## BLUE PRINT

**Time Allowed**: 3 hours  
**Maximum Marks**: 70

<table>
<thead>
<tr>
<th>S. No.</th>
<th>CHAPTER</th>
<th>VSA (1 mark)</th>
<th>SA-I (2 marks)</th>
<th>SA-II (3 marks)</th>
<th>LA (5 marks)</th>
<th>Total</th>
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<tbody>
<tr>
<td>1.</td>
<td>Electrostatics</td>
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<td>6(2)</td>
<td>-</td>
<td>15(7)</td>
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<td>2.</td>
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<td>4(2)</td>
<td>3(1)</td>
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<td>3.</td>
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<td>-</td>
<td>3(1)</td>
<td>5(1)</td>
<td>16(5)</td>
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<td>4.</td>
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<td>6(2)</td>
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<td>5.</td>
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<td>6.</td>
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<td>7.</td>
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<td>1(1)</td>
<td>-</td>
<td>3(1)</td>
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<td>10(4)</td>
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<td>8.</td>
<td>Atoms and Nuclei</td>
<td>-</td>
<td>-</td>
<td>6(2)</td>
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<td>9.</td>
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<td>3(1)</td>
<td>5(1)</td>
<td>12(4)</td>
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<td>10.</td>
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<td>2(1)</td>
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<td><strong>Total</strong></td>
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<td>14(7)</td>
<td>36(12)</td>
<td>15(3)</td>
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</table>
PHYSICS

Time allowed : 3 hours

Maximum marks : 70

General Instructions:

(i) All questions are compulsory. There are 27 questions in all.
(ii) This question paper has four sections: Section A, Section B, Section C and Section D.
(iii) Section A contains five questions of one mark each, Section B contains seven questions of two marks each, Section C contains twelve questions of three marks each, and Section D contains three questions of five marks each.
(iv) There is no overall choice. However, internal choices have been provided in two questions of one mark, two questions of two marks, four questions of three marks and three questions of five marks weightage. You have to attempt only one of the choices in such questions.
(v) You may use the values of physical constants wherever necessary.

SECTION - A

1. Can there be a potential difference between two adjacent conductors carrying the same charge?
2. What are the factors on which the resistivity of a conductor depends?
3. Why does microwave oven heats up a food item containing water molecules most efficiently?

OR

Name the electromagnetic waves, which (i) maintain the Earth’s warmth and (ii) are used in aircraft navigation.

4. When monochromatic light travels from one medium to another its wavelength changes but frequency remains the same. Explain.
5. Obtain the energy in joules acquired by an electron beam when accelerated through a potential difference of 2000 V.

OR

The maximum kinetic energy of photo electrons emitted from a surface, when photons of energy 6 eV fall on it is 4 eV. What is the stopping potential (in Volt) for the fastest photoelectrons?

SECTION - B

6. Find the current drawn from a cell of e.m.f 1.5 V and internal resistance 0.5 Ω connected to the electrical network given below.
OR

Plot a graph showing temperature dependence of resistivity for a typical semiconductor. How is this behaviour explained?

7. Describe briefly, with the help of a circuit diagram, how a potentiometer is used to determine the internal resistance of a cell?

OR

The length of a potentiometer wire is 5 m. An electron experiences a force of $4.8 \times 10^{-19}$ newton in this wire. Find the e.m.f. of the battery used in potentiometer.

8. An a.c. source of voltage $V = V_m \sin \omega t$, is applied across a series LCR circuit. Draw the phasor diagrams for the circuit when the
   (i) capacitive impedance exceeds the inductive impedance.
   (ii) inductive impedance exceeds the capacitive impedance.

9. Name the electromagnetic waves used for studying crystal structure of solids. What is its frequency range?

10. (a) State the condition for total internal reflection.

12. A transmitting antenna at the top of a tower has a height of 45 m and the height of the receiving antenna is 80 m. Calculate the maximum distance between them for satisfactory communication in LOS mode. (Radius of the Earth = $6.4 \times 10^6$ m)

SECTION - C

13. Three charges of 0.1 C each are placed at the corners of an equilateral triangle of each side 1 m. If energy is supplied at the rate of 1 kW, how many days would be required to move the charge at $A$ to a point $D$, which is the midpoint of line $BC$?

14. An electric dipole of length 10 cm having charges $\pm 6 \times 10^{-3}$ C, placed at $30^\circ$ with respect to a uniform electric field experiences a torque of magnitude $6\sqrt{3}$ N m. Calculate (i) magnitude of electric field (ii) the potential energy of the dipole.

15. Two wires made of tinned copper having identical cross-section ($= 10^{-6}$ m$^2$) and lengths 10 cm and 15 cm are to be used as fuses. Show that the fuses will melt at the same value of current in each case.

16. A convex lens made of a material of refractive index $\mu_1$ is kept in a medium of refractive index $\mu_2$. Parallel rays of light are incident on the lens. Complete the path of rays of light emerging from the convex lens if
   (i) $\mu_1 > \mu_2$ (ii) $\mu_1 = \mu_2$ (iii) $\mu_1 < \mu_2$

OR

Draw a ray diagram to show the image formation in a refracting type astronomical telescope in the near point adjustment. Write down the expression for its magnifying power. Why should the diameter of the objective of telescope be larger?
17. In Young’s double slit experiment, explain with reason in each case, how the interference pattern changes, when
   (i) width of the slits is doubled
   (ii) separation between the slits is increased and
   (iii) screen is moved away from the plane of slits.

18. An infinitely long wire is bent into the shape as shown in figure. A current is passed through it as shown in figure. Calculate the magnetic field at the centre $O$ of circular loop.

OR

An electron having energy 10 eV is revolving in a plane perpendicular to a uniform magnetic field of $1.0 \times 10^{-4}$ Wb m$^{-2}$. Calculate the following:
   (i) Radius of the path of the electron
   (ii) Cyclotron frequency
   (iii) Time period of revolution of the electron
   (iv) Work done by the magnetic force

19. A circuit is set up by connecting $L = 100$ mH, $C = 5$ μF and $R = 100$ Ω in series. An alternating emf of $150 \frac{\sqrt{2}}{\pi}$ V, $\frac{500}{\pi}$ Hz is applied across this series combination. Calculate
   (a) The impedance of the circuit.
   (b) The peak value of the current flowing in the circuit.
   (c) The power factor of this circuit.

OR

When an inductor $L$ and a resistor $R$ in series are connected across a 12 V, 50 Hz supply, a current of 0.5 A flows in the circuit. The current differs in phase from applied voltage by $\pi/3$ radian. Calculate the value of $R$.

20. Calculate the emf induced in the rod when a rod of length $l$ is (a) translated (b) rotated in a uniform magnetic field of induction $B$ as shown in figure.

21. A source of light of frequency $\nu > \nu_0$ is placed at 2 m from the cathode of a photocell. The stopping potential is found to be $V_0$. If the distance of the light source is halved, state with reason what changes occur in
   (i) stopping potential
   (ii) photoelectric current, and
   (iii) maximum velocity of photoelectrons emitted.

22. Group the following six nuclides into three pairs of (i) isotones (ii) isotopes (iii) isobars

   $^6$C$^{12}$, $^2$He$^3$, $^{80}$Hg$^{198}$, $^1$H$^3$, $^{79}$Au$^{197}$, $^6$C$^{14}$

How does the size of nucleus depend on its mass number? Hence explain why the density of nuclear matter should be independent of the size of the nucleus?
23. The total energy of an electron in the first excited state of the hydrogen atom is about –3.4 eV.

(a) What is the kinetic energy of the electron in this state?
(b) What is the potential energy of the electron in this state?
(c) Which of the answers above would change if the choice of the zero of potential energy is changed?

OR

Obtain the first Bohr’s radius and the ground state energy of a muonic hydrogen atom [i.e., an atom in which a negatively charged muon ($\mu^{-}$) of mass about 207 $m_e$ orbits around a proton].

24. (a) Draw the circuit diagram of a full wave rectifier using p-n junction diode.
(b) Show the output waveforms ($Y$) for the following inputs $A$ and $B$ of
(i) OR gate  (ii) NAND gate

\[ \text{SECTION - D} \]

25. Using Biot Savart’s law, find an expression for the magnetic field at the centre of a circular coil of $N$ turns and radius $R$, carrying current $I$.

Sketch the magnetic field for a circular loop, clearly indicating the direction of the field.

OR

Derive an expression for the force experienced by a current carrying straight conductor placed in a magnetic field. Under what condition is this force maximum?

26. Draw a graph to show variation in the angle of deviation $\delta$ with the variation of angle of incidence $i$ for a monochromatic ray of light passing through a prism of refracting angle $A$. Deduce the relation $\mu = \frac{\sin \frac{A + \delta}{2}}{\sin \frac{A}{2}}$.

Answer the following questions:
(i) The angle subtended at the eye by an object is equal to the angle subtended at the eye by the virtual image produced by a magnifying glass. In what sense then does a magnifying glass provide angular magnification?
(ii) In viewing through a magnifying glass, one usually positions one’s eye very close to the lens. Does angular magnification change if the eye is moved back?
(iii) Magnifying power of a simple microscope is inversely proportional to the focal length of the lens. What then stops us from using a convex lens of smaller focal length and achieving greater magnifying power?
(iv) Why must both the objective and eye-piece of a compound microscope have short focal lengths?
(v) When viewing through a compound microscope, our eyes should be positioned not on the eye-piece but a short distance away from it for best viewing. Why? How much should be that short distance between the eye and eye-piece?

27. In a p-n junction diode, the current $I$ can be expressed as

$$I = I_0 \left[ \exp \left( \frac{eV}{k_B T} \right) - 1 \right]$$

where $I_0$ is called the reverse saturation current, $V$ is voltage across the diode and is positive for forward bias and negative for reverse bias and $I$ is current through the diode, $k_B$ is Boltzmann constant ($8.6 \times 10^{-5}$ eV K$^{-1}$) and $T$ is the absolute temperature. If for a given diode $I_0 = 5 \times 10^{-12}$ A and $T = 300$ K, then
(a) What will be the forward current at a forward voltage of 0.6 V?
(b) What will be the increase in the current if the voltage across the diode is increased to 0.7 V?
(c) What is the dynamic resistance?
(d) What will be the change in current if reverse bias voltage changes from 1 V to 2 V

OR

(a) Which special type of diode can act as a voltage regulator. Give the symbol of this diode and draw its V-I characteristics.
(b) A battery of emf 2 V is applied across the block of a semiconductor. The length of the block is 0.1 m and the area of cross-section is $1 \times 10^{-4}$ m$^2$. If the block is of intrinsic silicon at 300 K, find the electron and hole currents.
(c) What will be the magnitude of the total current?
(d) What will be the magnitude of the total current if germanium is used instead of silicon?

Given

For Si at 300 K
\[
\mu_e = 0.135 \text{ m}^2 \text{V}^{-1} \text{s}^{-1}, \quad \mu_h = 0.048 \text{ m}^2 \text{V}^{-1} \text{s}^{-1}, \quad n_i = 1.5 \times 10^{16} \text{ m}^{-3}
\]

For Ge at 300 K
\[
\mu_e = 0.39 \text{ m}^2 \text{V}^{-1} \text{s}^{-1}, \quad \mu_h = 0.19 \text{ m}^2 \text{V}^{-1} \text{s}^{-1}, \quad n_i = 2.4 \times 10^{19} \text{ m}^{-3}
\]