

# **SYLLABUS FOR LAB ASSISTANT**

**(AUTOMOBILE ENG./MECHANIC DIESEL)**

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## Syllabus for Lab Assistant (Automobile)

### 1. Engineering Mechanics

#### Unit - I Basics of mechanics and force system

Significance and relevance of Mechanics, Applied mechanics, Statics, Dynamics. Space, time, mass, particle, flexible body and rigid body.

Scalar and vector quantity, Units of measurement (SI units) - Fundamental units and derived units.

Force - unit, representation as a vector and by Bow's notation, characteristics and effects of a force, Principle of transmissibility of force, Force system and its classification.

Resolution of a force - Orthogonal components of a force, moment of a force, Varignon's Theorem.

Composition of forces - Resultant, analytical method for determination of resultant for concurrent, non-concurrent and parallel co-planar force systems - Law of triangle, parallelogram and polygon of forces.

#### Unit- II Equilibrium

Equilibrium and Equilibrant, Free body and Free body diagram, Analytical and graphical methods of analysing equilibrium

Lami's Theorem - statement and explanation, Application for various engineering problems.

Types of beam, supports (simple, hinged, roller and fixed) and loads acting on beam (vertical and inclined point load, uniformly distributed load, couple),

Beam reaction for cantilever, simply supported beam with or without overhang - subjected to combination of Point load and uniformly distributed load.

Beam reaction graphically for simply supported beam subjected to vertical point loads only.

#### Unit- III Friction

Friction and its relevance in engineering, types and laws of friction, limiting equilibrium, limiting friction, co-efficient of friction, angle of friction, angle of repose, relation between co-efficient of friction and angle of friction.

Equilibrium of bodies on level surface subjected to force parallel and inclined to plane.

Equilibrium of bodies on inclined plane subjected to force parallel to the plane only.

#### Unit- IV Centroid and centre of gravity

Centroid of geometrical plane figures (square, rectangle, triangle, circle, semi-circle, quarter circle) Centroid of composite figures composed of not more than three geometrical figures

Centre of Gravity of simple solids (Cube, cuboid, cone, cylinder, sphere, hemisphere) Centre of Gravity of composite solids composed of not more than two simple solids.

#### Unit - V Simple lifting machine

Simple lifting machine, load, effort, mechanical advantage, applications and advantages. Velocity ratio, efficiency of machines, law of machine.

Ideal machine, friction in machine, maximum Mechanical advantage and efficiency, reversible and non-reversible machines, conditions for reversibility. Velocity ratios of Simple axle and wheel, Differential axle and wheel, Worm and worm wheel, Single purchase and double purchase crab winch, Simple screw jack, Weston's differential pulley block, geared pulley block.

### 2. BASIC MECHANICAL ENGINEERING

UNIT-I: Introduction to Thermodynamics - Role of Thermodynamics in Engineering and Science, Types of Systems, Thermodynamic Equilibrium, Properties, State, Process and Cycle, Elementary introduction to Zeroth, First and Second laws of thermodynamics, Heat and Work

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Interactions for various non-flow and flow processes; Concept of Heat Engine, Heat Pump & Refrigerator, Efficiency/ COP; Kelvin-Planck and Clausius Statements, Carnot Cycle, Carnot Efficiency, T-S and P-V Diagrams, Concept of Entropy (Definition only).

**Unit-II: Heat transfer & Thermal Power Plant:** Modes of Heat Transfer; Conduction: Composite Walls and Cylinders, Combined Conduction and Convection: Overall Heat Transfer Co-efficient, Simple Numerical Problems: Thermal Power Plant Layout; Rankine Cycle; Fire Tube and Water Tube boilers, Babcock & Wilcox, Cochran Boilers;

**Unit-III: Steam Turbines:** Impulse and Reaction Turbines; Condensers: Jet & Surface Condensers, Cooling Towers; **Internal Combustion Engines and Refrigeration:** Otto, Diesel and Dual cycles; P-V and T-S Diagrams; IC Engines: 2 - Stroke and 4 - Stroke I.C. Engines, S.I. and C.I. Engines.

**Unit-IV: Materials and Manufacturing Processes:** Engineering Materials, Classification and their Properties; Metal Casting, Moulding, Patterns, Metal Working: Hot Working and Cold Working, Metal Forming: Extrusion, Forging, Rolling, Drawing, Gas Welding, Arc Welding, Soldering, and Brazing.

**Unit-V: Machine Tools and Machining Processes:** Machine Tools: Lathe Machine and types, Lathe Operations, Milling Machine and types, Milling Operations, Shaper and Planer Machines: Differences, Quick-Return Motion Mechanism, Drilling Machine: Operations, Grinding Machine: Operations

### 3. FLUID MECHANICS & HYDRAULIC MACHINERY

**UNIT-I: Properties of fluid:** Density, Specific gravity, Specific Weight, Specific Volume, Dynamic Viscosity, Kinematic Viscosity, Surface tension, Capillarity, Vapour Pressure, Compressibility.

**Fluid Pressure & Pressure Measurement:** Fluid pressure, Pressure head, Pressure intensity, Concept of vacuum and gauge pressures, atmospheric pressure, absolute pressure, Simple and differential manometers, Bourdan pressure gauge, Concept of Total pressure on immersed bodies, center of pressure, Simple problems on Manometers.

**Unit-II: Fluid Flow:** Types of fluid flows, Path line and Stream line, Continuity equation, Bernoulli's theorem, Principle of operation of Venturimeter, Orifice meter and Pitot tube, Derivations for discharge, coefficient of discharge and numerical problems.

**Flow Through Pipes:** Laminar and turbulent flows; Darcy's equation and Chezy's equation for frictional losses, Minor losses in pipes, Hydraulic gradient and total gradient line, Numerical problems to estimate major and minor losses

**Unit-III: Impact of jets:** Impact of jet on fixed vertical, moving vertical flat plates, Impact of jet on curved vanes with special reference to turbines & pumps, Simple Numericals on work done and efficiency.

**Unit-IV: Hydraulic Turbines:** Layout of hydroelectric power plant, Features of Hydroelectric power plant, Classification of hydraulic turbines, Selection of turbine on the basis of head and discharge available, Construction and working principle of Pelton wheel, Francis and Kaplan turbines, Draft tubes - types and construction, Concept of cavitation in turbines, Calculation of Work done, Power, efficiency of turbines, Unit quantities and simple numericals.

**Unit-V: Centrifugal Pumps:** Principle of working and applications, Types of casings and impellers, Concept of multistage, Priming and its methods, Cavitation, Manometric head, Work done, Manometric efficiency, Overall efficiency. Numericals on calculations of overall efficiency and power required to drive pumps.

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**Reciprocating Pumps:** Construction, working principle and applications of single and double acting reciprocating pumps, Concept of Slip, Negative slip, Cavitation and separation.

#### 4. THERMAL ENGINEERING - I

**UNIT-I: Sources of Energy:** Brief description of energy Sources: Classification of energy sources Renewable, Non-Renewable; Fossil fuels, including CNG, LPG; Solar Energy: Flat plate and concentrating collectors & its applications (Solar Water Heater, Photovoltaic Cell, Solar Distillation); Wind Energy; Tidal Energy; Ocean Thermal Energy; Geothermal Energy; Biogas, Biomass, Bio-diesel; Hydraulic Energy, Nuclear Energy; Fuel cell.

**Unit-II: Internal Combustion Engines:** Assumptions made in air standard cycle analysis; Brief description of Carnot, Otto and Diesel cycles with P-V and T-S diagrams; Internal and external combustion engines; advantages of I.C. engines over external combustion engines; classification of I.C. engines; neat sketch of I.C. engine indicating component parts; Function of each part and materials used for the component parts - Cylinder, crank case, crank pin, crank, crank shaft, connecting rod, wrist pin, piston, cooling pins cylinder heads, exhaust valve, inlet valve; Working of four-stroke and two-stroke petrol and diesel engines; Comparison of two stroke and four stroke engines; Comparison of C.I. and S.I. engines; Valve timing and port timing diagrams for four stroke and two stroke engines.

**Unit-III: I.C. Engine Systems:** Fuel system of Petrol engines; Principle of operation of simple and Zenith carburettors; Fuel system of Diesel engines; Types of injectors and fuel pumps; Cooling system air cooling, water cooling system with thermo siphon method of circulation and water cooling system with radiator and forced circulation (description with line diagram). Comparison of air cooling and water cooling system; Ignition systems - Battery coil ignition and magneto ignition (description and working). Comparison of two systems; Types of lubricating systems used in I.C. engines with line diagram; Types of governing of I.C. engines - hit and miss method, quantitative method, qualitative method and combination methods of governing; their applications; Objective of super charging.

**Unit-IV: Performance of I.C. Engines:** Brake power; Indicated power; Frictional power; Brake and Indicated mean effective pressures; Brake and Indicated thermal efficiencies; Mechanical efficiency; Relative efficiency; Performance test; Morse test; Heat balance sheet; Methods of determination of B.P., I.P. and F.P.; Simple numerical problems on performance of I.C. engines.

**Unit-V: Air Compressors:** Functions of air compressor; Uses of compressed air; Types of air compressors; Single stage reciprocating air compressor - its construction and working (with line diagram) using P-V diagram; Multi stage compressors - Advantages over single stage compressors; Rotary compressors: Centrifugal compressor, axial flow type compressor and vane type compressors.

**Refrigeration & Air-conditioning:** Refrigeration; Refrigerant; COP; Air Refrigeration system: components, working & applications; Vapour Compression system: components, working & applications; Air conditioning; Classification of Air-conditioning systems; Comfort and Industrial Air-Conditioning; Window Air-Conditioner; Summer Air-Conditioning system, Winter Air-Conditioning system, Year-round Air-Conditioning system.

#### 5. THEORY OF MACHINES & MECHANISMS

**UNIT I: Cams and Followers:** Concept; Definition and application of Cams and Followers; Classification of Cams and Followers; Different follower motions and their displacement diagrams like uniform velocity, SHM, uniform acceleration and Retardation; Drawing of profile of radial cam with knife-edge and roller follower with and without offset with reciprocating motion (graphical method).

**UNIT II: Power Transmission:** Types of Drives - Belt, Chain, Rope, Gear drives & their comparison; Belt Drives - flat belt, V-belt & its applications; Material for flat and V-belt; Angle of lap, Belt length, Slip and Creep; Determination of Velocity Ratio, Ratio of tight side

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and slack side tension; Centrifugal tension and Initial tension; Condition for maximum power transmission (Simple numericals); Chain Drives – Advantages & Disadvantages; Selection of Chain & Sprocket wheels; Methods of lubrication; Gear Drives – Spur gear terminology; Types of gears and gear trains, their selection for different applications; Train value & Velocity ratio for compound, reverted and simple epicyclic gear train; Methods of lubrication; Law of gearing; Rope Drives – Types, applications, advantages & limitations of Steel ropes.

**UNIT III: Flywheel and Governors:** Flywheel - Concept, function and application of flywheel with the help of turning moment diagram for single cylinder 4-Stroke I.C. Engine (no Numericals); Co-efficient of fluctuation of energy, Coefficient of fluctuation of speed and its significance; Governors  
- Types and explanation with neat sketches (Centrifugal, Watt and Porter); Concept, function and applications & Terminology of Governors; Comparison between Flywheel and Governor.

**UNIT IV: Brakes, Dynamometers, Clutches & Bearings:** Function of brakes and dynamometers; Types of brakes and Dynamometers; Comparison between brakes and dynamometers; Construction and working of i) shoe brake, ii) Band Brake, iii) Internal expanding shoe brake iv) Disc Brake; Concept of Self Locking & Self energizing brakes; Numerical problems to find braking force and braking torque for shoe & band brakes; Construction and working of i) Rope Brake Dynamometer, ii) Hydraulic Dynamometer, iii) Eddy current Dynamometers; Clutches- Uniform pressure and Uniform Wear theories; Function of Clutch and its application; Construction and working of i) Single plate clutch, ii) Multiplate clutch, iii) Centrifugal Clutch iv) Cone clutch and v) Diaphragm clutch. (Simple numericals on single and Multiplate clutch); Bearings – i) Simple Pivot, ii) Collar Bearing, iii) Conical pivot. Torque & power lost in friction (no derivation). Simple numericals.

**UNIT V: Balancing & Vibrations:** Concept of balancing; Balancing of single rotating mass; Graphical method for balancing of several masses revolving in same plane; Concept and terminology used in vibrations, Causes of vibrations in machines; their harmful effects and remedies.

## 6. Introduction to basic structure of an automobile

**UNIT-I: Introduction to basic structure of an automobile:** Basic engine components; Cylinder block; Cylinder head; Gaskets; cylinder liners, types of cylinder liners; Piston and piston pin; piston rings, types of piston rings; Connecting rod; Crank shaft; Cam shaft; Crankcase; Engine valves; Fly-wheel and Governor.

**Unit-II: Cooling and lubrication system:** The necessity of cooling system; Types of cooling system - air cooling and water cooling; Air cooling system; Types of water cooling system - Thermosyphon system and pump circulation system; Advantages and disadvantages of air cooling and water cooling systems; The components of water cooling system - fan, radiator, pump and thermostat; The necessity of lubrication system; S.A.E rating of lubrication system; Types of lubrication system; Petrol lubrication and high pressure lubrication system.

**Fuel feed system:** Conventional fuels and alternative fuels: Cetane and octane numbers; Types of carburettors; Working of simple carburettor; Multi point and single point fuel injection systems; Different fuel transfer pumps; Working of S.U electrical and A.C mechanical pump; Fuel filters; Fuel injection pump; Fuel injectors.

**Unit-III: Ignition system:** Introduction to ignition system; Battery Ignition systems and magneto Ignition system; Electronic Ignition system; Construction and working of lead acid battery; Elements of charging system; Elements of starting system; Types of lights used in the automobile;

**Transmission and steering system:** General arrangement of clutch; Principle of friction clutches; Constructional details of Single plate clutch; Constructional details of multi-plate

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clutch; Constructional details of centrifugal clutch; Necessity for gear ratios in transmission; Types of gear boxes; Working of sliding mesh gear box; Working of constant mesh gear box; Working of propeller shaft Working of propeller shaft; Working of universal joint; Working of differential; Types of rear axle; Purpose of front axle; Necessity of steering system; Caster, camber and king pin inclination; Rack and pinion steering system; Power steering.

**Unit-IV: Suspension system:** Necessity of suspension system; Torsion bar suspension systems; Leaf spring and coil spring suspension system; Independent suspension for front wheel and rear wheel; Working of telescopic shock absorber; Functions of brakes; Types of brakes; Working of internal expanding brake; Working of disc brake

**Unit-V: Special vehicles:** Introduction to Special vehicles; Tractor; Motor grader; Scrappers; Excavators; Duper trucks.

## 7. Automobile Transmission System:

### Unit-1.0 Introduction to Automobile Transmission System

Major assemblies – their locations and functions, Flow of power transmitted in front wheel drive, rear wheel drive and four wheel drive, Different layout of chassis, Advantages and disadvantages of various chassis layout, Different types of frame, Frame construction and material, Loads acting on frame.

### Unit-2.0 Clutch

Principle, function and requirements of Clutch, Construction and functions of different types of clutches– single plate, multi-plate clutches dry & wet clutches, centrifugal clutch and diaphragm clutch, Clutch actuating mechanism-Hydraulic & mechanical clutch linkage, Materials used for clutch lining, Fluid coupling- principle, construction and working, Maintenance of clutch: checking clutch plate for thickness, run out, Check pressure plate for wear, scoring and warpage, free and seated height of pressure springs, Check clutch shaft for bent and distorted splines, procedure of clutch adjustment, Cause and remedies for clutch slip, clutch noise, clutch grab and chatter.

### Unit-3.0 Gear Box

Function and necessity of Gear Box, Construction and functions of Sliding mesh, Constant mesh, Synchromesh, Epicyclical train & automatic transmission, Lubrication of gear box, Operation of Gear shifting mechanisms with line diagram of motion flow, Concept of semiautomatic and automatic transmission, Transmission control system:

- Automatic transmission control
- Continuously Variable Transmission (CVT) control
- Dual-clutch transmission (DCT) control

Torque converter and overdrive- construction & working, Maintenance of gearbox , Cause and remedies for gear box noise, hard gear shifting.

### Unit-4.0 Propeller Shaft and Universal Joint

Need of propeller shaft, universal joint and slip joint, Construction & functions of various types of propeller shafts, Construction & functions of various types of universal joints-Constant velocity Joints- Rzeppa Joint, Tripod Joint, Function and construction of slip joint, Construction of Hotchkiss drive and torque tube drive, Maintenance of propeller shaft and universal joint assembly.

### Unit-5.0 Final Drive, Differential and Rear Axle

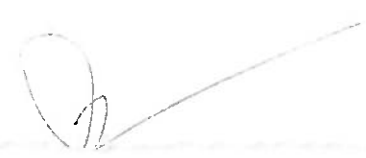
Principle, Necessity and function of final drive and differential, Construction & functions of final drive, Types of rear axles- semi - floating, three quarter floating and full floating type, Loads acting on rear axle, Maintenance of Final drive, Differential and rear axle

### Unit-6.0 Wheels and Tires

Various types of wheels, Salient features of wheels, Salient features of different types of rims, Types of tires, Constructional details of tube and tubeless tires, Tire retreading procedure, Rating of tire, Factors affecting life of tire, Tire rotation and Tire specification, General Maintenance of wheel assembly and Greasing of wheel hub, Care of wheels and tires, procedure of wheel alignment, procedure of wheel balancing.

## 8. Auto-Component Manufacturing Process

Unit-1.0 Basics of Manufacturing Processes



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Nature, role and scope of manufacturing process, Classification, Selection and Applications of each manufacturing processes, Fundamentals of Basic Machine Tools, Working principle and operation of: lathe, milling, drilling, shaper, planer and grinding machine, Factors affecting the selection of suitable Machine tool.

#### Unit-2.0 Metal Casting Processes

Basics and classification of metal casting methods, Working principles of sand casting, Types of patterns, allowances and pattern materials, Types of moulding sands and its properties, Introduction about Gating system, Working of melting furnaces, Working principles and manufacturing methods for piston, piston rings, cylinder block, carburetors, engine head, oil pan, wet and dry liners, Casting defects & remedial measures.

#### Unit-3.0 Metal Working Processes

Fundamentals and classification of metal working methods, Hot and cold working processes, Working principles of: Rolling, Blanking, Piercing, Wire and Tube Drawing, Spinning, Forging, Bending, Embossing and Extrusion and applications of each processes in automobile, Forging hand tools, forging methods and forging sequences for auto components –connecting rod, crankshafts, camshafts, valve, piston pin and spanners, Defects observed in cold and hot working processes & its Remedial measures, Classification, construction and working principle of press machine, Material used in press work for automobile industry.

#### Unit-4.0 Metal Joining Processes

Basics and classification of metal joining methods, Types of Welding joints, Working principles, application, and limitations of Gas Welding, Arc Welding, Special welding processes such as TIG, MIG, friction welding, Resistance Welding, Laser beam welding and Electron beam welding, Working principle of Soldering, Brazing and Braze Welding, Defects and Remedial Measures in Welding.

#### UNIT 5.0 Surface Treatment Processes

Surface Cleaning Processes: acid alkaline, electrolytic cleaning, blasting and tumbling, Metallic Surface Coating: Electroplating, Galvanizing, Metal Spraying and Powder Coating, Surface finishing methods: honing, buffing, lapping and polishing.

#### Unit-6.0 Modern Manufacturing Processes

Classification, comparison between conventional and non- conventional machining processes, Need and Role of Automation in manufacturing of automobile industry, Basic concepts of NC, CNC, DNC, CIM, GT, FMS, Application of Automated Material handling tools like AGVs, AS/RS and Robots, Working principles, applications, and limitations of Electrical Discharge Machining (EDM), Ultrasonic Machining (USM), Abrasive Jet Machining (AJM), Laser Beam Machining (LBM), Electron Beam Machining (EBM), Classification, basic principles and need of Additive Manufacturing.

### 9. Automobile Engine:

#### Unit-1.0 Engine principles and Fundamentals

Introduction, Basic engine nomenclature, Classification of automobile engines, Engine specifications and application, Merits and Demerits of vertical and horizontal engines, Four stroke SI and CI engine, Two stroke cycle engine, Comparison of two stroke and four stroke cycle engines, Reasons for using single cylinder two stroke and four stroke cycle engines.

#### Unit-2.0 Constructional Features of Automobile Engine Components

Cylinder block, cylinder liner, types of liner, comparison of dry and wet liners, cylinder head, gaskets, type of gaskets etc, Piston, piston rings, Piston ring joints, piston pin, Crank shaft, camshaft, connecting rod, valve, valve cooling, valve mechanisms, valve timing, port-timing diagram, manifolds, silencers, flywheel etc, Types of camshaft drives, Rotary and reed valve.

#### Unit-3.0 Engine Cooling and Lubrication System

##### Part A

Necessity and Function of engine cooling system, Cooling Systems- Air cooling system, water cooling systems, Comparison of air- & water-cooling systems, Parts of cooling system:

- Thermostat, water expansion tank, Temperature Indicator Pressure cap, water pump, fan and fan belt.
- Radiator: Construction and type of radiator cores.
- Types and Characteristics of a Coolant, and their effect on performance of engine cooling;

##### Part B

Lubrication system: Need, Properties and additives of lubricating oil, Parts to be lubricated, Classification of

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Lubricating Oils on the basis of Viscosity (SAE) and Load (API) Severity rating, Types of lubrication system: Splash, Pressure – wet sump and dry sump, Function of Components: Oil filters, Pump and its drive, pressure regulator, oil pressure gauge.

#### Unit-4.0 Fuel Systems

**Part A-Petrol Engine** Fuel feed system in petrol engines, Mechanical fuel pump, electrical fuel pump, Principles of carburetion, Simple Carburetor, Starting, Idling & slow running, acceleration, Main metering system, choke system, S.U. Carburetor, Solex Carburetor, Carburetors used in two wheelers and four wheelers.

#### Part B- Diesel engine

Requirement of fuel injection system, Various components & Diesel Fuel injection system, Types of fuel injection pumps for single and multi-cylinder engines, inline and rotary types of fuel injection pumps, Types of fuel injectors, Air fuel mixture ratio in a petrol and diesel engine and comparison, Mixture requirement for Transient conditions.

#### Unit-5.0 Engine Performance and Testing

Engine Power – Indicated, Brake and Frictional Power, Efficiency- Mechanical, Thermal, Relative and Volumetric, Fuel Consumption- BSFC, Morse test, Motoring test, Heat Balance Sheet.

### 10. Automobile Control System:

#### Unit-1.0 Introduction to Automobile Control Systems

Basics of control systems, Types of control systems used in automobiles, Open-loop vs. closed-loop control systems, Components of an automobile control system

#### Unit-2.0 Brake and Braking Control System

Purpose and requirement of brakes, Layout of braking system, Component of brake, Construction and working of mechanical, hydraulic, Air braking system and Exhaust brake, Construction and working of Disc brake and drum brake and their materials, Brake fluid, Brake shoes and brake clearance, Friction materials and its characteristics, Braking Control Systems:

- Antilock braking system (ABS)
- Electronic Brake-force Distribution (EBD)
- Traction Control System (TCS)

#### Unit-3.0 Steering and front axle

Purpose and requirement, Steering mechanism and function, Steering geometry- camber, caster, king pin inclination, toe in and toe out, Ackerman principle of steering mechanism, Constructional details of steering gear box - Rack & pinion and Re-circulating ball type, Worm and roller types' steering gear box, Power steering necessity, construction and working, Types of front axle- Dead axle, Live axle, Types of stub axle arrangements- Elliot, Reverse Elliot, Lemoine type

#### Unit-4.0 Suspension and its Control System

Purpose and function of suspension system, Classification of suspension system, Types- Rigid and independent suspension system, Shock absorber construction and working, Different type of spring- Torsion bar, Air spring, Leaf spring, Coil spring, Hydrodynamic spring, Air suspension system, Suspension Control Systems:

- Electronic Stability Control (ESC)
- Adaptive Suspension Systems

#### Unit - 5.0 Sensors and Actuators

Role and types of sensors used in Automobiles (e.g., speed sensors, temperature sensors, pressure sensors, Position sensors, Air flow measurement sensor, Combustion knock sensors, Exhaust Oxygen level sensor etc.), Actuators and their functions (e.g., fuel injectors, throttle actuators, brake actuators, etc.)