SAMPLE QUESTIONS FOR PHYSICS HONOURS THIRD SEMESTER

UNIT-II: CURRENT ELECTRICITY-II

1. Define steady current.
2. Define drift velocity.
3. What is current density?
4. Write down the equation of continuity.
5. Write the differential form of Ohm's law.
6. What are the differences between drift current and diffusion current?
7. Define *circuit element, branch, network, loop, mesh, node or junction.*
8. State Kirchhoff's laws.
9. Show that Kirchhoff's current law is consistent with the law of conservation of charge and voltage law is consistent with the principle of conservation of energy.
10. Using Kirchhoff's laws, obtain an expression for the current through the galvanometer in an unbalanced Wheatstone bridge.
11. Discuss briefly on the *sensitivity* of Wheatstone bridge.
12. Discuss about the limitations of Wheatstone's bridge.
13. State Superposition theorem as applied to network analysis. Considering a simple resistive T-network and two DC sources, verify the validity of this theorem.
14. State and prove Thevenine's theorem as applied to network analysis.
15. State and prove Norton's theorem.
16. State and establish Maximum power transfer theorem.
17. Explain the term '*current source'.*
18. Give the underlying principle on which a platinum resistance thermometer works.
19. How can you measure the temperature co-efficient of resistance of a metal using Callender& Griffith Bridge? Give the constructional details of a platinum resistance thermometer and also discuss how can you determine the boiling point of a liquid using platinum resistance thermometer?
20. (a) A cube is formed by joining equal wires each of resistance R and a battery is connected to two opposite corners of a face of the cube. Find the effective resistance between these points.
    (b) A cube is formed by joining equal wires each of resistance R. Calculate the equivalent resistance between two corners on the same edge of the cube.
    (c) A cube is formed by joining equal wires each of resistance R. Calculate the equivalent resistance between the diagonally opposite corners of the cube.
21. Three cells are connected in parallel with similar poles connected together with wires of negligible resistances. The emf's of the cells are 2, 1 and 4 volts respectively and corresponding internal resistances are 4, 3 and 2 ohm. Find the current through the 4-volt cell.
22. Two cells of e. m. f.$e_1$ande_2 and internal resistances $r_1$and r_2 are connected in parallel to the ends of the wire of resistance R. Show that the current I in the wire is $= (e_1r_2 + e_2r_1)/(Rr_1 + Rr_2 + r_1r_2)$.
23. Two cells each of e. m. f. E and internal resistance r are connected in parallel across a variable load R. Find the value of the load for which the power delivered becomes maximum. Also find the maximum power.

24. Six identical wires each of resistance R are connected in the form of a regular tetrahedron. Find the equivalent resistance between any two corners of the tetrahedron.
25. A voltage source of internal resistance r delivers same power when connected separately to the loads R_1 and R_2. Show that $r = \sqrt{R_1 R_2}$.
26. State the principle on which a potentiometer works.
27. Using a potentiometer, how can you (i) compare the e. m. f.s of two cells, (ii) determine the internal resistance of a given cell, (iii) determine a very small current. In all cases, the necessary circuit diagram alongwith the working formula to be given.
28. **What is *electromagnetic induction*?**
29. **State Faraday's law (also known as Neumann's law) on electromagnetic induction.**
30. **State Lenz's law on electromagnetic induction.**
31. **Establish the differential form of Faraday's law.**
32. **What are *eddy currents* ? Write some of its applications.**
33. **Define Self inductance and mutual inductance.**
34. **Derive an expression for the self inductance of a long solenoid.**
35. **Show that the self inductance of solenoid of finite length is given as,**

$$L = \frac{\mu_0 N^2 A}{l}\sqrt{1 + (\frac{a}{l})^2} - \frac{a}{l}$$

36. **Derive expressions for self inductance of (i) a long co-axial cable (b) Two wire transmission line.**
37. **What is non-inductive winding?**
38. **Derive expressions for the mutual inductance for two parallel circular coaxial coils.**
39. **What is the co-efficient of coupling?**
40. **When is a winding said to be perfect, closely coupled and loosely coupled?**
41. **Derive an expression for equivalent inductances when two inductors L_1 and L_2 (mutual inductance between them being M) are connected in (i) series and (ii) parallel.**
42. **Show that the energy stored in an inductor is $\frac{1}{2}LI^2$, where I is the current through it. Or, Derive an expression for the energy stored in an inductor.**
43. (a) What is Ballistic galvanometer?
    (b) How does it differ from a dead-beat galvanometer?
    (c) Work-out the theory of working of a suspended coil type ballistic galvanometer.
    (d) Explain the meaning of *critical damping* and *log decrement.*
    (e) Define the term *'critical damping resistance'.*
    (f) Define '*current sensitivity'* and *'voltage sensitivity'* of the galvanometer.
    (g) Discuss the theory of determination of High Resistance by the method of leakage.
44. (a) Define *thermoelectricity*, *thermo e. m. f.*, *thermocouple*, *thermoelectric series* or *seebeck series*, *thermoelectric power*.
    (b) What is Seebeck effect?
    (c) What is Peltier effect?

(d) What is Thomson's effect?
(e) Explain all thermoelectric effects on the basis of *electron theory.*
(f) Draw the variation of thermo e. m. f. as a function of the temperature of the hot junction and hence define *neutral temperature* and *inversion temperature.*
(g) Establish a relation among neutral temperature and inversion temperature.
(h) What are the differences between Peltier effect and Joule's heating?
(i) Define Peltier coefficient? What is its unit?
(j) Define Thomson's coefficient? State its unit.
(k) Why is Thomson's co-efficient known as specific heat of electricity?
(l) State and explain two laws of thermoelectricity. Mention the important consequence of the law of intermediate metals.
(m) Applying thermodynamics in a thermocouple, establish the following relations:

(i) $\pi = T\frac{dE}{dT}$,

(ii) $\sigma_a - \sigma_b = -T\frac{d^2E}{dT^2}$

(n) What is thermoelectric diagram or Tait diagram?
(o) Show how thermoelectric diagram can be used to represent total Seebeck emf, Peltier and Thomson's coefficients, neutral and inversion temperatures.
(p) Mention some applications of thermoelectric effects.
(q) The thermoelectric power of silver and iron with respect to lead are given by $3.34 + 0.008t\ \mu V/^0$C and $16.65 - 0.030t\ \mu V/^0$C respectively. Calculate the e. m. f. of a Ag-Fe thermocouple with the junctions at 20^0C and 80^0C.

45. (a) What are transient currents?
(b) Why is no transient phenomena observed in a purely resistive circuit?
(c) Find the expressions for the growth a decay of current when an inductor L is connected in series with a resistor.
(d) Define time constant of LR circuit. What is its physical significance?
(e) A series RC circuit is excited by a source of constant voltage switches on at time$t = 0$. Find expressions for the growth of charge on the capacitor. If the source is suddenly withdrwan after the charge attained a steady value, find the expression for the charge on the capacitor again.
(f) Define the time constant in RC circuit.
(g) An e. m. f. is suddenly applied to a circuit containing a resistance, an inductance and a capacitance in series. Investigate the growth of the charge in the circuit. Point out the conditions for non-oscillatory and oscillatory growths. For the second case, obtain an expression for the frequency of oscillation of capacitor charge.
(h) What is meant by *critically damping resistance (CDR)?*
(i) Investigate the discharge of a capacitor in a series RLC circuit. Point out all the conditions of non-oscillatory and oscillatory decays. For the second case, obtain an expression for the frequency of oscillation.
(j) Examine whether the discharge of a charged capacitor of 0.1 μF through an inductive coil of inductance 100 mH and resistance 200 ohm is oscillatory or not. If it is oscillatory, then find the frequency of oscillation.

(k) In an oscillatory circuit, L =0.1 H, C= 0.047 μF, find the maximum value of the resistance so that the circuit may oscillate.

46. (a) What is alternating e. m. f. and alternating current?
(b) Derive an expression for the average value of alternating current/voltage for the positive half.
(c) What will be average value of alternating current/voltage for a complete cycle?
(d) Derive an expression for the r. m. s. value of alternating current/voltage.
(e) Define form factor. What are its values for AC and DC?
(f) Define Peak factor. What are its values for AC and DC?
(g) Why is 220 V AC more dangerous than 220 V DC?
(h) Derive an expression for the average power in Alternating circuit.
(i) What are power and Wattless components of currents?
(j) Define power factor in an AC circuit.
(k) Discuss the AC responses of resistance, an inductance and a capacitance.
(l) What is inductive reactance? Show graphically how it varies with the frequency of applied voltage.
(m) What is capacitive reactance? Show graphically how it varies with the frequency of applied voltage.
(n) What is the principle of 'Choking coil'?
(o) A sinusoidal e. m. f. is applied to a circuit containing an inductor and a resistor in series. Using rotating vectors/phasors method, derive expressions for the instantaneous current and power factor of the circuit.
(p) A sinusoidal e. m. f. is applied to a circuit containing a capacitor and a resistor in series. Using rotating vectors/phasors method, derive expressions for the instantaneous current and power factor of the circuit.
(q) A sinusoidal e. m. f. is applied to a circuit containing an inductor, a capacitor and a resistor in series. Using rotating vectors/phasors method, derive expressions for the instantaneous current and power factor of the circuit.
(r) Explain the term reactance and impedance of AC circuit.
(s) What is meant by 'resonance in series RLC circuit'?
(t) Find an expression for the resonant frequency.
(u) A series resonant circuit is known as an acceptor circuit-why?
(v) A series resonant circuit has the property of selectivity-explain.
(w) What is meant by the term 'sharpness of resonance'?
(x) Define quality factor.
(y) Define band width.
(z) Derive a relation between the Q-factor and the bandwidth.
47. (a) What is parallel resonant circuit?
(b) Why is it called a rejector circuit?

(c) Find an expression for the impedance of a parallel LC circuit.
(d) How does the impedance of a parallel LC circuit vary with the applied frequency?
(e) What is meant by the Q-factor of this circuit?
(f) Distinguish between the series resonant and parallel resonant circuit.

48. (a) What is a transformer?
(b) Establish the transformer equation in an ideal transformer.
(c) What is auto-transformer?

49. A series LCR circuit has L = 1 mH, C = 0.1 μF and R = 1 ohm. Find the resonant frequency and the bandwidth of the output power.

50. A step-up ideal transformer has a primary to secondary turns ratio 2 : 25, if the primary voltage is 220 V and the transformers supplies 1 A current to an external load, find the output power.