Measurement of Runoff Flow, Rating Curve, Correction of Flow Rating Curve, Extension of Flow Rating Curve, Statistical Analysis of floods, Probability and Return Period, Flood Frequency Analysis, Gumbel and Normal Distributions, Rational Formula, Run-off Coefficient, Time of Concentration)
- Hydrograph Analysis: Separation of Base Flow, Infiltration Index, ϕ Index, Estimation of Net Rainfall and Surface Run-off, Unit Hydrograph Theory, Derivation of Unit Hydrograph from Natural Hydrograph, Conversion of Unit Hydrograph from one duration to another, S Curve, Instantaneous Unit Hydrograph, Derivation of IUH from Unit Hydrograph and vice-versa, Synthetic Unit Hydrograph, Snyder's Method
- Design and Operation of Reservoirs: Use of the Mass Curve in Reservoir Capacity, Spill Volume and Sustainable Yield Studies

- Flood and Reservoir Routing: Simple techniques of Routing a Flood Hydrograph through a reservoir and through a section of Channel, Muskingum Method
- Introduction to Groundwater as a component of the Hydrological Cycle, Types of Aquifers, Igneous/Metamorphic/Sedimentary formations, Non-indurated Sediments, Equations of Groundwater Flow in Cartesian and Radial Coordinates for Steady and Unsteady Flow including recharge and abstraction, Boundary and Initial Conditions, Steady State flow in Confined and Unconfined Aquifers with Cartesian coordinates (one dimensional only) and Radial coordinates, Pumping Tests, Analysis of Pumping Test data using Theis Equation, Jacob's Method, Theis Method, Analysis of Recovery Data, Introduction to Groundwater Models, Finite Difference Digital Models, Electrical Resistance Capacitance Models
- Coastal Engineering: Coastal Zone Planning, ocean waves along the coast, wave statistics, wave refraction, wave diffraction, wave shoaling, wind and wave generation, tides and tidal currents, sand migration, coastal erosion and erosion control, erosion around structures due to waves and currents and propeller erosion

10. Environmental Science and Engineering (6)

- Introduction to the natural world and the concept of ecosystems, basic principles of Ecology, biodiversity, population dynamics, population equilibrium, species adaptation, ecosystem response to disturbance
- Sustainability and development, local/regional/global environmental issues, Environmental quality
- Introduction to Environmental Impact Assessment, Environmental regulations in Sri Lanka
- Introduction to surface and ground water pollution control measures, Solid and Hazardous Waste Management, Air Pollution and Noise Control
- Water supply, water treatment principles and design
- Wastewater collection, sewer hydraulics and sewer designs
- Wastewater treatment principles and design, wastewater and effluent disposal, effluent disposal standards, design of on-site wastewater treatment and disposal
- Introduction to advance water and wastewater treatment methods

11. Geotechnical Engineering (10)

- Concept of consolidation, Terzaghi's theory for one dimensional consolidation, determination of consolidation characteristics in the laboratory, stress distributions in the soils, estimation of amount and rate of settlement due to loading, consolidation due to dewatering, secondary consolidation, improvement of soft clays using preloading.
- Methods of geotechnical investigation, methods of advancing a borehole in soil, methods of coring in rock, in situ tests, methods of obtaining undisturbed samples, borehole logging, idealization of a soil profile with borehole data.
- Relevance of shear strength of soils, Mohr Coulomb failure criterion, drained and undrained conditions, determination of shear strength in the laboratory by Direct shear test and triaxial tests, applicability of different types of triaxial tests, pore water pressure development and Skempton's Law, stress invariants and stress paths, vane shear test, shear strength of unsaturated soils.
- Different modes of slope instability, drained and undrained behavior, shallow translational slides, analysis of rotational slides by friction circle method, Taylor's charts, Bishop and Morgenstern charts, ordinary slices method, Bishop's method of slices, concept of probability of failure, stabilization of slopes.
- Rock mass and rock material, discontinuities, rock mass classification, investigation in rock, orientation of discontinuities, stereo-plots, stability of rock slopes, plane failure and wedge failure, stabilization of rock slopes, tests on rocks

12. Construction Management (6)

- Planning construction activities for building and civil engineering projects, use of bar charts, use of network diagrams, critical path analysis, scheduling and control, progress and cost monitoring, use of planning software
- Introduction to Project Management, the design brief, introduction to estimating, preparation of rates, use of a 'cost data bank', preparation of rates for BOQ items and estimates for building and civil engineering work
- Planning the construction site and organizational set up, material management, stores management, work supervision to ensure quality control and quality assurance
- Construction planning process for construction and earthwork operations, productivity in construction operations
- Types of construction contracts, contract documents, introduction to contract administration, basics of contract law, ICTAD conditions of contract
- Organizing equipment/plant for construction activities

- Introduction to Cost control and Cash flow forecasting
- Safety in construction & first aid

13. Concrete Technology (4)

- Properties of fresh concrete and test methods
- Properties of hardened concrete and test methods
- Constituents of concrete and methods to ensure their quality (cement, aggregates, water and admixtures)
- Mix Design
- Ready mixed concrete
- Machineries used in concreting
- Formwork
- Recent advances related to concrete
- Strength assessment in structural elements and strengthening (relating to structural analysis)
- Plastic analysis of reinforced concrete beams, frames and slabs

14. Management, Law & Ethics (10) – Refer page 31

Assessment Strategy

Assessment mode 1

Paper D: Syllabus of IESL General Qualifying Examination for AMIESL

1. Mechanics (5)

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

2. Mechanics of Materials (7)

- Concept of stress
- Introduction to Elasticity
- Bending of Beams
- Torsion of circular bars
- 2D Stress transformation
- Deflection of beams
- Buckling Instability of Columns
- Theory of Elasticity
- Unsymmetrical Bending of Beams
- Shear Stresses in Beams
- Torsion
- Strain Measurements
- Failure Criteria
- Axi-symmetric Components
- Energy methods
- Theory of Plasticity
- Fatigue Failure
- Creep and Viscoelasticity
- Numerical Methods

3. Engineering Drawing and Computer Aided Modelling (5)

- Orthographic Projection Methods and orthographic Views
- Loci, Lines and Planes
- Interpenetration Curves
- Developments
- Isometric views
- Draw orthographic projections using a CAD package
- Introduction to 3-dimensional modelling on a CAD package
- Carry out Engineering Graphics on the CAD system
- Introduction to parametric 3-dimensional modelling
- Generate orthographic projections from the solid model.

4. Thermodynamics, Heat Engines and Work Transfer Devices (7)

- Heat and Work and their estimations
- Ideal gases and pure substances.
- First Law of Thermodynamics
- Second Law of Thermodynamics
- Availability Analysis
- Heat engines, heat pumps, Ideal cycles
- Vapour Power Cycle
- Gas Power Cycle
- Turbines
- Air Compressors
- Compressible Fluid Flow
- Combustion

- Basic Refrigeration Cycles
- Refrigerants
- Vapour compression cycle
- Vapor Absorption System
- Refrigeration Equipment
- Psychrometry
- Thermal Comfort
- Heating and Cooling Load Calculation
- Air Distribution System

5. Manufacturing Engineering (7)

- Workshop safety
- General drawing, production drawings, Interpretation of drawings.
- Machines, tools and equipment
- Factories ordinance and general labour law
- Manufacturing processes
- Introduction to machining operations
- Detailed study of principal Machining Processes
- Surface treatment and finishing
- Engineering Metrology and Instrumentation
- Metal Casting
- Fabrication
- Mechanics of Forming
- Volume Forming Processes,
- Glass, Rubber, Plastics, ceramics and Epoxies in engineering applications
- Processing of Powder Materials and Ceramics
- Revision of Mathematics of Natural Curves and Curve Manipulations
- Curve and Surface Design using Cubics
- Computer-Aided Design
- Computer Integrated Manufacturing
- Computer Interfacing to Manufacturing Units
- Computer Aided Process Planning
- Numeric Control (NC) and Computer Numerical Control (CNC)
- Computer-Aided Manufacturing
- Advanced aspects of forming processes
- Advanced welding technologies
- Non-conventional and advanced machining processes and technology
- Competitive Aspects of Manufacturing
- Advanced metrology
- Rapid Prototyping, Rapid Tooling, Rapid Manufacturing

6. Fluid Dynamics and Fluid Power Systems (6)

- Properties of fluid in motion and Classification of fluids and flows
- Behavior of real fluids
- Governing Equations in Fluid Mechanics
- Ideal Fluid Flow
- Viscous Flow
- Dimensional Analysis and Similarity Theory
- Elements of CFD and role of CFD,
- Applications of CFD
- Conservation Laws of Fluid Motion and Boundary Conditions
- Preliminary Computational Techniques
- Turbulence Model ing
- Finite Volume Method for Diffusion Problems
- Finite Volume Method for Diffusion-Convection Problems
- Finite Volume Discretisation, Multi-dimensional Grids, Solution Algorithms
- Finite Volume Method for Unsteady Flows
- Boundary conditions in the discretised equations of the FVM
- Fluid Power Transmission Systems

- Lubrication
- Boundary Layer Theory
- Particle Mechanics
- Fluid Machinery
- Design of Industrial Flow Systems

7. Mechanics of Machines (7)

- Method of Virtual Work
- Planar Linkages
- Gear Drives
- Balancing of Rotating Masses
- Balancing of Reciprocating Masses
- Single Degree of Freedom Vibrations
- Turning Moment Diagram and Flywheel
- Three Dimensional Kinematics of Rigid Bodies
- Three Dimensional Kinetics of Rigid Bodies
- Two Degree of Freedom Vibrations
- Vibrations of Multi Degree of Freedom Systems
- Undamped Vibration of Continuous Systems
- Whirling of Shafts

8. Machine Design (4)

- Basic Design Considerations, Traditional and Innovative Design, Design Standards, Designing for static and dynamic loading.
- Load and Stress analysis
- Design of machine elements
- Design Methodology
- Design optimisation
- Conceptual design
- Selection of materials
- Detailed design calculation
- Geometric modelling and Production drawings
- Design of a practical industrial machine or equipment

9. Automotive Engineering (2)

- History of Automobiles, Types of motor vehicles, layout and configuration,
- Power train and Vehicle Performance,
- Working Principles of Engines
- Transmission System
- Braking System
- Steering System
- Suspension System
- Electrical System
- Legislation

10. Control Systems & Instrumentation (7)

- Sensors, signal conditioning and instrumentation
- Motors, actuators and valves
- Mathematical modelling of physical systems
- Open loop and Closed loop systems, Open loop and closed loop transfer functions
- Stability and time domain analysis for control systems
- Frequency domain analysis
- Closed Loop controllers
- Programmable logic controllers

11. Energy Technology and Energy Conservation (2)

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

- Wind Energy
- Small Hydro
- Biomass Energy
- Environmental Impacts
- Energy Conservation in Boiler and Steam Systems.
- Energy Conservation in Electrical Systems
- Energy conservation in Fluid machinery
- Pumping systems, Fans and blowers
- Energy Management
- Economic Analysis

12. Industrial Engineering (6)

- Production and Sales Forecasting
- Facilities Planning
- Introduction to Project Management
- Production Planning
- Inventory Management
- Productivity, Performance and Ethics
- Work Study and Job Design
- Ergonomics and Safety
- Value Engineering
- Quality Control
- Maintenance and Reliability
- World class manufacturing
- Lean systems and Agile manufacturing

13. Robotics and Industrial Automation (2)

- Evolution of robots and robotics, Laws of robotics
- Robot kinematics
- Robot dynamics and control
- Robot Sensors and Vision
- Robot Applications
- PLC Programming Methods
- Programmable Automation Controllers
- Distributed Control Systems
- Industrial Communication Systems.
- Material Handling and Transport Systems
- Human Machine Interface
- SCADA systems

14. Engineering Materials (7)

- Structure of atoms, atomic theories, atomic bonding in materials
- Crystal structures and defects
- Mechanical properties of materials
- Electrical properties of materials
- Introduction to nanomaterials
- Corrosion of metals
- Radioactivity and nuclear properties
- Phase diagrams, Binary alloy phase diagrams and evolution of microstructures, iron-carbon equilibrium phase diagram, steels & cast irons, Introduction to material failures
- Polymers
- Ceramic materials

15. Application of Electrical Engineering (3)

- Basic DC circuit analysis
- AC theory
- Electrical measurement
- Electrical installations
- Transformers

- Induction motors
- DC machines
- Special purpose motors
- Solid state control
- Electrical lighting
- Heating and welding
- Electrical wiring
- Economics of power utilization
- Introduction to Power Generation, Transmission, Distribution and Utilisation,

16. Basic and Applied Electronics (3)

- Materials Used in Electronic
- Diodes, Diode Circuits and Application
- Bipolar Junction Transistors and Circuits
- Field Effect Transistors and Circuits
- Integrated Circuit Amplifiers
- Logic Gates and Circuits
- Application of Electronics
- Electronic systems

17. Management, Law & Ethics (10) – Refer page 31

Assessment Strategy

Assessment mode 2

Paper E: Syllabus of IESL General Qualifying Examination for AMIESL

1. Fundamentals of Mechatronic Systems (6)

- Definition and evolution levels of mechatronic System, Advantages and disadvantages of mechatronic System, Characteristics of mechatronic systems, Components of mechatronic system, Role of various engineering disciplines in mechatronic system, Examples of mechatronic systems.
- Sensors and sensing technologies.
Sensing principles, Mechanical and Electromechanical sensors, Thermal sensors, Magnetic sensors, Radiation sensors
- Actuators and Actuating technologies
Mechanical actuators, Electrical actuators, Hydraulic and Pneumatic actuators, piezoelectric actuators and Micro-positioning systems
- Signal conditioning and Data Acquisition systems
Analogue and digital signals, Operational amplifier and Filtering, Analogue-to-Digital Converters (ADCs), Digital-to-Analogue Converters (DACs), Measurement Techniques and Data recording and logging

2. Embedded Systems (4)

- Fundamentals of Microprocessors, Microcontrollers, Programmable Logic Controllers (PLC) and embedded systems.
Development of microprocessors, Microprocessor systems, characteristics and applications of microcontrollers, Microcontroller programming Introduction to PLCs and Input / Output processing and programming
- Architectures Microprocessor & Microcontrollers.
- Microprocessor and microcontroller systems.
Memory, I/O interfacing, interrupts and interrupt handling, Serial and parallel communications.
- Microcontroller programming.
Programming Techniques, Integrated development environment
- Physical Computing with AVR microcontrollers.
Introduction to AVR AVR-microcontroller based development boards, Programming, I/O interfacing, Communication, PWM, Motor Controlling, Sensor interfacing.

3. Smart Sensors/Actuators (4)

- Classification of smart sensors and smart actuators, Sensor performance characteristics and terminology, advanced sensing principles and actuating technologies.
- Materials for Smart Sensors and Actuators
Isotropic and Anisotropic materials, Single-Crystal Silicon, Silicon Carbide, Polycrystalline Silicon, Conductive Polymers, Piezoelectric Crystals, Shape Memory Alloys (SMA), Electro-active Polymers (EAP).
- Sensing principles and Applications of Smart Sensors.
Accelerometers, Gyroscopes, Pressure Sensors, Tactile Sensors, Temperature Sensors, Optical Sensors, Acoustic Sensors, Vision Sensors, Hall Effect sensors, Radiation Sensors.
- Actuation Technologies and Applications of Smart Actuators.
Electrostatic, Piezoelectric, Thermal, Magnetic, comb-actuators, micro rotary actuators, micro pumps, micro grippers, micro robots.
- Automatic Identification and Data Capture (AIDC).
Radio Frequency Identification (RFID), Biometric Identification Systems, Barcode readers, Magnetic Stripes, Optical Character Recognition (OCR), Smart cards, Voice recognition

4. Control Systems Engineering (5)

- Mathematical modelling of physical systems.
Mathematical modelling related to mechanical, electrical, hydraulic and pneumatic systems, electromechanical systems and combined systems. Laplace transforms, Simplify the system using block diagram algebra.
- Fundamentals of Control Systems.
Definitions, Open loop and Closed loop systems, Open loop and closed loop transfer functions.
- Stability and time domain analysis for control systems.

Dynamic response of systems, Time domain analysis of first order and second order control systems.
Routh's Stability criterion, Root locus techniques

- Frequency domain analysis.
Frequency responses, Bode plot, Polar plot, Relative stability with definition of Gain margin and Phase margin.
- Closed Loop control ers.
Two step control, P, PD, PI and PID control ers.
- Introduction to digital control systems; discretization, analysis using z-transform and bilinear transform; implementation using digital circuits, e.g., microcontrol ers and programmable logic control ers (PLCs)

5. Industrial Automation (4)

- Architecture of Industrial Automation Systems
Discrete Automation and Process Automation, Process and Instrumentation Diagrams (P&ID), Industrial sensors and Instruments, PLC programming techniques
- PLC Programing Methods and Types of PLCs.
Industrial sensors and Instruments, PLC programming techniques
- Distributed Control Systems (DCS)
Programmable Automation Control ers (PACs)
- Industrial Communication Systems.
Basic communication techniques, Network Protocols and Topologies, Industrial Networks
- Human Machine Interface(HMI)
HMI devices, Interfacing HMI devices, development of Graphical y User Interfaces (GUI) for automations systems
- Supervisory Control and Data Acquisition (SCADA) Systems.
Design and Development of SCADA systems, Applications of SCADA systems in automation industry

6. Robotics and Autonomous Systems (6)

- History of robotics, Laws of robotics, Current developments in robotics, Robot anatomy, Robot categorization, Industrial and non-industrial applications of robots.
- Robotic manipulators.
Workspace of a robot, Components of a robot manipulator, Fundamental of manipulator design.
- Robot kinematics.
Coordinate Frames, Mapping and transforms, Forward kinematics of robot manipulators, Inverse kinematics of robot manipulators.
- Robot dynamics and control.
Fundamental of robot dynamics, Control of manipulators
- Design and Development of autonomous robots.
Mechanics, Kinematic and Dynamic analysis of Mobile robots, Mechanical Design of a mobile robot, Factors affecting the performance of a mobile robots, Human sensing, Robotic Sensing, different types of Sensors used in robots, electro mechanical actuator for mobile robots. Mobile robot control, sensors, actuators, software, hardware and communication systems

7. Application of Electrical Engineering (2)

- Basic DC circuit analysis
- AC theory
- Electrical measurement
- Electrical instal ations
- Transformers
- Induction motors
- DC machines
- Special purpose motors
- Solid state control
- Electrical lighting
- Heating and welding
- Electrical wiring
- Economics of power utilization
- Introduction to Power Generation, Transmission, Distribution and Utilization

8. Basic and Applied Electronics (2)

- Materials Used in Electronic
- Diodes, Diode Circuits and Application
- Bipolar Junction Transistors and Circuits
- Field Effect Transistors and Circuits
- Integrated Circuit Amplifiers
- Logic Gates and Circuits
- Application of Electronics
- Electronic systems

9. Mechanics (3)

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

10. Mechanics of Materials (6)

- Concept of stress
- Introduction to Elasticity
- Bending of Beams
- Torsion of circular bars
- 2D Stress transformation
- Deflection of beams
- Buckling Instability of Columns
- Theory of Elasticity
- Unsymmetrical Bending of Beams
- Shear Stresses in Beams
- Torsion
- Strain Measurements
- Failure Criteria
- Axi-symmetric Components
- Energy methods
- Theory of Plasticity
- Fatigue Failure
- Creep and Viscoelasticity
- Numerical Methods

11. Engineering Drawing and Computer Aided Modelling (3)

- Orthographic Projection Methods and orthographic Views
- Loci, Lines and Planes
- Interpenetration Curves
- Developments
- Isometric views
- Draw orthographic projections using a CAD package
- Introduction to 3-dimensional model ing on a CAD package
- Carry out Engineering Graphics on the CAD system
- Introduction to parametric 3-dimensional model ing
- Generate orthographic projections from the solid model

12. Thermodynamics, Heat Engines and Work Transfer Devices (5)

- Heat and Work and their estimations
- Ideal gases and pure substances.
- First Law of Thermodynamics
- Second Law of Thermodynamics
- Availability Analysis
- Heat engines, heat pumps, Ideal cycles
- Vapour Power Cycle

- Gas Power Cycle
- Turbines
- Air Compressors
- Compressible Fluid Flow
- Combustion
- Basic Refrigeration Cycles
- Refrigerants
- Vapour compression cycle
- Vapor Absorption System
- Refrigeration Equipment
- Psychrometry
- Thermal Comfort
- Heating and Cooling Load Calculation
- Air Distribution System

13. Manufacturing Engineering (5)

- Workshop safety
- General drawing, production drawings, Interpretation of drawings.
- Machines, tools and equipment
- Factories ordinance and general labour law
- Manufacturing processes
- Introduction to machining operations
- Detailed study of principal Machining Processes
- Surface treatment and finishing
- Engineering Metrology and Instrumentation
- Metal Casting
- Fabrication
- Mechanics of Forming
- Volume Forming Processes,
- Glass, Rubber, Plastics, ceramics and Epoxies in engineering applications
- Processing of Powder Materials and Ceramics
- Revision of Mathematics of Natural Curves and Curve Manipulations
- Curve and Surface Design using Cubics
- Computer-Aided Design
- Computer Integrated Manufacturing
- Computer Interfacing to Manufacturing Units
- Computer Aided Process Planning
- Numeric Control (NC) and Computer Numerical Control (CNC)
- Computer-Aided Manufacturing
- Advanced aspects of forming processes
- Advanced welding technologies
- Non-conventional and advanced machining processes and technology
- Competitive Aspects of Manufacturing
- Advanced metrology
- Rapid Prototyping, Rapid Tooling, Rapid Manufacturing

14. Fluid Dynamics and Fluid Power Systems (4)

- Properties of fluid in motion and Classification of fluids and flows
- Behavior of real fluids
- Governing Equations in Fluid Mechanics
- Ideal Fluid Flow
- Viscous Flow
- Dimensional Analysis and Similarity Theory
- Elements of CFD and role of CFD,
- Applications of CFD
- Conservation Laws of Fluid Motion and Boundary Conditions
- Preliminary Computational Techniques
- Turbulence Model ing
- Finite Volume Method for Diffusion Problems

- Finite Volume Method for Diffusion-Convection Problems
- Finite Volume Discretization, Multi-dimensional Grids, Solution Algorithms
- Finite Volume Method for Unsteady Flows
- Boundary conditions in the discretized equations of the FVM
- Fluid Power Transmission Systems
- Lubrication
- Boundary Layer Theory
- Particle Mechanics
- Fluid Machinery
- Design of Industrial Flow Systems

15. Mechanics of Machines (6)

- Method of Virtual Work
- Planar Linkages
- Gear Drives
- Balancing of Rotating Masses
- Balancing of Reciprocating Masses
- Single Degree of Freedom Vibrations
- Turning Moment Diagram and Flywheel
- Three Dimensional Kinematics of Rigid Bodies
- Three Dimensional Kinetics of Rigid Bodies
- Two Degree of Freedom Vibrations
- Vibrations of Multi Degree of Freedom Systems
- Undamped Vibration of Continuous Systems
- Whirling of Shafts

16. Machine Design (6)

- Basic Design Considerations, Traditional and Innovative Design, Design Standards, Designing for static and dynamic loading.
- Load and Stress analysis
- Design of machine elements
- Design Methodology
- Design optimization
- Conceptual design
- Selection of materials
- Detailed design calculation
- Geometric modeling and Production drawings
- Design of a practical industrial machine or equipment

17. Engineering Materials (5)

- Structure of atoms, atomic theories, atomic bonding in materials
- Crystal structures and defects
- Mechanical properties of materials
- Electrical properties of materials
- Introduction to nanomaterial
- Corrosion of metals
- Radioactivity and nuclear properties
- Phase diagrams, Binary alloy phase diagrams and evolution of microstructures, iron-carbon equilibrium phase diagram, steels & cast irons, Introduction to material failures
- Polymers
- Ceramic materials

18. Fundamentals of Micromechatronic Systems (4)

- Micro/Nano Electro Mechanical Systems (MEMS/NEMS)
MEMS/NEMS, Microsystems and Microelectronics, The multidisciplinary nature of Microsystem Design and Manufacture, Applications of Microsystems
- Materials for MEMS/NEMS devices and Systems.
Single crystal Silicon, Isotropic and Anisotropic materials, semiconductor properties and mechanical properties of Si, Substrates and Wafers, Silicon Compounds

- Fundamentals of Micromanufacturing.
Bulk Micromachining, Surface Micromachining, Lithography, Galvanoformung, Abformung (LIGA) process
- Micro/Nano Fabrication Techniques.
Photolithography, Diffusion, Ion Implantation, Oxidation, Chemical Vapor Deposition, Physical Vapor Deposition, Chemical Etching, Plasma Etching, inductively coupled plasma (ICP) process
- Actuation and Sensing Principles of MEMS/NEMS based devices and Systems.
Piezoresistive properties of silicon diffused layers, Piezoresistors, Piezoresistor design and applications, Capacitive sensing for MEMS/NEMS devices, piezoelectric effect and its applications, Electrostatic actuation
- MEMS/NEMS Sensors and Actuators.
MEMS/NEMS based Accelerometers, Gyroscopes, Pressure sensors, Comb-drive actuators and micro/nano devices and systems.
- MEMS/NEMS Devices and Systems Packaging.
Mechanical packaging of microelectronics, materials and interfaces for MEMS/NEMS packaging, MEMS/NEMS packaging technologies
- MEMS/NEMS Device Physics and Design.
Scaling laws in miniaturization, Design considerations, Process, Design, mechanical design using Finite Element Method (FEM), ANSYS.

19. Management, Law & Ethics (10) – Refer page 31

Assessment Strategy

Assessment mode 2

Syllabus for Paper F - General Qualifying Examination for AMIESL

1. Engineering Materials (7)

- Structure of atoms, atomic theories, atomic bonding in materials
- Crystal structures and defects
- Mechanical properties of materials
- Electrical properties of materials
- Introduction to nano-materials
- Corrosion of metals
- Radioactivity and nuclear properties
- Phase diagrams, Binary alloy phase diagrams and evolution of microstructures, iron-carbon equilibrium phase diagram, steels & cast irons, Introduction to material failures
- Polymers
- Ceramic materials

2. Thermodynamics, Heat Engines and Work Transfer Devices (10)

- Heat and Work and their estimations
- Ideal gases and pure substances.
- First Law of Thermodynamics
- Second Law of Thermodynamics
- Availability Analysis
- Heat engines, heat pumps, Ideal cycles
- Vapour Power Cycle
- Gas Power Cycle
- Axial Turbines
- Air Compressors
- Combustion
- Basic Refrigeration Cycles
- Refrigerants
- Vapour compression cycle
- Refrigeration Equipment
- Psychrometry
- Thermal Comfort
- Heating and Cooling Load Calculation
- Air Distribution System

3. Manufacturing Engineering (7)

- Workshop safety
- General drawing, production drawings, Interpretation of drawings.
- Machines, tools and equipment
- Factories ordinance and general labour law
- Manufacturing processes
- Introduction to machining operations
- Detailed study of principal Machining Processes
- Surface treatment and finishing
- Engineering Metrology and Instrumentation
- Metal Casting
- Fabrication
- Mechanics of Forming
- Computer-Aided Design
- Computer Aided Process Planning
- Numeric Control (NC) and Computer Numerical Control (CNC)
- Computer-Aided Manufacturing

4. Fluid Dynamics and Fluid Power Systems (7)

- Properties of fluid in motion and Classification of fluids and flows
- Behavior of real fluids
- Governing Equations in Fluid Mechanics
- Ideal Fluid Flow
- Viscous Flow
- Dimensional Analysis and Similarity Theory
- Elements of CFD and role of CFD,
- Applications of CFD
- Conservation Laws of Fluid Motion and Boundary Conditions
- Preliminary Computational Techniques
- Fluid Power Transmission Systems
- Lubrication
- Boundary Layer Theory

- Particle Mechanics
- Fluid Machinery
- Design of Industrial Flow Systems

5. Mechanics of Machines (8)

- Method of Virtual Work
- Planar Linkages
- Gear Drives
- Balancing of Rotating Masses
- Balancing of Reciprocating Masses
- Single Degree of Freedom Vibrations
- Turning Moment Diagram and Flywheel
- Three Dimensional Kinematics of Rigid Bodies
- Three Dimensional Kinetics of Rigid Bodies
- Two Degree of Freedom Vibrations
- Vibrations of Multi Degree of Freedom Systems
- Undamped Vibration of Continuous Systems
- Whirling of Shafts

6. Machine Design (7)

- Basic Design Considerations, Traditional and Innovative Design, Design Standards, Designing for static and dynamic loading.
- Load and Stress analysis
- Design of machine elements
- Design Methodology
- Design optimization
- Conceptual design
- Selection of materials
- Detailed design calculation
- Geometric modelling and Production drawings
- Design of a practical industrial machine or equipment

7. Control Systems & Instrumentation (7)

- Sensors, signal conditioning and instrumentation
- Motors, actuators and valves

- Mathematical modelling of physical systems
- Open loop and Closed loop systems, Open loop and closed loop transfer functions
- Stability and time domain analysis for control systems
- Frequency domain analysis
- Closed Loop controllers
- Programmable logic controllers
- PLC Programming Methods
- Programmable Automation Controllers

8. Industrial Engineering (5)

- Production and Sales Forecasting
- Facilities Planning
- Introduction to Project Management
- Production Planning
- Work Study and Job Design
- Ergonomics and Safety
- Quality Control
- Maintenance and Reliability

9. Application of Electrical Engineering (7)

- Basic DC circuit analysis
- AC theory
- Electrical measurement
- Electrical installations
- Transformers
- Induction motors
- AC generators
- DC machines
- Special purpose motors
- Solid state control
- Electrical lighting
- Electrical wiring
- Economics of power utilization
- Parallel operation of AC generators

10. Basic and Applied Electronics (5)

- Materials Used in Electronic
- Diodes, Diode Circuits and Application
- Bipolar Junction Transistors and Circuits
- Field Effect Transistors and Circuits
- Integrated Circuit Amplifiers
- Logic Gates and Circuits
- Application of Electronics
- Electronic systems

11. Marine Internal Combustion Engines (10)

- Constructional details of two stroke, cross head, marine diesel engines
- Constructional details of four stroke marine diesel engines.
- Auxiliary systems serving the engine plant; fuel, scavenge, lubricating oil, cooling, starting etc
- Periodic maintenance and surveys
- Performance monitoring

12. Marine Auxiliary Systems (8)

- Marine pumps and Pumping systems; Ballast, Bilge, fire etc.
- Marine Boilers (including exhaust gas boilers) and associated systems, operation and maintenance
- Electric Power generation
- Steering gears
- Deck Machinery
- Propulsion transmission systems
- Marine Refrigeration and Air-conditioning

13. Naval Architecture (12)

- Classification of ship types
- Ship's Terminology, Definition and Principles dimensions
- Hydrostatics particulars and their estimations using Simpson's rule
- Metacentric height and Initial stability
- Stability at large angles of heel and Righting lever
- Longitudinal stability and trim
- Liquid in tanks and free surface effect
- Damage stability of ships

- Ship resistance and powering
- Ship propellers and propeller selection

14. Ship Construction (10)

- **Introduction to Shipbuilding**

Ship types, functions and features; Ship dimensions and form; Shipbuilding industry; Shipbuilding process; Preliminary ship design; Shipyard practices, Shipyard layout, Shipyard equipment, Design for production, Prefabrication, Launching, Shipyard management and organization

- **Loads and Stresses**

Static loads, Dynamic loads, Docking stresses, Stresses due to local loading, Stresses due to discontinuities; Shear and bending forces and stresses, Cyclic loading and fatigue

- **Ship Structure**

Keel and bottom structure, Framing systems and Shell plating, Decks, hatches and deck plating, Fore end structure and design considerations, Aft end structure and design considerations, Bulkheads and pillars, Superstructures and accommodation ; Minor Structural items – Watertight doors, Shaft tunnel, Deep tanks, Bulwark ; Specialized Cargo Carriers – Container ships, Tankers, Liquefied Gas carriers, Bulk carriers, Ro-Ro Ships ; Outfit - Hatch covers, Mooring equipment, Masts, derricks and deck cranes ;

- **Shipbuilding Materials**

Desirable properties, Material behavior, Shipbuilding steels, Steel sections, Aluminium Alloys

- **Welding and Cutting Processes**

Welding processes used in shipbuilding, Testing of welds and welded joints, Cutting processes, Safety practices in welding and cutting.

- **Corrosion and Corrosion Control**

Nature and forms of corrosion; Corrosion control methods – Sacrificial anode method, Impressed current method, Paints; Surface preparation; Anti-fouling paints; Corrosion reduction by good design

- **Organizations and Regulations**

International Maritime Organization and Classification Societies and their functions; Tonnage and Freeboard assignment, Ship Surveys and maintenance

15. Management, Law & Ethics (Common for all engineering disciplines) (10)

Assessment Strategy

Assessment Mode 1

Management, Law & Ethics Syllabus

- **Management**
Management Process, Roles of a Manager, Levels of Management, Business Environment and stakeholders, Overview of the key Functional areas of Management (Human Resource Management, Marketing Management, Financial Management, Management Information Systems, Operations Management, Financial Accounting and Management Accounting), Entrepreneurship and Intrapreneurship, Contemporary Issues in Modern Management
- **Law**
Legal System of Sri Lanka, Commercial Law, Sole Proprietorship, Partnerships and Incorporated bodies, Contract Law, Intellectual Property Law, Industrial Relations
- **Ethics**
Professional Ethics and its importance, Code of Ethics by the Institute of Engineers Sri Lanka (including duties, responsibilities, rights and privileges of an engineer), Ethical Perspectives (Individual ethical decision making – moral philosophies and values, Organizational ethical decision making – role of ethical culture and leadership), Corporate Social Responsibility, Respect for other Professions, Workplace Ethical issues and possible solutions (such as Civil disobedience and whistle blowing, privacy, safety and fairness concerns, bullying and harassment at workplace, and Intellectual property and legal issues)

Assessment Strategy

Each discipline has one of two modes of examinations, which is listed in the syllabi itself.

Assessment Mode 1

This mode involves one examination paper of 4 hour duration containing 120 MCQs, set to cover the breadth and depth of the syllabus. Questions may involve background calculations in order to test the candidate's knowledge in designs, calculations, fundamentals, operations, experimentations, appraisals, safety aspects, general knowledge, competency etc. but answerable within the nominal time for a question. Structure of the paper is as follows:

- 120 MCQs
- 4 hour duration
- 90 questions from core areas ($\pm 10\%$)
- 20 questions from affiliated areas ($\pm 10\%$)
- 10 questions from management, law & ethics (common for all disciplines)
- Each question having 5 close answers
- Equal marks for each MCQ
- No negative marks
- Pass mark 50%

Assessment Mode 2

This mode involves two examination papers, one 3 hour paper containing 90 MCQs and another 1 hour paper of a design. The 90 MCQs are set to cover the breadth and depth of the syllabus. As in mode 1 examination, questions may involve background calculations in order to test the candidate's knowledge in designs, calculations, fundamentals, operations, experimentations, appraisals, safety, general knowledge, competency etc. but answerable within the nominal time for a question. Second paper on design has two questions but one to be answered within 1 hour duration. These questions are from core areas and mainly on systems designs involving the use of standards, code of practices etc., meeting specifications.

MCQ Paper

- 90 MCQs
- 3 hour duration
- 60 questions from core areas ($\pm 10\%$)
- 20 questions from affiliated areas ($\pm 10\%$)
- 10 questions from management, law & ethics (common for all disciplines)
- Each question having 5 close answers
- Equal marks for each MCQ
- No negative marks
- Pass mark 50%

Design Paper

- 1 to be selected from 2 questions
- Questions are from core areas
- 1 hour duration
- Pass mark 50%