



KALASALINGAM

ACADEMY OF RESEARCH AND EDUCATION

(DEEMED TO BE UNIVERSITY)



Under sec. 3 of UGC Act 1956. Accredited by NAAC with "A" Grade

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M.Tech – Automotive System engineering (ARAI) **Entrance Examination Syllabus**

Question Category	Objective type Question	Stream Options
<u>Part- 1</u> Engineering Mathematics (Common to All Branches)	25 Questions	1. Automobile Engineering 2. Mechanical Engineering 3. Electrical and Electronics Engineering 4. Electronics and Communication Engineering 5. Instrumentation, Electronics and Control Engineering 6. Production and Industrial Engineering
<u>Part - 2</u> Basic Engineering (Common to All Branches)	25 Questions	
<u>Part- 3</u> Based on Specialization	50 Questions	

PART - I
ENGINEERING MATHEMATICS
(Common to all Candidates)

Determinants and Matrices: Solving system of equations – Rank of the Matrix – Eigenvalues and eigenvectors – Reduction of quadratic form to canonical form.

Calculus and Differential Equations : Partial derivatives – Jacobians – Taylor's expansion – Maxima and Minima. Linear ordinary differential equations with constant coefficients – Simultaneous first order linear equations with constant coefficients. Formation of partial differential equation (PDE) – Solution of first order PDE – Solution of linear higher order PDE with constant coefficients.

Vector Calculus: Double and triple integrations and their applications – Gradient, Divergence, Curl and Laplacian – Green's, Gauss divergence and Stroke's theorem.

Functions of Complex Variables and Complex Integration: Analytic functions – Conformal Mapping – Bilinear transformation – Cauchy's integral theorem and integral formula – Taylor and Laurent Series – Singularities – Residues – Residue theorem and its applications.

Transforms: Laplace Transform – Inverse transforms – Application to solution of linear ordinary differential equations with constant coefficients. Fourier integral theorem – Fourier transform pair – Sine and Cosine transforms. - transform – Inverse Z–transform – Solution of difference equations using Z– transform.

Numerical Methods : Solution of linear system by direct and iterative methods – Interpolation and approximation – Numerical Differentiation and Integration – Solving Ordinary Differential Equations.

Applied Probability : Probability and Random variables – Standard Discrete and Continuous distribution – Moments – Moment generating function and their properties. Two-Dimensional Random Variables – Covariance – Correlation and Regression.

PART – II
BASIC ENGINEERING & SCIENCES
(Common to all Candidates)

Applied Mechanics: Law of Mechanics – Lamé's theorem – Forces, Moments and Couples – Displacement, velocity and Acceleration – Friction – Moment of Inertia.

Mechanical Engineering: Laws of thermodynamics – Open and closed systems – Equation of state – Heat and Work.

Physics: Sound – Lattices – Ultrasonic flaw detector – X-ray radiography – Interference Fringes – Planck's quantum theory – Laser and Fibre Optics.

Material Science: Fracture – Magnetic and Dielectric materials – Conductor and Semi conductor materials – Ceramic and Super conductor materials.

Civil Engineering: Fluid Statics and Dynamics – Boundary Layer – Pumps and Turbines – Environmental Pollution.

Electrical Engineering: Ohm's law – Kirchoff's law – A.C. circuits – D.C. machines – Transformers – Synchronous machines – Instrumentation.-

Computers: Computer organization – Architecture – Arrays – Pointers – User defined function – C program.

Chemistry: Adsorption – Chromatography – Chemical kinetics – Electrochemistry – Spectroscopy – Fuels and Combustion.

PART – III
(Based on Specialization)

1. AUTOMOBILE ENGINEERING

Mechanics: Statics of Particles, Equilibrium of Rigid Bodies, Properties of surfaces and Solids, Dynamics of particles, Friction and Element of Rigid Body Dynamics – Basics of Mechanism, Kinematics of Linkage Mechanism, Kinematics of Cam Mechanism, Gears and Gear Trains, Friction, Force Analysis, Balancing and Vibration.

Strength of Materials and Design: Stress, Strain and Deformation of solids, Transverse Loading on Beams and Stresses in Beams, Deflection of Beams, Energy Principles, Thin Cylinders and Spherical vessels Torsion – Fundamentals of design for strength and Stiffness of Machine members, Design of Shaft and Couplings, Design of Fasteners and Welded Joints, Design of Spring and Engine parts, Design of Engine parts, Bearing and Flywheel, Design of Transmission system for flexible elements, Spur Gears and Parallel Axis Helical Gears, Bevel, Worm Gears and Crossed Helical Gears, Design of Gear boxes, Design of Cam, Clutches and Brakes.

Thermodynamics: Basic concepts and First Law, Second Law, Entropy and Availability, Properties of Steam, Air standard cycles, Otto, Diesel and Dual cycles, Air compressors, Rankine cycle, Brayton cycle, Steam Turbines, Gas Turbine – Steam Nozzle, Refrigeration and air Conditioning, Conduction, Phase Change Heat Transfer and heat Exchangers, Radiation, Refrigeration Cycles, Refrigerants, System Components, VAPOR, Psychrometry, Air Conditioning system.

Production Technology: Foundry Technology, Hot and Cold Working, Forging, Principles and Application of Joining Process, Centre Lathe and Special purpose Lathes, Reciprocating Machines, Milling Machines and Gear Cutting, CNC Machine Tools, Part Programming.

Automotive Chassis: Front axle types front wheel geometry condition for true rolling motion steering geometry Ackermann and Davis steering. Types of steering gear box. Propeller shaft Universal joints. Final drive differential types. Type of brakes and constructional details. Types of suspension, Independent suspension-front and rear Rubber, pneumatic, hydro-elastic suspension.

Automotive Transmission: Construction and operation of friction clutches. Different types of gear boxes. Fluid couplings and torque converters. Wilson gear box. Hydrostatic drive systems. Electric drive. Continuously Variable Transmission (CVT) types of car bodies classification of bus bodies.

Vehicle Body Engineering: Body optimization techniques for minimum drag. Wind tunnel technology. Classification of vibration, definitions. Single degree of freedom, free, forced and damped vibrations. Rolling resistance,

cornering properties of tyres. Directional stability of vehicle Choice of suspension spring rate calculation of effective spring rate. Vehicle suspension in fore and aft. Vehicle ride model, Load distribution.

Automotive Electrical and Hybrid: Types of Batteries, Principle, Construction, Starting System. D.C. Generators and Alternators. Regulations for charging Electronic ignition systems. Types of sensors and actuators for automobiles. Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, series and parallel hybrid electric drive train design.

Pollution and Control: Emission formation in SI and CI Engines. Effects of design and operating variables controlling techniques constant volume sampling systems. Measurement techniques of HC, CO, NO_x and Smoke emission. Dilution Tunnel and Sound level meters.

Alternate Fuels: Properties alcohols, vegetable oils, biogas natural gas LPG and hydrogen as engine fuels methods of using all the fuels in SI and CI engines. Performance, emission and combustion behaviour of the fuels in SI and CI engines.

2. MECHANICAL ENGINEERING

Mechanics, Kinetics and Dynamics :

Statics of Particles, Equilibrium of Rigid bodies, Properties of Surfaces and Solids, Dynamics of Particles, Friction and Elements of Rigid Body Dynamics, Basics of Mechanisms, Gears and Gear Trains, Friction in Machine Elements, Force Analysis, Balancing, Single Degree Free Vibration, Forced Vibration, Mechanisms for Control and Vibration.

Strength of Materials and Design :

Stress, Strain and Deformation of Solids, Transverse Loading on Beams and Stresses in Beams, Torsion, Deflection of Beams, Energy Principles, Thin Cylinders and Thick Cylinders, Spherical Shells, Fundamentals of Design for Strength and Stiffness of Machine Members, Design of Shafts and Couplings, Design of Fasteners and Welded Joints, Design of Springs, Design of Engine parts, Design of Bearings, Design of Flywheels, Design of Transmission Systems for Flexible Elements, Spur Gears and Parallel Axis Helical Gears, Bevel Gears, Worm Gears and Crossed Helical Gears, Design of Gear Boxes, Design of CAM, Clutches and Brakes.

CAD / CAM / CIM / FEA :

Fundamentals of Computer Graphics, Geometric Modeling, Visual Realism, Assembly of Parts, CAD Standards, Fundamentals of CIM, Production Planning and Control and Computerized Process Planning, Cellular Manufacturing, Flexible Manufacturing System and Automated Guided Vehicle System, Industrial Robotics, One Dimensional Problems in FEA, Two Dimensional Scalar Variable Problems, Two dimensional vector variable Problems, Isometric Parametric Formulation.

Materials Science and Metallurgy

Constitution of alloys and phase diagrams, steels, cast iron, TTT diagram, heat treatment of ferrous and non-ferrous metal, surface modification techniques, non-metallic materials, mechanical properties and testing, crystal defects and strengthening mechanisms, conducting and semi conducting materials, magnetic and dielectric materials, Engineering ceramics, Engineering and commodity polymers.

Production Technology :

Foundry Technology, Hot and Cold working, metal forming processes, metal joining processes, welding metallurgy, welding defects, Metal cutting, center lathe and special purpose lathe, drilling, milling, grinding, gear cutting, broaching unconventional machining processes, CNC machine tools, Part programming.

Metrology & Measurements

Linear and angular measurements, Interferometry-laser interferometers – Types, Computer Aided Inspection, Basic concept of CMM- Types of CMM, Machine vision, Form measurement-Straightness- Flatness, Roundness, Surface finish measurement, Measurement of power, flow and temperature.

Thermodynamics: Basic concepts, Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; Carnot cycle. irreversibility and availability; behaviour of ideal and real gases, thermodynamic relations, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion, Fuel and combustion.

Heat and Mass Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Basic Concepts of Mass transfer – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

Applications: Power Engineering: Steam Tables, Rankine, Brayton cycles with regeneration and reheat. I.C. Engines: air-standard Otto, Diesel cycles. Refrigeration and air-conditioning: Vapour refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle; moist air: psychrometric chart, basic psychrometric processes. Turbomachinery: Pelton-wheel, Francis and Kaplan turbines – impulse and reaction principles – velocity diagrams

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

3. ELECTRICAL AND ELECTRONICS ENGINEERING

Electrical Circuits and Fields: KCL, KVL, Nodal & Mesh analysis, transient response of D.C and A.C networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point admittance and transfer functions of two port network, three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line plane and spherical charge distribution, dielectric, capacitance calculations for simple configurations; Ampere's and Biot-Savart' law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer – equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformer –connections; auto transformer; principles of energy conversion, windings of rotating machines; D.C generators and motors-characteristics, starting and speed control, armature reaction and commutation: three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators – performance, regulation; synchronous motors – starting characteristics, applications, synchronous condensers; fractional horsepower motors: permanent magnet and stepper motors.

Power Systems: Electric power generation – thermal, hydro, nuclear; transmission line parameters; steady –state performance of overhead transmission lines and cables and surge propagation; distribution system, insulators, bundle conductors, corona and radio interferences effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principle of over current, differential and distance protections; concepts and solid state relays and digital protection; circuit breakers; principles of system stability –swing curves and equal area criterion; HVDC system – Principle of operation, control and design consideration, HVDC circuit breaking; FACTS - Reactive power control, Uncompensated transmission line, Series compensation, SVC, thyristor control, series capacitor, static synchronous compensator, UPFC and applications.

Control Systems: Principles of feedback; transfer function; block diagram; steady –state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear time Invariant systems.

Power Electronics and Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTO, MOSFETs and IGBTs-static characteristic and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

Microprocessor and Microcontrollers: Microprocessor : General 8 bit microprocessor Architecture- 8085, 8086 processor – Architecture, Memory, I/O interfacing, Instruction set, Addressing modes, Timing diagram & delays, Machine cycles, Interrupts, counters, Assembly language programming. Microcontrollers: 8 bit microcontroller -8051 architecture, bus configuration, Instruction sets, programming & applications.

Digital Signal Processing: Analog signals - sampling & Aliasing- Discrete time signals & systems – LTI systems – Convolution sum-Difference equation representation-Z Transform & its Inverse – Discrete Fourier series & Fourier transform- Radix 2 FFT – Decimation in me and frequency – Inverse DFT using FFT – Analog Butterworth & Chebyshev filter design –IIR & FIR filter design and Realization.

High Voltage Engineering: Causes of overvoltages and its effects on power system – Lightning, switching surges and temporary overvoltages – concepts of reflections and refraction of travelling waves. Dielectric breakdown- Gaseous breakdown – Vacuum breakdown, Corona discharges – Generation of high voltage, High current and its measurements – DC, AC, impulse voltages and currents; High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers
– Peak Voltmeter , CVT, Electrostatic Voltmeters – Sphere Gaps – High current shunts; High voltage testing of electrical power apparatus as per International and Indian standards – Insulation Coordination.

Electric energy – Conservation and utilization: Fundamentals of Electric drives – choice and applications; traction motors – characteristic features – electric braking train movement and energy consumption; Design of illumination systems and various lighting schemes; Electric heating – methods of electric heating and its types – Electric welding - Principles of the conversion of solar radiation into heat; Solar Collectors-flat-plate collectors – concentrating collector – cylindrical parabolic; Wind energy conversion system – basic principles – site selection – basic components – Classification of WECS – Types of wind machines.

4. ELECTRONICS AND COMMUNICATION ENGINEERING

Circuit Analysis: DC Circuit analysis, Thevenin's and Norton's equivalent circuits, Sinusoidal steady state analysis, Transient and resonance in RLC circuits.

Electronic Devices: Diodes, Bipolar Junction Transistors, FET, MOSFET, UJT, Thyristor.

Electronic Circuits: Small signal amplifiers using BJT and FET devices, Large signal amplifiers, Power supplies, Feed back amplifiers, Oscillators, Pulse shaping circuits. Digital Electronics: Logic gates, Combinational circuits, Sequential circuits. Linear Integrated Circuits: Operational amplifiers and its applications, PLL, Voltage regulators, A/D and D/A converters. Measurements and Instrumentation: Transducers, Digital Instruments, Display and Recording systems. Microprocessor and its applications: Microprocessors-8085 and 8086 architectures and interfaces, Micro-controller and applications.

Electromagnetic Fields: Static Electric and Magnetic fields, Time varying Electric and Magnetic fields, Maxwell equations. Transmission Lines and Networks: Transmission line equations, impedance matching, Filters. EM waves and waveguides: Guided waves, Rectangular and cylindrical waveguides. Antennas and Propagation: Aperture antennas, arrays, Propagation of radio waves. Microwave Engineering: Microwave tubes, semiconductor devices, Passive components, Microwave measurements.

Communication Theory and Systems: AM, FM and PM, Sampling and Quantization, PCM, DM, ADM, Multiplexing. Digital Communication: Base band signaling, Band pass signaling, Error control coding, Spread spectrum techniques. Computer Communication Networks: Definition of layers, data link protocols, Network interconnection. Message routing technologies, End-End protocols.

Optical Communication: Optical Fibers, optical transmitters and receivers.

Signals and Systems: Continuous time signals and systems-Fourier Transform, Laplace transform, Discrete time signals and systems-DTFT, DFT, Z-Transform. Digital Signal Processing: IIR and FIR filters, Realization and implementation, Quantization effects. Control Systems: Transfer function, Time and frequency response analysis, Stability analysis, state variable analysis

5. INSTRUMENTATION, ELECTRONICS & CONTROL ENGINEERING

Electrical Circuits :

Voltage and current sources: independent, dependent, ideal and practical; v-i relationships of resistor, inductor, and capacitor; transient analysis of RLC circuits with dc excitation.

Kirchoff's laws, mesh and nodal analysis, superposition, Thevenin, Norton, maximum power transfer and reciprocity theorems.

Peak, average and rms values of ac quantities; apparent, active and reactive powers; phasor analysis, impedance and admittance; series and parallel resonance, realization of basic filters with R, L and C elements.

One-port and two-port networks, driving point impedance and admittance, open - circuit, and short circuit parameters.

Signals and Systems :

Periodic, aperiodic and impulse signals; Laplace, Fourier and z-transforms; transfer function, time response and frequency response of first and second order linear time invariant systems; convolution and correlation.

Discrete time system: impulse response, frequency response, pulse transfer function; DFT and FFT; basics of IIR and FIR filters.

Analog Electronics

Characteristics and applications of diode, Zener diode, BJT and MOSFET; small signal analysis of transistor circuits; feedback amplifiers.

Characteristics of operational amplifiers; applications of opamps: difference amplifier, adder, subtractor, integrator, differentiator, instrumentation amplifier, precision rectifier, active filters and other circuits.

Oscillators, signal generators, voltage controlled oscillators and phase locked loop.

Digital Electronics

Combinational logic circuits, minimization of Boolean functions; IC families: TTL and CMOS; Arithmetic circuits, comparators, Schmitt trigger, multi-vibrators, sequential circuits, flip-flops, shift registers, timers and counters.

Sample-and-hold circuit, multiplexer, analog-to-digital (successive approximation, integrating, flash and sigma-delta) and digital-to-analog converters (weighted R and R-2R ladder). Characteristics of ADC and DAC (resolution, quantization, significant bits, conversion/settling time).

8-bit microprocessor and microcontroller: applications, memory and input-output interfacing; basics of data acquisition systems.

Measurements

SI units; systematic and random errors in measurement, expression of uncertainty, accuracy and precision, propagation of errors; PMMC, MI and dynamometer type instruments; dc potentiometer; bridges for measurement of R, L and C; Q-meter; Measurement of voltage, current and power in single and three phase circuits; true rms meters; instrument transformers; time, phase and frequency measurements; digital voltmeter and digital multi-meter; oscilloscope; shielding and grounding.

Sensors and Industrial Instrumentation:

Resistive, capacitive, inductive, piezoelectric, Hall effect sensors and associated signal conditioning circuits; transducers for industrial instrumentation: displacement (linear and angular), velocity, acceleration, force, torque, vibration, shock, pressure (including low pressure), flow (differential pressure, variable area, electromagnetic, ultrasonic, turbine and open channel flow meters) temperature (thermocouple, RTD (3/4 wire), thermistor, pyrometer and semiconductor); liquid level, pH, conductivity and viscosity measurement.

Analytical Instrumentation

Spectral methods of analysis: Spectro-Photometers, sampling systems, source detectors and applications; conductivity and pH meters; Chromatography; NMR & X ray spectroscopy; GM and proportional counters; Mass spectrometer.

Communication and Optical Instrumentation:

Amplitude and frequency modulation and demodulation; Shannon's sampling theorem; frequency and time division multiplexing; Digital Communication : PCM, DPCM, amplitude, phase, frequency, pulse shift keying for digital modulation; optical sources and detectors: LED, laser, photo-diode, light dependent resistor and their characteristics; Basics of fiber optic sensing.

Control System and Computer Control of Processes:

Feedback principles, signal flow graphs, transient response, steady-state-errors, Bode plot, phase and gain margins, Routh and Nyquist criteria, root loci, design of lead, lag and lead-lag compensators, state-space representation of systems; time-delay systems; mechanical, hydraulic and pneumatic system components, synchro- pair, servo and stepper motors; on-off, P, P-I, P-I-D, cascade, feed-forward, and ratio controllers.

6. PRODUCTION AND INDUSTRIAL ENGINEERING

Basic Mechanisms and Elements of Design : Mechanisms, Friction, Gearing and Cams, Balancing, Vibration, Fundamentals of Design, Design of Basic Machine Elements, Design of Mechanical drives, Design of Automotive components, Recent Advances.

Casting, metal forming and metal joining processes : Casting Processes, Welding Processes, Special Casting Processes, Testing of Castings & Weldments - Fundamentals of Metal Forming, Forging and Rolling, Extrusion and Drawing Processes, Sheet Metal Forming Processes, Recent Advances, Mechanisms, Friction, Gearing and Cams, Balancing, Vibration, Fundamentals of Design, Design of Basic Machine Elements, Design of Mechanical drives, Design of Automotive components, Recent Advances.

Tool Engineering, Machine tool operation, Metrology and Inspection : Mechanics of Metal Cutting, Tool Material, Tool Wear and Tool Life, Gear Manufacture, General Concepts of measurements, Linear and Angular measurements, Measurement of Surface Finish Measuring Machines, Metrology of Screw Thread & Gears, Computer Aided Inspection and Laser Metrology - Strength and rigidity of machine tool structures, Sideways, Spindles and spindle supports, Machine Tool Dynamics.

Engineering Materials : Introduction and Constitution of Alloys and Phase Diagrams, Heat Treatment, Ferrous and Non Ferrous Metals, Mechanical Properties and Testing, Welding and Foundry Metallurgy, Manufacturing Processes for Plastic, Mechanical, Chemical and Electro-chemical energy based processes, Electrical Energy based Waste Processes, Thermal Energy Process, Polymer Matrix Composites, Metal Matrix Composites, Ceramics Matrix Composites, Advances in Polymers & Composites.

Product and Process Design, Design of Jigs and Fixtures and Press Tools : Product Design Concepts, Recent Advances, Process Planning, Estimating, Costing and Elements of Cost, Analysis of Overhead Expenses, Estimation of Costs for Forging, Casting and Welding, Estimation of Machining Time, Purpose Types and Functions Of Jigs and Fixtures, Jigs, Fixtures, Press working Terminologies and Elements of dies and Strip Layout, Design and Development of Dies.

CAD/CAM and CIM: Computer Aided Design, Computer Graphics, Geometric Modelling, Rapid Prototyping, Concept & Programming of CNC machines, Robotics-anatomy and specifications, Automated production lines, GT and FMS.

Operations Research: Linear Programming, Transportation, Assignment CPM/PERT, Inventory Models, Decision Analysis, Game Theory, Waiting Line Models.

Operations Management: Concept of Productivity, Method Study and work measurement, Ergonomics, Forecasting, Aggregate Planning, Capacity Management, MRP, Production Activity Control, Estimation and Costing, Costing Methods.

Quality, Reliability and Maintenance : Quality Concepts, Total Quality Management and Six Sigma Concepts, Statistical Process Control, Process Capability Analysis, Acceptance Sampling, Reliability Concepts, Failure Data Modeling, Reliability Prediction and Modeling, Maintenance Concept, Maintenance Models, Total Productive Maintenance.