FURTHER DETAILS REGARDING MAIN TOPICS OF PROGRAMME NO. 5/2013 (Item No. 13)
RESERVE SUB INSPECTOR TRAINEE / ARMED POLICE SUB INSPECTOR TRAINEE
(MOTOR TRANSPORT UNIT)
POLICE
(CATEGORY NO. 461/2010)

1 ***Study of I C Engines***

Different types of I.C.Engines. Different Systems in I.C. Engines, Engine components- Crankshaft, Piston, Connecting Rod, Flywheel, Engine Block etc. Fuel System: Air Fuel Ratio for different engine speeds in S.I. Engine AC – Mechanical Pump, Carburetion, Functions of Carburettor, Working – Solex Carburettor, S.V. Carburettor. Fuel System in Diesel Engine – Fuel Filters, Working of BOSCH pump. Injector and injection nozzle. Electronic fuel injection, working of coil ignition and magnetic ignition in S.I.Engine, Electronic Ignition System, Cooling System, Classification of cooling system, radiators, thermostat, temperature indicators, water pump, I.C.Engine Lubrication, properties of lubricants, splash system, forced system, Governing, Quantity governing, quality governing. Hit and miss governing, Emission from automobiles, Pollution from S.I.Engines, Pollution from C.I. Engines. Emission standards Euro II & III. Pollution control techniques. Noise Pollution, Noise reduction techniques. S.I. Engines Gasoline injection system (MPFI), Common Rail Direct Injection (CRDI) in C.I. Engines.

2 ***Automobile Running Gear***

Various components in transmission. Requirement for a good transmission system. Principle of friction clutches. Constructional features and working of single plate dry friction clutch; Diaphragm clutch, Cone clutch, Centrifugal clutch, Semi Centrifugal clutch, Vacuum clutch, Hydraulic clutch, Electromagnetic Clutch, Multiple clutch (Dry & Wet) Fluid flywheel, Clutch Disc – Constructional details and functions of each part. Clutch operating mechanism, Necessity and functions of gearbox. Gearbox construction and working of sliding mesh gearbox, constant mesh gearbox, Epicyclical gearbox. Torque converter. Gear selector and shifting mechanism. 2 wheeler transmission - Gear Drive, Chain Drive, V-matic transmission. C.V.T., Propeller shaft 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, Stub axles, wheel mountings, Types of live rear axles, semi floating, three quarter floating and full floating axles. Suspension. Leaf springs, Spring shackles, Independent suspension, air suspension, Steering mechanism, steering wheel, steering column, steering gears. Worm and sector, Rack and Pinion, recirculating ball, power steering, centre point steering, steering geometry,Camber, Caster, King Pin, inclination, Toe in and out. Types of wheels, Spoke wheel, Disc wheels, Cast wheels, Size of wheel, Wheel balancing, Tubeless and Tubed type tyres, Parts of tyre, Carcass bead, tread, side walls, Ply rating, Bias, Radial tyre material, tread pattern, Inflation pressure, tyre wear. Brakes – hydraulic, pneumatic, Mechanical, dual brake system, Master cylinder, wheel cylinder, leading and trailing brakes, Brake shoes, lining, Drum materials, Bleeding of brakes, antilocking brake system.

3 *Fluid Mechanics and Machinery*

Importance of hydraulics, Density, specific weight, specific volume, specific gravity, viscosity, kinetic 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, Pascal's Law, absolute, gauge, atmospheric and vacuum pressures, measurement of fluid pressure, Piezo meter tube, simple manometer, differential manometer, inverted differential manometer, Bourdon's tube pressure gauge, problems, total pressure, total pressure on immersed surface-horizontal, vertical, inclined, Kinematics of fluid flow, 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, Energy of a liquid in motion, potential energy, kinetic energy, pressure energy, total energy, total head of liquid in motion, Bernoulli's equation, practical applications of Bernoulli's equation, venturimeter, orifices, types of orifices, vena contracts, co-efficient of contraction, co-efficient of velocity , co-efficient of discharge, notches, types of notches, rectangular notches, triangular notches, trapezoidal notch, discharge over notches, flow through pipes, loss of head in pipes, majority energy losses, loss of energy due to friction, Darcy's formulae for loss of head in pipes, Chezys formulae for loss of head in pipes.

Centrifugal pump – working, priming, cavitations, efficiencies, discharge, power required to drive multi stage pumps, reciprocating pump – Types, comparison of centrifugal and reciprocating pump. Discharge, slip, power required, air vessels, Gear pumps, screw pumps, vane pumps, Lobe pumps, simple piston pumps, Hydraulic and Pneumatic system, Basic elements of hydraulic system, Flow control valves – types, gate, globe, butterfly valves, Non return valve – Application, Circuits of control valves, functions, classifications. Describe the

working of pressure control valves, types, sliding spool type. Check valves, 1 way, 2 way, 3 way directional control valves. Solenoid control valve, Comparison of pneumatic system with hydraulic system. Identification of standard pneumatic symbols, Basic pneumatic system, air filter, pressure regulator, lubricator, mugglers, air cylinders, types, light, medium, heavy, tandem, duplex, double end types.

4 *Thermodynamics*

Thermodynamic system, thermodynamic properties, boundary state, processes, internal energy, flow of work, heat, enthalpy, first and second law of thermodynamics. Specific heat at constant volume and at constant pressure. Establish the relationship between specific heat and gas constant. Derivation of formulae for work, heat, change in internal energy, relation between pressure, volume and temperature during constant volume. Constant pressure, constant temperature, adiabatic and polytropic processes. Power developed in IC engines, Indicator diagram and measurement of mean effective pressure. Engine indicators, indicated power, brake power, friction power, indicated thermal efficiency, volumetric efficiency, specific fuel consumption, Morse text and preparation of heat balance sheet. Air compressor, use of compressed air, classification of air compressors – working of single stage and multi stage air compressors - Inter cooler. Principles of heat transfer – Modes of heat transfer and field of application of heat transfer, Thermal conduction, Fourier's law of thermal conduction, thermal conductivity, condition through plain wall, composite plain wall - simple problems. Thermal radiation, reflection, absorption and transmission of radiation. Absorptivity, reflectivity and transmitivity. Concept of black body, concept of grey. Free convection, and forced convection. Basic principles and heat exchanger. Evaporator and condenser.

5 *Strength of Materials*

(i) Direct stresses and strain

Types of stresses and strain – Tensile and Compressive – Longitudinal and Lateral strain, Poisson's ratio – behavior of mild steel under tension, Stress – strain diagram, Limit of proportionality – elastic limits – yield points – Ultimate stress – Working stress – factor of safety – comparison of stress strain, diagram of mild steel and a brittle material - Hook's Law and Youngi modulus – Principles of super position – Stresses in varying sections – Stresses in composite section-Simple problems.

(ii) Shear stress and sheer strain

Shear stress and strain – modulus of rigidity – volumetric strain, bulk modulus.

(iii) Thermal stress and strain

Natural and magnitude of stress due to change in temperature –total or partial prevention of expansion and contraction – temperature stresses on composite bar.

(iv) Friction : Introduction, types of friction, static friction, dynamic friction, sliding friction, rolling friction, pivot friction, limiting friction, angle of friction, co-efficient of friction, cone of friction, state laws of friction, Static friction and kinetic friction. Force analysis of a sliding body resting on a horizontal plane – Force acting along plane and at an angle.

(v) Centre of gravity of sections

Centroids – centre of gravity – axis of symmetry and axis of reference, methods to find centre of gravity, simple geometric sections as a rectangle, triangle, circle and semicircle sections, combinations of symmetrical sections such as T, I and channel sections, combinations of unsymmetrical sections such as L section – plane section with cut out holes.

(vi) Moments of inertia of sections:

Moments of inertia – radius of gyrations – methods to find moments of inertia – moments of inertia of rectangular and circular sections by integration method. Parallel axis theorem – Moments of inertia of standard geometric sections such as T, I, L and channel sections.

6 *Production process of Components*

Measuring instruments – classification, direct reading, indirect reading, Precision, non precision instruments – Micrometer, Vernier Micrometer, gauges, screw gauges, comparators, sine bar, vernier height gauges, sine bar, slip gauges. Foundry – Pattern making and materials, Classification of patterns and pattern allowances – Types of moulding and moulding operations – Green sand moulding, dry sand moulding, Plaster moulding, Shell moulding. Cast iron – types, methods of manufacture, casting methods, sand casting, permanent mould casting,

centrifugal casting, special casting, die casting – Steels – different process of steel making, open hearth process, Bessemer process, L-D process, Forging operations, Open hearth, closed hearth furnaces – Cold working process – Cold working, basic cold working operations like drawing, squeezing, bending shearing cutting and blanking, extruding, shot Peening. Hot working, rolling drawing, extruding. Welding – arc welding, principles of arc welding, welding machines and uses of arc welding, submerged arc welding, thermit welding, safety in welding, Gas welding, oxy acetylene welding, resistance welding, classification of resistance welding, TIG and MIG welding, soldering and brazing explanation and application of soldering and brazing advantages and limitations.

Machine tools – Lathe – types, Engine and tool room lathe, Lathe parts and functions. Cylindrical turning, taper calculations, measurements, taper turning methods. Tail stock set over and swiveling the tool post. Thread cutting basics. Other operations on lathe, drilling, boring, reaming, key way cutting, knurling. N.C. and C.N.C. machines, advantages of CNC systems over conventional systems. Drilling machines. Bench type, parts of a drilling machines. Shaping machines. Use of a shaper – shaper component and their functions. Quick return motion – crank and slotted lever – slotting machines. Uses of a slotter, slotter parts. Grinding – Grinding machines – uses and types, Grinding wheels – type – milling machine – use of milling machine – types of milling machine – principle, parts, different milling operations. Fundamentals of Gear manufacturing methods – Indexing methods – Gear milling, Gear hobbing.

7 *Electrical and Electronics Engineering*

Alternating current – production of alternating voltages, Mathematical representation. Explanation of cycle, period, frequency, RMS value, average value, maximum value, Form factor, vector representation of alternating quantities – Phase differences – Inductance and capacitance, Impedance, Current calculations in general RLC series circuit. Calculations of power factor inductance – capacitance – AC three resistance – 3 phase circuits, Star and Delta connections – Voltage and current relations. Expression for power transformers. Principles of operation of a single phase transformer, 3 phase transformer, Auto transformer. Principle, advantages and uses of welding transformer.

Electronic circuits - Logic circuits, Instrument Amplifier, Band width, Oscillator, Condition of Oscillator, Fundamentals of Digital Electronics, Logic Gates, AND, OR, NOT, XOR. Boolean Algebra, simplification of expressions, De-Morgans Theorem, K-Map, Universal Gates, NAND, NOR Electronic instruments – CRO, CRT, Digital Multimeter.

8 ***Engineering Materials***

Properties of Materials – Impact, Strength, fatigue, Creep resistance, Malleability, toughness etc. 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. Need for heat treatment. Description of different processes and their applications. Annealing, tempering, hardening, case hardening. Normalizing and nitriding. Alloy steels. Need for alloying elements. Effect of alloying on properties. Stainless steel - different types, specific properties, uses of types of steels. Non ferrous metals and alloys. Commercial specification and uses of alloys of copper, aluminium. Non metallic materials – Characteristics of plastic fibre glass and synthetic polymers.

9 ***Mathematics***

Co-ordinate Geometry:-

Straight line – slope, equation of a straight line in the forms

i) $y = mx + c$

ii) $y - y_1 = m(x - x_1)$

iii) $\frac{y - y_1}{y_1 - y_2} = \frac{x - x_1}{x_1 - x_2}$

iv) $\frac{x}{a} + \frac{y}{b} = 1$

Point of intersection of 2 lines. Angle between 2 lines. Condition for 2 lines to be parallel and perpendicular.

Methods of differentiation

Definition of derivative of x^n, Sin x, Cos x etc. by using first principle. Find derivative of x and log x. Fundamental formulae. Product and quotient number. Derivatives of other trigonometric functions. Simple problems.

Integration

Definition of integration, Fundamental problems. Integral of product of 2 functions, Formulae, Simple problems. Applications of integration. Finding areas between the curve y = f (x) and axes. Volume of Solid, problems.

Differential equation

Solution of equation of the forms variable separable Linear equation.

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.