

BACHELOR OF SCIENCE EXAMINATION 2019(1ST Year, 1st Semester)**GENERIC ELECTIVE-1, PHYSICS**

Time: Two hours

Full marks: 50

Answer any **FIVE** questions.

1. (a) Define scalar field and vector field and give one example for each field.
- (b) Find the curl of the vector field, $\vec{V} = -y\hat{i} + x\hat{j}$.
- (c) Calculate the line integral, $\int \vec{V} \cdot d\vec{l}$ of the vector field $\vec{V} = -y^2\hat{i} + 2x(y+1)\hat{j}$, from the point (1,1,0) to the point (2,2,0) along the two routs, (i) (1,1,0) \rightarrow (2,1,0) \rightarrow (2,2,0), and (ii) (1,1,0) \rightarrow (2,2,0), through the direct straight line. (2+2)+2+(2+2)=10

2. (a) Using Gauss's theorem in electrostatics find the electric field due to a uniformly charged infinite cylinder.
- (b) Show that electrostatic field is conservative. What do you understand by equipotential surface?
- (c) The total charge within a sphere of radius r in a cloud is given by

$$q \frac{r^2}{a^2} (e^{-r/a} - e^{-2r/a}).$$

Determine the corresponding electrostatic potential and electric field.

3+4+3=10

3. (a) Obtain Coulomb's law from Gauss's theorem.
- (b) A thin circular ring of radius R carries a uniform surface charge density, σ . Calculate the electric potential and field at a point on the axis of the ring.
- (c) Find an expression for the mechanical force per unit area on the surface of charged conductor. 2+4+4=10
4. (a) By using the Biot-Savart's law, find the expression of magnetic field at a distance z from an infinite, straight wire carrying a steady current, I .
- (b) Find the expression of force per unit length between two parallel straight wires a distance d apart carrying steady currents I_1 and I_2 , respectively, along the same direction.

(c) Find the expression of magnetic field a distance z above the center of a circular loop of radius r , which carries a steady current I , with the help of Biot-Savart's law. 3+3+4=10

5. (a) By using the principle of conservation electric charge, derive the equation of continuity.

(b) Explain how Maxwell does fix the differential form of Ampere's law by introducing the concept of displacement current with the help of equation of continuity.

(c) Write down the Maxwell's equation with proper explanations.

(d) By using the Maxwell's equation obtain the differential form of the electromagnetic wave equation in vacuum. 2+3+2+3=10

6. (a) What are the conditions for observing sustained and distinct interference pattern?

(b) Show that bright and dark fringes are equally spaced in Young's double slit interference pattern.

(c) The diameter of the 10th dark ring in a Newton's ring experiment is 0.50 cm in the reflected system. Calculate the thickness of the air film at the position and also the radius of curvature of the lens. Wave length of the light is 5900 Angstrom. 2+5+3=10

7. (a) Distinguish between Fresnel and Fraunhofer class of diffraction.

(b) Find an expression for the intensity distribution due to a single slit Fraunhofer diffraction pattern.

(c) From the above relation find the positions of the diffraction minima. 2+6+2=10

8. (a) Explain the behavior of a p-n junction diode under forward and reverse bias.

(b) Design a bridge rectifier and explain its operation using a suitable diagram.

(c) What do you mean by the load-line and Q-point of a transistor? Draw the circuit diagram and output characteristics of a npn transistor in CE mode. 3+3+4=10

9. (a) State the characteristics of an ideal OP-AMP. Compare it with IC 741.

(b) Design a circuit using OP AMP whose output is given by $V_0=3V_1+2V_2$, where V_1 and V_2 are the two inputs.

(c) Draw the circuit diagram of an AND gate using diodes.

(d) Verify the Boolean identity: $A + B + A\bar{B}C + BC = A + B$ 3+3+2+2=10