

## ENGINEERING SCIENCE (867)

### This subject may not be taken with Physics.

The syllabus is designed for candidates who have followed a course with a bias towards engineering.

The examiners will attach importance to an understanding of scientific principles and will look for evidence that these have been studied practically. The examiners may ask to see the practical notebooks.

### CLASS XI

*There will be one paper of three hours duration of 100 marks.*

**Section A** of the paper will contain short answer questions, all of which are to be answered.

**Section B** of the paper will contain six questions of which candidates must answer five questions.

*Note: All questions will be set in the S.I. System. The unit abbreviations to be used in all question papers in this subject will be those contained in the Guide to the use of International System (SI) units SP; 5-1969 (Published by the Indian Standards Institution).*

1. Velocity and acceleration. Laws of motion. Force, mass and acceleration. Acceleration due to gravity. Measurement of  $g$ , including examples of bodies moving with variable acceleration, treated graphically.
2. Angular velocity and angular acceleration.
3. Composition and resolution of velocity. Simple problem on projectiles, involving combined horizontal and vertical motion.
4. Measurement and effects of force. Equilibrium of concurrent forces in plane. Parallelogram, triangle and polygon of forces. Reaction, resultant and equilibrant. Bow's notation. Equilibrium of body on inclined plane. Treatment by graphical and mathematical methods.
5. Moments. Application to parallel forces, levers, vertically loaded rigid beams. Centre of gravity: experimental determination and calculation in simple cases. Its relation to stability.
6. Pressure in liquids and its transmission. Principle of Archimedes; floatation. Density and specific gravity of solids and liquids. Simple hydraulic pumps and jacks. Lift and force pumps; the siphon.
7. Air Pressure. Boyle's law. Barometers. Manometers and the Bourdon gauge. The bicycle pump. (Details of the Fortin barometer are not required.)
8. Temperature and temperature scales.
9. Thermal expansion of solids, liquids and gases. Coefficient of linear expansion of solids and coefficient of cubical expansion of liquids and gases. Charles' law. Absolute temperature. (Questions will not be set on apparent coefficients of expansion).
10. Quantity of heat. Joule, Centigrade heat unit. Specific heat capacity of solids and liquids; their determination. Change of state. Latent heats: their determination. Melting and boiling points; the effect of pressure. Heat as a form of energy. Calorific value of fuels (excluding experimental determination).
11. Conduction, convection and radiation.
12. Conversion of heat to mechanical energy and vice versa. Mechanical equivalent of heat, including any one method of determination.

## CLASS XII

There will be one paper of three hours duration of 100 marks.

**Section A** of the paper will contain short answer questions, all of which are to be answered.

**Section B** of the paper will contain six questions of which candidates must answer five questions.

*Note: All questions will be set in the S.I. System. The unit abbreviations to be used in all question papers in this subject will be those contained in the Guide to the use of International System (SI) units SP; 5-1969 (Published by the Indian Standards Institution).*

- Strength of materials. Simple problems. Hooke's law, stress and strain. Young's modulus. Tension and compression. Elastic limit. Ultimate strength. Factors of safety.
- Friction. Conditions affecting friction. Lubrication. Conditions should include types of materials, their surface finish and wetness or dryness.
- Limiting friction. Coefficients of friction.
- Work. Work done by constant and by varying force; graphical representation of and calculations thereon. Energy, potential and kinetic. Conservation of energy and conversion into work, work done in rotation. Torque.
- Machines. Simple single-string pulley systems. Simple and differential wheel and axle. Weston pulley block. Screw jack. Worm (single start thread and wheel). Gear and belt drives. Velocity ratio, mechanical advantage and efficiency.
- Power. Simple treatment of steam and internal combustion engines. Indicators diagrams. Indicated mean effective pressure. Indicated and brake horsepower. Methods of measurement of power. Rope brake and Prony brake. Hydraulic power (as given by the product of constant pressure and rate of volume change). Mechanical efficiency. Relationship between rev/min and working strokes per minute in double-acting steam engines and in two and four-stroke internal combustion engines. The oscillating cylinder steam engine is not required.
- Momentum. Conservation of momentum, including rate of change of momentum and relationship with mass and acceleration. Knowledge of coefficient of restitution is not required.
- Magnetism. Magnetic properties of iron and steel. The magnetic circuit; qualitative treatment only, with examples from transformers and machines. The compass needle. Magnetic effect of current in straight wire, single turn coil and solenoid, treated qualitatively. Electromagnets and their simple applications. Relation of direction of current in conductor and lines of magnetic force applied. Examples of the application of electromagnets to include electric trembler bell and relay.
- The simple circuit. Conductors and insulators. Electromotive force, potential difference, current, quantity and resistance; the volt, ampere, coulomb ampere-hour and ohm. Ohm's law. Measurement of resistance, including Wheatstone bridge, Resistivity. Resistors in series and in parallel.
- Heating effect of current. Energy and power. Conversion of electrical to mechanical energy and vice versa. The joule, watt, and kilowatt-hour. Simple applications of heating effect. Effect of temperature on resistance. Temperature coefficient. Examples to include various domestic heating appliances and filament lamps.
- Chemical effect of current field. Electrolytes. Electrolysis. Electrochemical equivalent. Production of current by chemical action. Simple voltaic cell. Primary and secondary cells. Polarisation: prevention and removal. Cells in series and in parallel. Chemical equations are not required.
- Current-carrying conductor in magnetic field. The D.C. motor including series and shunt windings. Galvanometers, voltmeters and ammeters. Shunts and multipliers. A qualitative treatment of multiple D.C. motors is included.
- Electromagnetic induction: the laws of induction. Back e.m.f. of motor. Starting resistance for D.C. motor. Simple a.c. and D.C. generators. Relation of direction of lines of force, motion of conductor and current in coil. Eddy currents. Transformers. The induction coil; the coil ignition system. A qualitative treatment of multipole D.C. generators is included.