DETAILED SYLLABUS FOR THE POST OF JUNIOR INSTRUCTOR (MECHANIC AUTO ELECTRICAL AND ELECTRONICS)

(Cat.No.: 461/2021)

(Total Marks - 100)

1. AUTOMOBILE WORKSHOP TECHNOLOGY

Basic first aid, safety signs - for Danger, Warning, caution & personal safety message. Safe handling of Fuel Spillage, Fire extinguishers used for different types of fire. Safe disposal of toxic dust, safe handling and Periodic testing of lifting equipment, Authorization of Moving & road testing vehicles. Energy conservation-Definition, Energy Conservation Opportunities (ECOs)-Minor ECOs and Medium ECOs, Major ECOs), Safety disposal of Used engine oil, Electrical safety tips.

Study of Hand & Power Tools. Marking scheme, Marking material-chalk, Prussian blue. Cleaning tools- Scraper, wire brush, Emery paper, Description, care and use of Surface plates, steel rule, measuring tape, try square. Calipers-inside and outside. Dividers, surface gauges, scriber, punches-prick punch, center punch, pin punch, hollow punch, number and letter punch. Chisel-flat, crosscut. Hammer- ball pein, lump, mallet. Screw drivers-blade screwdriver, Phillips screw driver, Ratchet screwdriver. Allen key, bench vice & Cclamps, Spanners- ring spanner, open end spanner & the combination spanner, universal adjustable open end spanner. Sockets & accessories, Pliers - Combination pliers, multi grip, long nose, flat-nose, Nippers or pincer pliers, Side cutters, Tin snips, Circlip pliers, external circlips pliers. Air impact wrench, air ratchet, wrenches- Torque wrenches, pipe wrenches, car jet washers Pipe flaring & cutting tool, pullers-Gear and bearing.

Micrometers- Outside and depth micrometer, Micrometer adjustments, Vernier calipers, Telescope gauges, Dial bore gauges, Dial indicators, straightedge, feeler gauge, thread pitch gauge, vacuum gauge, tire pressure gauge.

Study of different types of screws, nuts, studs & bolts, locking devices, Such as lock nuts, cotter, split pins, keys, circlips, lock rings, lock washers and locating where they are used. Washers & chemical compounds can be used to help secure these fasteners. Function of Gaskets, Selection of materials for gaskets and packing, oil seals. Cutting tools Study of different type of cutting tools like Hacksaw, File-

Definition, parts of a file, specification, Grade, shape, different type of cut and uses., OFF-hand grinding with sander, bench and pedestal grinders, safety precautions while grinding. Limits, Fits &Tolerances:- Definition of limits, fits & tolerances with examples used in auto components

Description and study of Bench type Drilling machine, Portable electrical Drilling machine, drill holding devices, Work Holding devices, Drill bits. Taps and Dies: Hand Taps and wrenches, Calculation of Tap drill sizes for metric and inch taps. Different type of Die and Die stock. Screw extractors. Hand Reamers - Different Type of hand reamers, Drill size for reaming, Lapping, Lapping abrasives, type of Laps.

State the various common metal Sheets used in Sheet Metal shop Sheet metal operations - Shearing, bending, Drawing, SqueezingSheet metal joints - Hem & Seam Joints Fastening Methods -Riveting, soldering, Brazing. fluxes used on common joints. Sheet and wire-gauges. The blow lamp- its uses and pipe fittings.

(10 Marks)

2. BASIC AUTOMOBILE ENGINEERING

Auto Industry - History, leading manufacturers, development in automobile industry, trends, new product. Brief about Ministry of Road transport & Highways, The Automotive Research Association of India (ARAI), National Automotive Testing and R&D Infrastructure Project (NATRIP), & Automobile Association.

Basic engine terminology- TDC, BDC, Bore, Stroke, Swept volume, clearance volume, total volume, compression ratio. Working principle of 2-stroke and 4-stroke SI and CI engines. Comparison of SI and CI engine. Differentiate 2-stroke and 4-stroke engines. Classification of engine according to valve arrangement I-Head, L-Head, T- Head and F- Head engines. List out the components in valve operating mechanism. Valve timing diagram. Manifolds.

Different fuel feed system-AC mechanical pump and SU electrical pump. Petrol fuel filters, and air cleaners. Various air fuel ratios. Working of simple carburetors-classifications. Carburetors circuits. Float, Choke, Idling, slow speed, Normal, acceleration pump. Introduction to Electronic Fuel Injection systems. Types of mufflers.

Component layout of a conventional diesel fuel system. Types of solid fuel injection system- Jerk and distributor. Working principle of Inline and distributor type FIP, fuel feed pump. Types of diesel fuel filter. Working principle of fuel injector, types of fuel injector. Introduction to CRDI. Governors – purpose and types (Pneumatic and centrifugal governors)

Properties of lubricating oil. Single and multi grade oils. Concept of lubrication, Working of engine lubrication. Engine lubrication system- Petroil, splash, pressure, dry sump and wet sump. Functions of oil cooler, oil filter, pressure relief valve. Cooling system, significance, Type-Air cooling system, thermo siphon system, pump circulation system, use of thermostat, type of radiator core, functions of radiator cap, types of coolants – antifreeze agents in coolant. Functions of cooling fans.

Definition: - Classification of vehicles on the basis of load as per central motor vehicle rule, wheels, final drive, and fuel used, axles, position of engine and steering transmission, body and load. Brief description and uses of Vehicle hoists -Two post and four post hoist, Engine hoists, Jacks, Stands. **(10 Marks)**

3. AUTOMOBILE CHASSIS

Chassis -Introduction, Constructional details, Types of frame. Frame for 2 wheeler, 3 wheelers, and 4 wheeler, frame sections, sub frames. Materials used. Introduction to Suspension systems, Types of front suspension for Two, three & four wheeler. Air suspension, Hydro-elastic suspension. Rear Suspension system, Types-.Introduction to springs and Shock absorbing devices, Types leaf coil, springs & their arrangements, Helper spring, Spring shackle – shackle pin , Telescopic type Shock – absorber, Hydraulic, gas filled type, Mono tube and Twin tube type, Basic suspension movements pitching, bouncing, rolling.

Introduction to Steering system & steering geometry, Principles of steering, Ackerman , Davis fifth wheel,Steering gear box – types, Worm & roller, worm & sector, Re-circulating ball, Rack & pinion, Steering linkages – arrangement – components Power steering – integral – linkage type, Collapsible type steering column. Wheel alignment –Factors affecting wheel alignment.

Introduction to Brake Systems , principle of operation, weight transfer principle, types of brakes– mechanical, hydraulic, pneumatic, servo brake, Air brake – vacuum

brake – fail safe brake – dual brake – anti lock brake, Drum and disc brake system – Internal expanding and externally contracting- Layout of brake system, mechanical Components, hydraulic – master cylinder, types– working principle – wheel cylinder – brake bleeding, brake shoe. Air brake – construction details – working – details components – servo brakes -working of servo brake – types, vacuum and air - disc brake – constructional details and working of engine exhaust brake.

(5 Marks)

4. AUTOMOBILE TRANSMISSION

Introduction - Various components required for a good transmission system. Principle of friction clutches. Constructional features and working of-Single plate dry clutch-Diaphragm clutch, Cone clutch,Centrifugal clutch-Semi centrifugal clutch-Vacuum clutch-Hydraulic clutch-Electro magnetic clutch-Over running clutches-Multiplate clutch (dry & wet)-Fluid fly wheel. Clutch disc – constructional details and functions of each part, Pressure plate – constructional details and functions of each part. Clutch operating mechanisms.

Introduction – Necessity and functions of a gearbox - constructional features & working of - Sliding mesh gearbox-Constant mesh gearbox-Synchro mesh gearbox-Progressive type gearbox - Epicyclic gearbox- Torque converter -Gear selector and shifting mechanisms, 2Wheeler transmissions-Gear drive Chain drive-V matic transmission, CVT& ECVT-Automatic transmission in cars. MODULE III Introduction of Propeller shaft, slip joint and universal joint-Torque tube drive-Hotchkiss drive-Variable velocity joints-Constant velocity joints-Front wheel drive-Differential mechanism-Locking differential - Limited slip differential-Rear Axles-types

Introduction of wheels & tyres-Wheels – wire – spoked wheel, disc wheel, and alloy cast wheel, composite wheel-Wheel specification-Tyres-Tyre specification-Tyre construction(cross sectional details).Tubeless tyre-Tyre treads patterns-Inflation pressure and its effects (both over & under inflation)-Factors affecting tyre performance. **(10 Marks)**

5. MATERIAL SCIENCE AND STRENGTH OF MATERIALS

Welding processes - Principles of Arc welding, brief description, classification and applications. Manual Metal Arc welding - principles, power sources, electrodes, welding parameters, edge preparation & fit up and welding techniques; Oxy -

Acetylene welding - principles, equipment, welding parameters, edge preparation & fit up and welding techniques; Mechanism of grain formation, effect of rate of cooling on grain size, effect of grain size on mechanical properties, factors promoting fine grain. Heat treatment of metals – cooling curve for pure iron – Need for heat treatment, Definition of heat treatment, Definition of Annealing, Normalizing, Hardening and tempering. Case hardening, Nitriding, Induction hardening and Flame Hardening process used in auto components. Alloy steels - need for alloying, alloying elements, effect of alloying on properties. Stain less steel – different types, specific properties and uses. Non-metallic materials – characteristics of plastics, fiberglass, and fiber reinforced plastics, synthetic polymers. Non-destructive Testing Methods- Importance of Nondestructive Testing In Automotive Industry, Definition of NDT, Liquid penetrant and Magnetic particle testing method - Portable Yoke method.

Mechanical properties, tensile strength, compressive strength, ductility, hardness, impact strength, fatigue, creep resistance, malleability, toughness etc., Definition and explanation of tensile, compressive and shear load, stress and strain, behavior of ductile material under tension – limit of proportionality, modulus of elasticity, elastic limit, yield point, ultimate stress, percentage elongation, percentage reduction in area. Explanation of the term working stress – relation between ultimate stress and working stress – factor of safety – need for factor of safety, commonly used values of factor of safety for members under static and dynamic load. **(5 Marks)**

6. HYDRAULICS AND PNEUMATICS

Introduction, Properties of Fluids- Importance of hydraulics. Density – specific weight – specific volume – specific gravity problems – viscosity – kinematic viscosity – Newton’s law of viscosity – types of fluids – compressibility – surface tension – capillarity Fluid pressure and its measurement Fluid pressure at a point – pressure head

Kinematics of fluid flow introduction – types of fluid flow – steady and unsteady flow – uniform and non-uniform flow – laminar and turbulent flow – compressible and incompressible flow – rate of flow or discharge – equation of continuity of a liquid flow – simple problems – energy of a liquid in motion – potential energy – kinetic

energy – pressure energy – total energy – total head of liquid in motion – Bernoulli's equation – simple problems – practical applications of Bernoulli's equation – venturimeter – Flow through Orifices, Notches& Pipes Orifices – types of orifices – Vena contracta – coefficient of contraction – coefficient of velocity – coefficient of discharge – problems Notches – types of notches – Rectangular notches – triangular notch – trapezoidal notch – discharge over notches

Definition of Pascal law, pressure, Force, viscosity. Description, symbols and application in automobile of Gear pump-Internal & External, single acting, double acting & Double ended cylinder; Directional control valves-2/2, 3/2, 4/2, 4/3 way valve, Pressure relief valve, Non return valve, Flow control valve used in automobile. Pneumatic Symbols, Description and function of air Reciprocating Compressor. Function of Air service unit (FRL-Filter, Regulator & Lubricator)

(5 Marks)

7. AUTO ELECTRICAL AND ELECTRONICS

Fuses & circuit breakers, Ballast resistor, Stripping wire insulation, cable colour codes and sizes, Resistors in Series circuits , Parallel circuits and Series-parallel circuits, Electrostatic effects, Capacitors and its applications, Capacitors in series and parallel.

Batteries & cells, Types of batteries. Brief description of lead acid and alkaline cell, Constructional details of lead acid cell, nickel alkaline cell, Active materials of lead acid cell, Chemical action of lead acid cell, Rating of Battery, Capacity of Battery – ampere hour and watt hour, Efficiency of Battery – ampere hour and watt hour, Effect of discharge rate on voltage and capacity ,Effect of temperature on voltage and capacity, Battery charging, Constant voltage, Constant current. Defects - Effect of overheating, Effect of overcharging, Dislocation of active material, sulphation, Internal short circuits, Corrosion / sulphation of terminals. Testing of Battery - Polarity test, State of charge, Specific gravity test by hydrometer, High rate discharge test by cell tester, Cadmium test, Lamp test Care and maintenance of battery - Topping up of Battery & other maintenance schedule, Storage of lead acid battery (in dry & wet condition), Stay Maintenance Free (SMF) batteries, Tubular battery.

GENERATOR & ALTERNATOR Introduction, Constructional details of automobile dynamo – special features of automobile dynamo Constructional details of alternator – special features of automobile alternator- Care & maintenance of alternator – Cooling, Lubrication. Charging System - Introduction – necessity, Types of Regulators – circuit diagram, Cut out, Voltage regulator, current regulator, – 3stage, Electronic voltage regulator in alternators . Starter motor & it’s drive mechanism -Introduction, Starting of I.C. Engine (Petrol & Diesel) – motor characteristics, Terms like Engine torque – motor torque – cranking speed – motor locked torque etc, , Starter motor – constructional features – special features of automobile starters, Care & maintenance of starter motors, Starter Motor Drives Necessity, Types of starter motor drives – mechanisms of - Standard Bendix drive, Folo-thru' Bendix drive, Over running clutch drive, Dyer drive, Pre-engaged type.

SPARK IGNITION SYSTEM Introduction, Types of ignition system – battery coil & magneto – study of coil ignition, Component study of ignition system - Ignition coil, Contact breaker points, Cam angle, Condenser, Distributor, Spark plug – types, Spark plug specifications, Spark advance & retard mechanism (centrifugal & vacuum), Magneto ignition system - Rotating armature & rotating magnet type, Polar inductor type. C.D. ignition system, Electronic ignition systems, Computer controlled ignition. Distributor less ignition system

Horn circuit, wiper circuit, power window components and circuit. Power door lock circuit, automatic door lock circuit, remote keyless entry system circuit, antitheft system, immobilizer system. Navigation system, Car radio and cassette player, car video

Discharge (HID) headlights. Headlight & dimmer circuits, Park & tail light circuits, Brake light circuits, turn signal circuit, Cornering lights, Fog lights circuit, interior lights- courtesy, reading and instrument panel lights, Smart lighting , Reverse lights

Description of wire size- Metric and American wire gauge (AWG), Importance of ground straps used in automotive wiring. Description of different type of terminals and connectors. Molded, multiple-wire hard shell, bulkhead, weather-pack, metri-pack, heat-shrink covered butt connectors. Importance of printed circuit boards, wiring harnesses, wiring diagrams and color codes and circuit numbering. Study of common electrical and electronic symbols used in wiring diagrams.

Voltage , Current, Resistance, Power and Energy. DC circuits, Ohm’s law, Problems related to Ohm’s law, Power and Energy. Series, Parellel and Combination connection of resistors. Faraday’s laws of electromagnetic induction. Fleming`s right hand rule, Single loop AC generator. Terms related to Ac circuits such as frequency, maximum value, average value, RMS value, form factor and Powerfactor. AC through resistance, inductance and capacitance

Description of Normally open, Normally closed, single pole single throw switch (SPST), ganged, and mercury switches used in Automobile circuit. Description of Relay, ISO Relays, Solenoids, Buzzers. Resistors- Description of different type of resistors and their colour codes.- Fixed, stepped, and variable resistors. Rheostat, Potentiometer. Description of Diodes, Diode identification and ratings, zener diodes, Avalanche diodes, Light emitting diodes, photo diodes and clamping diodes. Transistors- Description of NPN, PNP, field-effect transistor phototransistors. Description of Integrated circuits. Circuit protection devices- Description of fuses, different type of fuses- glass or ceramic, blade and bullet or cartridge fuses. Fusible links, maxi fuses, circuit breaker, Positive Temperature coefficient (PTC) resistor device. (**35 Marks)**

8. ADVANCED AUTOMOBILE ENGG

Electronic Diesel control, Electronic Diesel control systems, Common Rail Diesel Injection (CRDI) system, Hydraulically actuated electronically controlled unit injector (HEUI) diesel injection system. Sensors, actuators and ECU (Electronic Control Unit) used in Diesel Engines. Introduction to Electronic fuel injection (EFI) fuel supply system, Multi-point injection systems (MPI/MPFI), EFI air cleaners, Electronic mufflers, EFI fuel supply system components- Description of Fuel pumps, EFI sensors, Potentiometer, Auxiliary air valves, Idle speed control devices, Inertia sensors

Introduction to EFI Engine Management - EFI operation Modes of EFI, Idle speed control systems, Feedback &looping, Cold start systems, Air measurement, Air-flow monitoring, Variable intake manifold system, Electrical functions, EFI wiring diagram, Electronic control unit - ECU, EFI system ECU, Electronic control unit settings, Engine speed limiting, Malfunction indicator lamp. Importance of

Diagnostic Trouble Code (DTC) & its general format. Use of scan tool and retrievals of codes.

EFI sensors- Description, location and function of Intake Temperature sensor, Mass airflow sensor, Manifold absolute pressure sensor, Air vortex sensor, Fuel system sensor, Throttle position sensor, Exhaust gas oxygen sensor, Crank angle sensor, Hall effect voltage sensor.

Description and function of Airbags, Seatbelt, Vehicle safety systems, Crash sensors, Seat belt pre-tensioners, Tire pressure monitoring systems Integrated communications, Proximity sensors, Reflective displays, Global positioning satellites, Triangulation/ trilateration, Telematics. Application of Automotive bus system-currently used in cars: CAN (Control Area Network), LIN (Local Interconnect Network), FlexRay™ and MOST(Media Oriented Systems Transport)., Importance of E/E Architecture. (**10 Marks)**

9. AUTOMOTIVE AIR CONDITIONING

Heating Ventilation Air Conditioning (HVAC) legislation, Vehicle heating, ventilation & cooling systems, Basic air-conditioning principles, Air-conditioning capacity, Air-conditioning refrigerant, Humidity, Description and function of Fixed orifice, Control devices, Thermostatic expansion valve system, Thermal expansion valves, Air-conditioning compressors, Condensers & evaporators, Receiver drier, Lines & hoses, TX valve construction, Temperature monitoring thermostat, Refrigerants, Pressure switches, Heating elements. Air-conditioning ECU, Ambient air temperature sensor, Servo motors, Electric servo motors, Automatic climate control sensors, Evaporator temperature sensor, Blower speed control, Ventilation systems

(**5 Marks)**

10. FUELS AND COMBUSTION

Properties of SI and CI engine fuels –Properties of Petrol and Diesel, Properties and performances of LPG,CNG, Alcohol, Hydrogen and Bio-diesel, Bi-fuel and Dual fuel systems.

Stages of combustion in SI engines, P-θ Diagram, the effects of engine variables-ignition lag - flame propagation, abnormal combustion -detonation , pre-ignition& surface ignition

Stages of combustion in CI engines, P-θ Diagram, various air fuel ratios, delay period and variables affecting the delay period, Diesel knock and its control

Super charging, Effects of super charging, Methods of supercharging and turbo charging, Lean burn engines, Working of electric cars , hybrid vehicles, fuel cell vehicles. (**5 Marks)**

NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper.