RESEARCH ADMISSIONS
Phd Degree (Automotive Engineering)

(Jointly offered by VIT and ARAI)
1. General Information

1.1. The design and development of present day automobiles lay more emphasis on safety, alternative fuels, alternative power train, better emission control technologies and fuel efficiency.

1.2. R&D efforts in this field need to address issues such as emission control, noise, vibration and harshness, design of power plants, advanced automotive materials, structural dynamics, electronic control systems, mechatronics, information technology, etc.

1.3. VIT University and ARAI having recognized the need to carry out cutting-edge research in the aforementioned areas have signed an MoU to jointly offer research programmes leading to award of Ph.D degrees.

1.4. VIT has a pool of qualified faculty capable of imparting theoretical knowledge in aforementioned and allied engineering subjects. VIT University has world class infrastructure and laboratories in Mechanical Engineering, Electrical Engineering, Electronics and Computer Sciences. Further, VIT is setting up a Centre of Excellence in Automotive and Manufacturing involving leading Automotive Industries and USA Universities.

1.5. ARAI has state-of-the-art facilities and experts specialized in various areas like Power train, Alternate fuels, Emissions, Safety & Homologation, Passive Safety, Vehicle Evaluation, Automotive Electronics, Noise Vibration & Harshness (NVH), Computer Aided Engineering (CAE), Structural Dynamics, Automotive Materials and Calibration. ARAIAcademy has an excellent Learning Centre, Training Centre, Knowledge Centre and Computer Centre.

2. Areas of Ph.D offered under this joint programme

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<th>Automotive Materials &amp; Manufacturing and Structural / Vehicle Dynamics</th>
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<td>• Engine Material and Failures Analysis</td>
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<td>• Engine Testing and Clarification</td>
<td>• Advanced Manufacturing Technology</td>
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<td>• Automotive Fuels and Emissions</td>
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<td>• Engine Design and Development</td>
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<td>• Fuels Lubricants &amp; Coolant</td>
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<td>• Automotive Transmission</td>
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<th>Safety, Lighting and Component &amp; Vehicle Testing</th>
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<td>• Automotive Safety</td>
<td>• Fundamentals of NVH</td>
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<td>• Automotive Lighting</td>
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<th>Electronics &amp; Embedded Systems, Electric &amp; Hybrid Vehicles</th>
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<td>• Automotive Real Time Embedded Systems</td>
<td>• 2 / 3 Wheeler Technology</td>
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<td>• Model Based Design &amp; RPT</td>
<td>• Off Highway</td>
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<td>• HVAC</td>
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3. **Minimum Qualification For Admission**:
   
i Master’s degree in Engineering/Technology in Mechanical Engineering/Automotive Engineering/Electrical and Electronics/Electronics and Communication. or

ii Equivalent qualifications like M.Sc. (Engineering) / M.S. [By Research.]

*For all the Research Programmes it is mandatory that the candidate should have studied in regular, full time and formal education.*

4. **Categories**:

   The doctoral programme will be offered in part-time mode for sponsored candidates by industry and in full-time mode for others. The candidates who join under full-time mode are eligible to receive a stipend from VIT as per its rules and regulations.

5. **Minimum Period of Registration**:

   The minimum period of study and research from the date of registration for the Ph.D programme to the date of submission of thesis will be 30 months for full-time research scholars and 36 months for part-time Research Scholars.

6. **Selection Procedure**:

   The candidates, who satisfy the criteria prescribed, will be called for a written test and / or interview to be conducted jointly by VIT and ARAI. Selection will be based on the academic performance and the performance in the test and interview.

7. **Fees**:

   a. Application fee : Rs. 900/-
   
b. Tuition fee
   
   i. Full Time Candidate : Rs.20,000/- annum
   
   ii. Sponsored Candidate by industry : Rs.1,30,000/- annum in the first two years and Rs. 20,000/- for the subsequent years.
   
c. Thesis/ Dissertation Fee : Rs.10,000/-
   
   *(To be paid at the time of submission of Synopsis & Thesis/Dissertation)*
   
d. 1. ARAI annual library fee : Rs.1000/-
   
   2. ARAI Academy Alumni Association fee : Rs.750/-
   
   *Fee once paid will not be refunded under any circumstances*

   The Candidates selected for admission have to pay the fees through a Demand Draft only. The Demand Draft should be drawn in favour of “**VIT University**” and payable at **Vellore** (only computerized DD will be accepted).

8. **Joining the Research Programme**:

   The candidates admitted to Ph.D degree programme will have to report to the Director PG - Admissions and then the Deputy Director Academic Research concerned. All original documents/ certificates should be submitted in the admissions office along with the tuition fee at the time of joining.

   **Guide**: The students of this programme will have one guide from VIT and one guide from ARAI. Those who came from industry can have another guide from the parent organization depending on the need and availability.
**Course Work:** The students need to compulsorily take a minimum of four courses (offered by the University or ARAI at PhD/Masters level), as advised by the doctoral committee and to sit for the examinations conducted by the COE and complete the same with an average of minimum *C grade* in the four courses. If not, the scholar shall repeat one or more courses till he achieves the prescribed minimum average. If the course prescribed by the doctoral committee is not offered either at VIT or ARAI it can be completed under the guidance mode. (Attendance is not compulsory; however, the candidate should write the mid-term and term-end exams along with the other students)

**Research:** The students will carry out their research work at VIT, ARAI or parent organization.

**Comprehensive Examination:** After the successful completion of the course work a registrant for the PhD degree is required to undergo a comprehensive examination within a maximum period of two years (preferably within one and half years) from the date of registration. The comprehensive examination will be conducted by the Doctoral Committee either at VIT or at ARAI. The objective of the comprehensive examination is to test the general capability of the Research Scholar and breadth and depth of his/her knowledge in his/her discipline and areas related to his/her field of research.

**Paper Publication:** It is mandatory that the candidate publishes at least one paper based on his/her thesis work in a refereed journal of repute before submitting his/her synopsis.

**Colloquium:** The candidate should give at least one colloquium on his/her thesis work in the Centre/School before submitting the synopsis.

**Synopsis Meeting:** When the thesis is nearly ready for submission, the candidate shall submit the synopsis of his/her research work through the Guide(s) and Dean of the School to the academic section for consideration of the Doctoral Committee. The candidate should present the synopsis before the Doctoral Committee. The Doctoral Committee will, if it approves the work reported in the synopsis, permit the Research Scholar to submit the thesis.

**Thesis Submission:** The candidate shall within one month of acceptance of the synopsis submit four copies of the thesis embodying the results of his/her investigation and also five copies of a one-page abstract of the thesis.

**Thesis Defense/Viva-Voce Examination:**
Candidates are required to take an oral examination on the thesis at VIT. At the oral examination, the candidate will first give a seminar on his/her thesis work. The oral examination board then examines the candidate on his/her thesis work. The candidate is expected to answer satisfactorily all the questions raised by the thesis examiners, members of the oral examination board and the general audience present for oral examination. The oral examination board would, then, evaluate the performance of the candidate as ‘Satisfactory’ or ‘Not Satisfactory’.

**Award of PhD Degree:**
Based on the recommendation of the oral examination board, the Institute would award the PhD degree to the candidate after due approvals by the Academic Council and the Board of Management.
10. Important Dates:

- Issue of Application form: 12.05.2014
- Last date for Receipt of Application forms: 14.06.2014
- Date of Written exam:
  - Venue: VIT, Vellore campus and ARAI, Pune
  - 28.06.2014
- Date of interview:
  - Venue: ARAI campus
  - 10.07.2014
- Declaration of result: Within one week after the interview

11. Instructions for Completing the Application Form:

i. The name should be entered as in the Degree Certificate. Change in name/Initial, if any, should be supported by Gazette notification.

ii. Recent passport size photograph should be affixed in the application on the space provided and the same should be attested by a competent authority.

iii. They should indicate clearly the School/Centre and Area of research in the space provided in the application form.

iv. Applications from candidates who are currently employed must be routed through their employers.

v. Attested copies of the following documents must be enclosed with the completed application form.
   a. First page of SSLC / Higher Secondary / Matriculation or its equivalent certificate
   b. All marks sheets / grade cards, degree certificates beginning from first degree towards proof of qualification. (Original certificates should not be enclosed)
   c. Transfer certificate from the Institution last attended.
   d. Service certificate from the present employer (This is a must for all applicants under External Part Time category.)

viii. Applications received without the above documents will not be considered and no correspondence thereof will be entertained.

ix. The completed application form with “ADMISSION TO PhD PROGRAMME” superscribed on the cover should reach the office of The Director PG-Admissions, VIT University, Vellore 632014, Tamil Nadu, India, on or before June 14, 2014.

9. Other Information:

- All suits and actions arising out of or relating to VIT University shall be instituted within the jurisdiction of courts at Vellore, Tamil Nadu.

- Further correspondence / enquiry can be made to the Director PG-Admissions over phone, (No. +91-(0) 416-220 4600, 4700) or in person between 8.30 am & 5.30 pm on all working days except Saturdays & Sundays.
SYLLABUS FOR THE Ph.D. ENTRANCE TEST (MECHANICAL ENGINEERING)

**Engineering Mathematics**
Geometry Equations of straight line, common normal between straight lines in space;
Equations of circles, ellipse, etc.; Parametric representation.

**Linear Algebra**
Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

**Calculus**
Functions of single variable, Limit, continuity and differentiability, Mean value theorems,
Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima
and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives,

**Differential equations**
First order equations (linear and nonlinear), Higher order linear differential equations with
constant coefficients, Cauchy’s and Euler’s equations, Initial and boundary value problems,
Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace
equation.

**Control Theory**
Open and closed loop systems; Laplace transforms; Transfer function; Block Diagram
analysis; Concepts of stability; Input signals and system response; Nyquist stability criterion;
Bode plot.

**Probability and Statistics**
Definitions of probability and sampling theorems, Conditional probability, Mean, median,
mode and standard deviation, Permutations and combinations, Random variables, Poisson,
Normal and Binomial distributions. Properties of normal curve; Statistical quality control

**APPLIED MECHANICS AND DESIGN**

**Engineering Mechanics**
Free body diagrams and equilibrium; trusses and frames; virtual work; kinematics and
dynamics of particles and of rigid bodies in plane motion, including impulse and momentum
(linear and angular) and energy formulations; impact.

**Strength of Materials**
Stress and strain, stress-strain relationship and elastic constants, Mohr’s circle for plane stress
and plane strain, thin cylinders; shear force and bending moment diagrams; bending and
shear stresses; deflection of beams; thermal stresses.

**Theory of Machines**
Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of
slider-crank mechanism; flywheels.

**Vibrations**
Free and forced vibration of single degree of freedom systems; effect of damping; vibration
isolation; resonance, critical speeds of shafts.

**Technical drafting**
Engineering drawing practice; Indian standards for technical drawing. Machine Elements
Basic concepts of machine elements and their design; Stress concentration factor; Fatigue
Strength and S-N curve; failure theories.

**FLUID MECHANICS AND THERMAL SCIENCES**

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

**Heat Transfer**
Modes of heat transfer; one dimensional heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, radiative heat transfer, black and grey surfaces, shape factors; heat exchanger performance, LMTD and NTU methods.

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

**Applications**

**Power Engineering**

**Refrigeration and air-conditioning**
Vapour refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle; moist air psychrometric chart, basic psychrometric processes.

**Turbo machinery**
Pelton-wheel, Francis and Kaplan turbines, impulse and reaction principles, velocity diagrams.

**MANUFACTURING AND INDUSTRIAL ENGINEERING**

**Engineering Materials**
Structure and properties of engineering materials, heat treatment, stress-strain diagrams for engineering materials.

**Metal Casting**
Design of patterns, moulds and cores; solidification and cooling; riser and gating design, design considerations.

**Forming**
Load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy.

**Joining**
Physics of welding, brazing and soldering; adhesive bonding.

**Machining and Machine Tool Operations**
Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures.
Metrology and Inspection
Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

Production Planning and Control
Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Inventory Control
Deterministic and probabilistic models; safety stock inventory control systems.

Operations Research
Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

SOME CURRENT TRENDS IN DESIGN AND MANUFACTURING
Mechatronics System Design
Pneumatic and hydraulic systems; Electro-pneumatic and electro-hydraulic systems; Pneumatic, hydraulic and electric motors and actuators; Concepts of microcontrollers, Feedback devices; Point-to-point, continuous-path and servo control; Types of CNC machines and robots. Programmable logic controllers; CNC and robot programming. Some current developments in modern machine tools, robotics, mechatronics; Basic topics related to micro-electro mechanical systems (MEMS).

Computer Integrated Manufacturing
Basic concepts of CAD/CAM and their integration tools. Exchange of product design and manufacturing data; CNC and robot programming methods. CAD/CAM Software and Virtual Product Development; Rapid Manufacturing Technologies; Concepts of Machine vision and Jigless manufacturing;

Computer Aided Engineering
Finite Element Methods; Computational Fluid Dynamics; Mechanical Systems Simulation; Tools for conventional mechanisms and MEMS design.

Automotive Engineering
Development in Bio-fuels, other alternative fuels and hydrogen as future fuel; Emission standards; Electronic injection systems; Passenger comfort and safety devices; Indian auto industry and Automotive vehicles in Indian market.
SYLLABUS FOR THE Ph.D. ENTRANCE TEST (Electrical and Electronics Engineering)

GROUP I: ENGINEERING MATHEMATICS
Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.
Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series.
Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green’s theorems.
Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy’s and Euler’s equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.
Complex variables: Analytic functions, Cauchy’s integral theorem and integral formula, Taylor’s and Laurent’ series, Residue theorem, solution integrals.
Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.
Transform Theory: Fourier transform, Laplace transform, Z-transform

GROUP II: ELECTRIC CIRCUITS
Network graph, KCL, KVL, node and mesh analysis, transient response of dc and ac networks; sinusoidal steady-state analysis, resonance, basic filter concepts; ideal current and voltage sources, Thevenin’s, Norton’s and Superposition and Maximum Power Transfer theorems, two-port networks, three phase circuits.

GROUP III: ELECTRICAL MACHINES
Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; autotransformer; energy conversion principles; DC machines - types, windings, generator characteristics, armature reaction and commutation, starting and speed control of motors; three phase induction motors - principles, types, performance characteristics, starting and speed control; single phase induction motors; synchronous machines - performance, regulation and parallel operation of generators, motor starting, characteristics and applications; servo and stepper motors.

GROUP IV: CONTROL SYSTEMS AND INSTRUMENTATION
Principles of feedback; transfer function; block diagrams; steady-state errors; Routh and Niquist techniques; Bode plots; root loci; lag, lead and lead-lag compensation; state space model; state transition matrix, controllability and observability. Classification of Instruments, Moving iron, Moving Coil, Permanent magnet, and Dynamometer types.
Thermal, Electrostatic Rectifier Instruments, Instrument transformers, CT, PT, Power measuring instruments, power factor, frequency meters and synchroscope. Measurement of low, medium and high resistances, AC and DC measuring bridges, Magnetic measurement. General Transducers voltage, current, phase angle, optical, Hall effect and Industrial transducers.

GROUP V: ANALOG AND DIGITAL ELECTRONICS
Characteristics of diodes, BJT, FET; amplifiers - biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers -characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits; multiplexer; Schmitt trigger; multi-vibrators; sample and hold circuits; A/D and D/A converters; 8-bit microprocessor basics, architecture, programming and interfacing.

GROUP VI: POWER ELECTRONICS AND DRIVES
Characteristics and ratings of different thyristor family devices, their turn on and turn off methods with their protection, series and parallel connection of SCRs and their derating, Controlled single phase and three phase rectifiers for different types of load viz. R, R-L, R-L-E, single phase and three phase voltage source and current source inverter, cycloconverter, choppers, PWM techniques, Characteristics and principle of AC and DC machines, Methods of conventional controls and application of static controls and microprocessor based controls for AC and DC machines. Basic concepts of adjustable speed dc and ac drives.

GROUP VII: POWER SYSTEM
Transmission line parameters; Representation of short, medium, and long transmission lines – ABCD parameters; Circle Diagram; Per Unit representation; 3-Φ system; Short Circuit Studies; Sequence Networks; Load-flow Studies – Gauss Seidel method, Newton-Raphson Method; Automatic Generation Control; Load-Frequency Control; Automatic Voltage Regulator; Power System Stability – Equal area criteria; Swing Equation; Optimal Load dispatch in Power System. Protection Schemes for Transformer, Generators and Transmission Lines.
SYLLABUS FOR THE Ph.D. ENTRANCE TEST (Electronics and Communication Engineering)

**Differential equations:**
First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy’s and Euler’s equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

**Complex variables:**
Analytic functions, Cauchy’s integral theorem and integral formula, Taylor’s and Laurent’ series, residue theorem, solution integrals.

**Probability and Statistics:**
Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

**Numerical Methods:**

**Transform Theory:**
Fourier transform, Laplace transform, Z-transform.

**Networks:**

**Electronic Devices:**

**Analog Circuits:**
**Digital circuits:**
Boolean algebra, minimization of Boolean functions, logic gates; digital IC families (TTL, ECL, MOS, CMOS, PMOS, NMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers, decoders, EPROMs and PLAs. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories, Microprocessor (8086): architecture, programming, memory and I/O interfacing, Microcontrollers (8051) architecture and Programming

**Signals and Systems:**

**Control Systems:**
Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.

**Communications:**
Basic information theory. Analog communication systems: Amplitude modulation and demodulation systems, Frequency modulation and demodulation Systems spectral analysis of these operations, Transmitters and Receivers; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwidth consideration and probability of error calculations for these schemes. Basics of TDMA, FDMA and CDMA and GSM, OFDM, Spread spectrum analysis. Optical Communication: in free space and fiber optic; Propagation of signals at HF, VHF, UHF and microwave frequency; Satellite Communication.

**Electromagnetics:**
Elements of vector calculus: divergence and curl; Gauss’ and Stokes’ theorems, Maxwell’s equations: differential and integral forms. Wave equation, poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; S parameters, pulse excitation.
SYLLABUS FOR THE Ph.D. ENTRANCE TEST (Automobile Engineering)

ENGINEERING MATHEMATICS

Basics
Geometry Equations of straight line, common normal between straight lines in space, Equations of circles, ellipse, etc., Parametric representation.

Linear Algebra
Matrix algebra, Systems of linear equations, Eigen values and Eigenvectors.

Calculus
Functions of single variable, Limit, Continuity and Differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and Minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives.

Differential equations
First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy’s and Euler’s equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Probability and Statistics
Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Permutations and combinations, Random variables, Poisson, Normal and Binomial distributions. Properties of normal curve; Statistical quality control

AUTOMOTIVE ENGINEERING SYSTEMS

Chassis & Body
Classification of vehicles, layout with reference to powertrain, steering location and drive, chassis, construction and details (frames, sub-frames, defects in frame, frameless vehicles, vehicle dimensions), details of chassis & body materials, Integrated body construction, BIW type and corresponding design parameters, Vehicle interior system (dash board & seating system), Cosole design, Pillar trims (Type A, B, C), head roofs.

Transmission & Driveline
Clutches, Fluid coupling and Torque convertors, problems on performance of automobile such as resistance to motion, tractive efforts, engine speed, power and acceleration requirements. Determination of gear box ratios for different vehicle applications, different types of gear boxes, Automatic transmission, Effect of driving thrust and torque-reaction, Hotchkiss drives, Torque tube drive, Radius rods, Propeller shaft, Universal joints, Final drive- different types, Two speed rear axle, Rear axle construction: full floating, three quarter floating and semi-floating arrangements, Differential: conventional type & Non-slip type, differential locks.

Front Axle & Steering
Front axle types, rigid axle and split axle, constructional details, materials, front wheel geometry viz., camber, castor, kingpin inclination, toe-in and toe-out, Wheel alignment and balancing, Condition for true rolling motion of road wheels during steering, Steering geometry, Ackermann and Davis steering, Construction details of steering linkages, Different types of steering gear
box, Steering linkages layout for conventional and independent suspensions, Turning radius, instantaneous centre, wheel wobble and shimmy, Over-steer and under-steer, Power and power assisted steering.

**Braking & Suspension**
Type of brakes, Principles of shoe brakes, Constructional details – materials, braking torque developed by leading and trailing shoes, Disc brake, drum brake theory, constructional details, advantages, Brake actuating systems, factors affecting brake performance, Parking & Exhaust brakes, power & power assisted brakes, Antilock Braking System (ABS), Testing of brakes, Thermal Considerations.

Types of suspension, factors influencing ride comfort, types of suspension springs (leaf & coil springs), independent suspension (front and rear), Rubber, Pneumatic, Hydro-elastic suspension, Shock absorbers, types of wheels, construction of wheel assembly, types of tires and constructional details, Static and rolling properties of pneumatic tires, tubeless tires and aspect ratio of tires.

**Automotive Electronics**
Components for electronic engine management system, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control, parameters to be controlled in SI and CI engines, Sensors & Actuators, Digital Engine Control System, Engine Management, Common Rail Direct injection System.

**Automotive Safety**
Active and passive safety, driver assistance systems, crash worthiness, Roll over, Ergonomics and Human response to Impact, Vehicle safety systems: Survival space requirements, Restraints systems, safety belts, Head restraints, Air bags, Seats, bumper, Safety glasses, Rear view mirrors, Warning devices, Hinges and latches etc.

**ENGINEERING MECHANICS AND DESIGN**
**Engineering Mechanics**
Free body diagrams and equilibrium, trusses and frames, virtual work, kinematics and dynamics of particles and of rigid bodies in plane motion, including impulse and momentum (linear and angular) and energy formulations, impact.

**Strength of Materials**
Stress and strain, Strain gauges, stress-strain relationship and elastic constants, Mohr’s circle for plane stress and plane strain, thin cylinders, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, fatigue & fracture, thermal stresses.

**Theory of Machines**
Displacement, velocity and acceleration analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, flywheels.

**Noise & Vibration**
Free and forced vibration of single degree of freedom systems, effect of damping, vibration isolation, resonance, critical speeds of shafts, Sound measurement, Human sensitivity and weighting factors, Combining sound sources, acoustic materials, legislation, testing &
instrumentation, Incab&passby noise norms, noise quality, Source ranking, Noise path analysis, Modal analysis.

**Technical Drafting**
Engineering drawing practice, Indian standards for technical drawing, Machine Elements Basic concepts of machine elements and their design, Stress concentration factor, Fatigue Strength and S-N curve, failure theories.

**CAD/CAE/CFD**

**FLUID MECHANICS AND THERMAL SCIENCES**

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

**Heat-Transfer**
Modes of heat transfer; one dimensional heat conduction, fins, dimensionless parameters in free and forced convective heat transfer, radiative heat transfer, black and grey surfaces, shape factors, heat exchanger performance, LMTD and NTU methods.

**Thermodynamics**
Zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, Carnot cycle, irreversibility and availability, behavior of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes, analysis of thermodynamic cycles related to energy conversion.

**HVAC**
Vapour refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle, moist air psychrometric chart, basic psychrometric processes.

**Powertrain Engineering - I.C. Engines**
Transportation needs, energy pathway, fuel air cycle, efficiency improvements, customer requirements, functional requirements, engine performance, engine design process, overall engine system parameters, engine characteristics, engine layout & configuration, drives and challenges, duty cycles, simulation, combustion & emission, measurement & emission control, gasoline, diesel, alternate fuels, fuel cells, electric & hybrid vehicles.
Functional requirements, failure modes and design considerations for Cylinder block, Cylinder head, Crank Train, Valve Train, intake & exhaust system, EGR, after-treatment devices, turbocharger & supercharger, cooling system, lubricating system, fuel systems, etc.

**AUTOMOTIVE MATERIALS & MANUFACTURING**

**Engineering Materials**
Structure and properties of engineering materials, heat treatment, stress-strain diagrams for engineering materials, iron-carbon diagram, cast iron, steel, aluminum, magnesium alloy, composites, polymers, Laser material processing.

**Materials in Manufacturing and Design:** Material selection on the basis of cost, strength, formability and machinability, Advanced strength analysis of heat-treated and cold-formed parts including axial, bending, shear and cyclic deformation, Correlations of functional specifications and process capabilities.

**Metal Casting & Forming**
Design of patterns, moulds and cores; solidification and cooling; riser and gating design, design considerations, Load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy

**Joining**
Physics of welding, brazing and soldering, adhesive bonding, riveting.

**Machining and Machine Tool Operations**
Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures.

**Metrology and Inspection**
GD&T, Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, alignment and testing methods, tolerance analysis in manufacturing and assembly.

**Application of Materials in Engine & Vehicles.**

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