

TS ECET - 2023

Syllabus for Electronics and Instrumentation Engineering

MATHEMATICS (50 Marks)

Unit-I: Matrices

Matrices: Definition of Matrix, Types of matrices-Algebra of matrices-Transpose of a matrix-Symmetric, skew symmetric matrices-Minor, cofactor of an element-Determinant of a square matrix-Properties-Laplace's expansion-singular and non-singular matrices-Adjoint and multiplicative inverse of a square matrix-System of linear equations in 3 variables-Solutions by Cramer's rule, Matrix inversion method-Gauss-Jordan method.-Partial Fractions: Resolving a given rational function into partial fractions. Logarithms: Definition of logarithm and its properties, meaning of 'e', exponential function and logarithmic function.

Unit-II: Trigonometry

Properties of Trigonometric functions– Ratios of Compound angles, multiple angles, sub multiple angles – Transformations of Products into sum or difference and vice versa. Properties of triangles: sine rule, cosine rule, tangent rule and projection rule. Solution of a triangle when (i) three sides (SSS), (ii) two sides and an included angle (SAS), (iii) one side and two angles are given(SAA). Inverse Trigonometric functions, Hyperbolic functions.

Complex Numbers: Definition of a complex number, Modulus, amplitude and conjugate of complex number, arithmetic operations on complex numbers - Modulus-Amplitude form (Polar form) - Euler form (exponential form).

Unit-III: Analytical Geometry

Straight Lines–different forms of Straight Lines, distance of a point from a line, angle between two lines, intersection of two non-parallel lines and distance between two parallel lines. Circles- Equation of circle given center and radius, given ends of diameter-General equation- finding center and radius, center and a point on the circumference, 3 non-collinear points, center and tangent, equation of tangent and normal at a point on the circle. Conic Section – Properties of parabola, ellipse and hyperbola – Standard forms with vertex at origin.

Unit-IV: Differentiation and its Applications

Functions and limits – Standard limits – Differentiation of sum, product, quotient of functions, function of function, trigonometric, inverse trigonometric, exponential, logarithmic, Hyperbolic functions, implicit, explicit and parametric functions–Derivative of a function with respect to another function-Second order derivatives – Geometrical applications of the derivative (angle between curves, tangent and normal)–Increasing and decreasing functions–Maxima and Minima (single variable functions) using second order derivative only physical application – Rate Measure - Partial Differentiation–Partial derivatives up to second order–Euler's theorem.

Unit-V: Integration and its Applications

Indefinite Integral – Standard forms – Integration by decomposition of the integrand, integration of trigonometric, algebraic, exponential, logarithmic and Hyperbolic functions– Integration by substitution –Integration of reducible and irreducible quadratic factors – Integration by parts– Definite Integrals and properties, Definite Integral as the limit of a sum – Application of Integration to find areas under plane curves and volumes of Solids of revolution– Mean and RMS values, Trapezoidal rule and Simpson's 1/3 Rule for approximation integrals.

Unit–VI: Differential Equations

Definition of a differential equation-order and degree of a differential equation- formation of differential equations-solution of differential equation of the type first order, first degree, variable-separable, homogeneous equations, exact, linear differential equation of the form $dy/dx+Py=Q$, Bernoulli's equation, 2nd order linear differential equation with constant coefficients both homogeneous and non-homogeneous and finding the Particular Integrals for the functions e^{ax} , $\sin ax$, $\cos ax$, $ax^2 +bx+c$ (a,b,c are real numbers).

Unit–VII: Laplace Transforms

Laplace Transforms (LT) of elementary functions-Linearity property, first shifting property, change of scale property, multiplication and division by t - LT of derivatives and integrals, Unit step function, LT of unit step function, second shifting property, evaluation of improper integrals, Inverse Laplace transform (ILT)-shifting theorems, change of scale property, multiplication and division by s, ILT by using partial fractions and convolution theorem. Applications of LT to solve linear ordinary differential equations up to second order with initial conditions.

Unit–VIII: Fourier Series

Fourier series, Euler's formulae over the interval $(C, C+2\pi)$ for determining the Fourier coefficients. Fourier series of simple functions in $(0, 2\pi)$ and $(-\pi, \pi)$. Fourier series for even and odd functions in the interval $(-\pi, \pi)$ – Half range Fourier series – sine and cosine series over the interval $(0, \pi)$.

PHYSICS (25 Marks)**Unit-I: UNITS, DIMENSIONS AND FRICTION**

Physical quantity - Fundamental and derived quantities – Unit –definitions - S.I units - Advantages of S.I. units - Dimensions and dimensional formula - definitions-units and dimensional formula for physical quantities - Principle of homogeneity - Applications of dimensional analysis–Friction – causes - types of friction - Normal reaction - Laws of static friction - coefficients of friction - expression-rough horizontal surface - expressions for Acceleration, Displacement, Time taken to come to rest and Work done - Advantages and disadvantages of friction - Methods to reduce friction – Problems on friction only.

Unit-II: ELEMENTS OF VECTORS

Scalar and vector quantities – definitions and examples –Graphical representation of a vector - Classification of vectors (Proper vector, Unit vector, Equal vector, Negative vector, Collinear vector and Position vector) Resolution of a vector - Triangle law of vector addition – Parallelogram law of vectors – statement- expression for magnitude and direction of resultant vector –derivation-illustrations (working of sling and flying bird) - Representation of a vector in unit vectors \mathbf{i} , \mathbf{j} and \mathbf{k} – Scalar product of vectors-definition- application to work done by force – properties of scalar product - Vector product of vectors –definition – Right hand thumb rule and right hand screw rule - application to moment of force - properties of vector product - area of parallelogram and triangle in terms of vector product - related problems

Unit-III: MECHANICS

Projectile motion – definition - examples - Horizontal projection – Time of flight and Horizontal range – derivations - Oblique projection – Expression for path of a projectile in oblique projection - derivation– Maximum height, Time of ascent, Time of descent, Time of flight, Horizontal range and maximum horizontal range - derivations – Circular motion, angular velocity, time period and

frequency of revolutions–Definitions– Relation between linear velocity and angular velocity - derivation–centripetal force – centrifugal force – definitions and expressions only- application (banking of curved path) - angle of banking- expression only - related problems

Unit-IV: PROPERTIES OF MATTER

Elasticity and plasticity- definitions – examples - Stress and Strain – definitions and expressions - elastic limit - Hooke's law – statement - modulus of elasticity - Young's modulus – Derivation – Cohesive and adhesive forces - Surface tension - Illustrations - Capillarity –angle of contact – definition- examples for capillarity- Formula for Surface tension based on capillarity (no derivation) – Viscosity - Illustrations of viscosity - Newton's formula for viscous force – derivation - Coefficient of viscosity - Poiseuille's equation - Effect of temperature on viscosity of liquids and gases– streamlines - laminar flow - turbulent flow - Reynold's number - equation of continuity – statement - related problems.

Unit-V: HEAT AND THERMODYNAMICS

Heat – expansion of gases - Boyle's law –concept of absolute zero - Absolute scale of temperature – Charles' laws - Ideal gas equation – derivation - value of universal gas constant 'R' –Isothermal and Adiabatic processes - Differences between isothermal and adiabatic processes - Internal energy and external work done – Expression for work done – derivation – first law of thermodynamics – application of first law to isothermal and adiabatic processes - second law of thermodynamics – specific heat of a gas – molar specific heat of a gas – definitions – derive relation between C_p and C_v - related problems.

Unit-VI: CONSERVATION LAWS AND ENERGY SOURCES

Work and Energy - Potential Energy and kinetic energy–examples – expressions for PE and KE - derivations - Work-Energy theorem – derivation – Law of conservation of energy – examples - Law of conservation of energy in the case of freely falling body – proof – Illustration of conservation of energy in the case of simple pendulum– Non renewable and renewable energy sources - related problems

Unit-VII: WAVES AND SOUND

Wave motion – definition and characteristics – audible range – infrasonic and ultrasonic – longitudinal and transverse waves – examples – Relation between wavelength, frequency and velocity of a wave – derivation –stationary waves- beats - applications of beats - Doppler effect – list the applications – ultrasound and radar in medicine and engineering as special emphasis- echo – definition - applications - relation between time of echo and distance of obstacle –derivation- Reverberation and time of reverberation - Sabine's formula - Free and forced vibrations - Resonance - Conditions of good auditorium - noise pollution – definition – causes, effects and methods to minimize noise pollution - problems

Unit-VIII: SIMPLE HARMONIC MOTION

Periodic motion - Simple Harmonic Motion (SHM)– definition - examples - Conditions for SHM – Projection of circular motion on any diameter of a circle is SHM - Expressions for Displacement, Velocity and Acceleration of a particle executing SHM – derivations - Time period, frequency, amplitude and phase of a particle in SHM - Ideal simple pendulum – time period of simple pendulum –derivation - laws of simple pendulum-Seconds pendulum- problems

Unit-IX: MODERN PHYSICS

Photo electric effect - Einstein's photo electric equation – Work function and threshold frequency -

laws of photo electric effect - applications of photo electric effect – photo cell - concept of Refraction of light - critical angle and total internal reflection - principle of Optical fiber - Applications of optical fiber – LASER – definition and characteristics – principle of LASER - spontaneous emission and stimulated emission - population inversion - examples of LASER – Uses.

Unit-X: MAGNETISM

Magnetic field - magnetic lines of force -properties - Uniform and Non-uniform magnetic field – Magnetic length, pole strength – magnetic induction field strength- definition - Coulomb's inverse square law of magnetism - expression for moment of couple on a bar magnet placed in a uniform magnetic field – derivation - expression for magnetic induction field strength at a point on the axial line of a bar magnet –derivation - Dia, Para and Ferro magnetic materials – examples - related problems.

Unit-XI: ELECTRICITY AND MEASURING INSTRUMENTS

Ohm's law – Ohmic and non ohmic conductors – examples - Temperature dependence of resistance – coefficients of resistance with examples - Specific resistance – units – conductance- series and parallel combination of resistors - moving coil galvanometer - conversion of galvanometer into ammeter and voltmeter with diagram (qualitatively) – Kirchhoff's current and voltage laws in electricity – Expression for balancing condition of Wheatstone's bridge – derivation – Meter bridge –working with neat diagram –Superconductivity-definition-superconductors - definition and examples – applications - related problems.

Unit-XII: ELECTRONICS

Solids – definition – energy bands in solids- valence band, conduction band and forbidden band – Energy band diagram of conductors, insulators and semiconductors – concept of Fermi level - Intrinsic semiconductors - examples - Concept of holes in semiconductors - Doping - Extrinsic semiconductor - P-type and N-type semiconductors - PN Junction diode – Forward Bias and Reverse Bias - Applications of PN diode - Diode as rectifier – principle – principle of Light Emitting Diode and solar cell.

CHEMISTRY (25 Marks)

Unit-I: Fundamentals of Chemistry

Atomic Structure: Introduction - Atomic number - Mass number- Bohr's Atomic theory - Aufbau principle - Hund's rule - Pauli's exclusion Principle- Orbitals, shapes of s, p and d orbitals - Electronic configuration of elements

Chemical Bonding: Introduction - Electronic theory of valency - Types of chemical bonds - Ionic, covalent and co-ordinate covalent bond with examples - Properties of Ionic and Covalent compounds

Oxidation-Reduction: Electronic Concepts of Oxidation-Reduction, Oxidation Number-calculations.

Unit -II: Solutions and Colloids

Introduction-Classification of solutions based on physical state- Molecular weights,Equivalent weights - Expression of concentration - Mole concept, Molarity, Normality, Numerical problems on Mole, Molarity and Normality - Colloids- Types of colloids- Lyophilic and Lyophobic colloids -

Industrial applications of colloids.

Unit -III: Acids and Bases

Introduction - theories of acids and bases and limitations - Arrhenius theory-Bronsted-Lowry theory - Lewis acid base theory - Ionic product of water - pH and related numerical problems - Buffer solutions- buffer action - applications of buffer solution.

Unit -IV: Environmental Studies-I

Introduction - environment -scope and importance of environmental studies- important terms - renewable and non-renewable energy sources - Concept of ecosystem, producers, consumers and decomposers - Biodiversity, definition and threats to Biodiversity- Forest resources- Over exploitation-Deforestation.

Unit -V: Water Technology

Introduction -soft and hard water - causes of hardness – types of hardness -disadvantages of hard water - degree of hardness (ppm) - softening methods - permutit process - ion exchange process - drinking water - municipal treatment of water for drinking purpose - Osmosis, Reverse Osmosis - advantages of Reverse Osmosis – Desalination by Electro dialysis - Defluoridation – Nalgonda technique.

Unit -VI: Electrochemistry

Conductors, insulators, electrolytes –Types of electrolytes - Arrhenius theory of electrolytic dissociation - electrolysis -electrolysis of fused NaCl and aqueous NaCl - applications of electrolysis - Faraday's laws of electrolysis- numerical problems.

Unit -VI I: Metallurgy

Characteristics of Metals - distinguish between Metals and Non Metals- Ore, Gangue, Flux and Slag - Concentration of Ore -Froth floatation - Methods of Extraction of crude Metal - Roasting, Calcination and Smelting - Alloys-purpose of making alloys - Composition of Brass, German silver, Nichrome, Stainless steel and Duralumin

Unit –VIII: Corrosion:

Introduction - factors influencing the rate of corrosion - electrochemical theory of corrosion - composition, stress and concentration cells- rusting of iron and its mechanism - prevention of corrosion - coating methods, Paints-constituents and characteristics of paints-cathodic protection

Unit –IX: Polymers

Introduction - polymerization - types of polymerization - addition, condensation with examples - plastics - types of plastics - advantages of plastics over traditional materials - Disadvantages of using plastics - preparation and uses of the following plastics: 1. Polythene 2. PVC 3.Teflon 4.Polystyrene 5.Urea formaldehyde 6. Bakelite - Rubber - Elastomers –Preparation of Butyl rubber, Buna-s rubber, Neoprene rubber and their uses-Fibres-Preparation and uses of fibres-Nylon 6,6- Polyester

Unit –X: Fuels

Definition and classification of fuels- characteristics of good fuel - Calorific value-HCV and LCV- Calculation of oxygen required for combustion of methane and ethane - composition and uses of gaseous fuels - a) Water gas b) Producer gas, c) Natural gas, d) Coal gas, e) Bio gas and f)

Acetylene.

Unit –XI: Electro Motive Force

Galvanic cell – standard electrode potential -electro chemical series -emf of cell – Batteries-Types of batteries-Fuel cells.

Unit –XII: ENVIRONMENTAL STUDIES-II

Introduction- classification of air pollutants based on origin and states of matter - Air pollution; causes and effects - control methods - Water pollution; causes and effects - control measures.

ELECTRONICS AND INSTRUMENTATION ENGINEERING (100 Marks)

Unit-I: Electrical Engineering

Basic principles of electricity: Ohm's law, Kirchhoff's laws, Ideal voltage source, Ideal current source and its conversions, Magnetic materials-Classification, properties, Biot-Savart's law, Fleming's rules, Faraday's laws, Lenz's law, self and mutual inductance, Lifting power of magnet.

Electrostatics: Laws of electrostatics, Coulomb's laws, Permittivity, Dielectric strength, Dielectric constant, Energy stored in a capacitor – Solenoid & Toroid.

Batteries: Primary cell, Secondary cell, Different types, Charging and discharging, Maintenance free batteries.

Single phase transformers: Constructional features, Principles, Turns ratio, Applications of transformers

Network theorems & Machines: Node voltage and Mesh current analysis, Crammers rule, Reciprocating theorem for impedance matching, Superposition theorem, Thevenin's and Norton's theorems, DC Maximum power transfer theorem, Resonance in series circuits, Q-factor, Motors and generators.

AC Machines: Alternator, Induction motor, Synchronous motor.

Unit-II: Electronics

Resistors, Capacitors and Inductors and their specifications, Chokes, AF, RF Chokes, Basics of Switches, Fuses, Relays, Microphones and Loud speakers, PCBs, Conductors, Semiconductors and Insulators, Formation of P-N junction, Forward and Reverse biasing voltages, Zener diode, Varactor diode, Tunnel diode and their applications, Diode as rectifier, Half wave rectifier, Full wave rectifier, Need for filter, Classification of filters, Working of clipper and clamper using diodes, Working and Configurations of PNP and NPN transistors, UJT, FET, Photo Diode & Photo Transistors, LED, LCD.

Amplifiers: h-parameter model of CE, CB and CC amplifiers, RC coupled amplifier, Transformer coupled amplifier, Darlington and Cascode amplifiers, Class-A and Class-B push-pull amplifier, Complementary type power amplifier, Heat sinks, Oscillator principle, RC phase shift oscillator, Hartley oscillator, Colpitt's oscillator, Bootstrap sweep circuit, Current sweep circuit using transistor, Transistor as an amplifier in different configurations, AC and DC load line, Operating points, Direct coupled amplifier, Differential amplifier, Positive and Negative

feedback amplifiers.

Unit-III: Digital Electronics

Number systems, Different postulates, De-Morgan's theorems, Simplification of Boolean expressions, K-map (up to 3 variables reductions), Logic families – TTL NAND and CMOS NAND gates - Logic gates, Half adder, Full adder, Serial adder, Parallel adder, 2's complement subtractor – Tristate Buffer. RS, T, D and Master- slave JK type flip-flops, Encoders, Decoders, 4x1 Multiplexer, 1x4 De-multiplexer, Counters, Modulus of counter, Synchronous, Asynchronous counters and their working, Decade counter, Ripple counter, Binary counter, up down counter. Registers, Shift registers, Universal shift register, Basic memories (RAM and ROM). Types of memories - EEPROM, UVPRM, Applications of flash ROM.

Unit-IV: Process Instrumentation

Fundamentals of Instrumentation, Basic transducer theory for the measurement of displacement (LVDT, Potentiometer, inductive, capacitive, RVDT) Angular velocity (Moving iron, Moving coil type), AC & DC tacho generators, Photoelectric tachometer. Temperature (Thermometers, RTD, Thermo couple, Thermistor, Pyrometers) Pressure (Elastic elements, Strain gauge, Piezoelectric transducer, Dead weight tester), Variable capacitance pressure transducer, Mcleod gauge, Flow (Bernoulli's theorem, Head type flow meters, Rota meter, Electromagnetic flow meter, Anemometers, Ultrasonic flow meter, thermal flow meters), Level measurement (Resistive method, capacitive method, gamma rays method, ultrasonic method), Force and torque-working of load cell, column type, proving ring, hydraulic, pneumatic, piezo electric, digital force transducers. Density and viscosity-displacement type, fluid dynamic type, ultrasonic type density measurement, capillary viscometer, falling ball viscometer and rotational viscometer. Humidity-Hair hygrometer. Nuclear instrumentation-Types of ionization radiation, radiation detectors (Geiger Muller, Ionization chamber, Scintillation counter method). Smart sensors-Evolution of smart sensors (1st, 2nd, 3rd, 4th and 5th generation)-Proximity sensors, IR sensors, Motion detection sensors, accelerometer sensors, Gyroscope sensors.

Instrumentation in process industries: Power plant, Petro chemical, Iron and Steel, Paper and Pulp plant, cement plant, textile industry.

Unit-V: Control Engineering

Basics of open loop and closed loop control systems.

Process Control: Different process variables, Process characteristics, Control system parameters, ON-OFF Control, Proportional, Integral and Derivative Controllers, PID Controller, Tuning of PID Controller, Flapper nozzle system Actuators (Pneumatic, Electro-Pneumatic, Hydraulic) P to I and I to P converters, Solenoid valve, Stepper motor actuator, Basics of control valves, Classification of control valves-Sliding stem control valve-Single seat plug, Rotating shaft, Butterfly control valves, Cascade Controller, Ratio Controller, Feed forward control systems, Adaptive Control, Line Diagrams, Letter Codes, Standards.

Unit-VI: Linear IC Applications

Types of ICs: Based on integration (SSI, MSI, LSI and VLSI).

Characteristics of Operational Amplifier : Applications of Operational Amplifier like Summer, Integrator, Differentiator, Inverter, Voltage follower, Voltage to Current Converter, Current to Voltage Converter, Op-amp based LPF, HPF, Square wave Generator, Triangular wave generator, Mono Stable Multi-vibrator, Astable multi-vibrator, Wien-bridge Oscillator, Schmitt Trigger, ADC (Counter type & Successive approximation type) and DAC (R-2R ladder method

& weighted resistor method), Applications of 555 timer IC (Mono stable multi vibrator, Astable multi vibrator, Square wave generator) Regulated power supply using 78XX regulator, PLL-LM565.

Unit-VII: Microcontroller & PLC

Microcontroller: Architecture and Instruction set of 8051 Microcontroller, Programming concepts of 8051, interfacing peripherals (8255, 8251 and 8257) and Applications of 8051.

PLCs: Basics of PLC architecture, Instruction set of PLC and PLC ladder diagrams of various applications, Basic concepts of SCADA, DCS, DAS, ROBOT, CNC.
