054(E)

(JULY, 2009)

Time : 3.00 Hours] *[Maximum Marks : 100*

Instructions :

(1) This question paper contains **60** questions. **All** the questions are **compulsory**.
(2) Use log table or simple calculator if necessary.
(3) Symbols (in this question paper) have their ususal meanings.
(4) Begin new section on **new** page. Write answers in sequence.

SECTION - A

*Question numbers from sl. **1** to **16** are objective type (multiple choice) carrying **1** mark each. Select the correct option.* **16**

1. The dimensions of Permittivity [ε_0] are ..... . Take Q as dimension of charge.

(A) $M^1L^{-2}T^{-2}Q^{-2}$ (B) $M^{-1}L^2T^{-3}Q^{-1}$

(C) $M^{-1}L^{-3}T^2Q^2$ (D) $M^{-1}L^3T^{-2}Q^{-2}$

2. The resistance of a 10 meter long potentiometer wire is 20 Ω. It is connected in series with a 3 V battery and 10 Ω resistor. The potential difference between two points on the wire seperated from each other by a distance 50 cm is equal to .....

(A) 0.06 V (B) 0.5 V

(C) 0.1 V (D) 1.2 V

3. If a Proton is moving with velocity 3×10^5 ms^{-1} at an angle 30° in a magnetic field of 0.3 T, then the radius of curvature of its trajectory will be .....

(for Proton $e/m = 10^8$ C/kg.)

(A) 0.5 cm (B) 0.02 cm

(C) 2 cm (D) 0.866 cm

4. A bar magnet has magnetic dipole moment M. Its initial position is parallel to a uniform magnetic field. In this position, the torque and force acting on it are ...

(A) 0, 0 (B) $\vec{M} \times \vec{B}$ and MB

(C) $\vec{M} \cdot \vec{B}$ and MB (D) None of these

5. The self inductance of a coil of 600 turns and some radius is 108 mH. Then the self inductance of an identical coil having 500 turns will be ..... mH.

(A) 90 (B) 75

(C) 155 (D) 130

6. The maximum value of $\vec{E}$ in an electro magnetic wave is equal to $18\,Vm^{-1}$, then the maximum value of $\vec{B}$ will be equal to .....

(A) 11×10^{-11} T (B) 9×10^{-9} T

(C) 6×10^{-8} T (D) 4×10^{-6} T

7. An image of an object obtained by convex mirror is n times smaller than object, if focal length of lens is f, object distance would be .....

(A) $\frac{f}{n}$ (B) $\frac{f}{n-1}$

(C) $(n-1)f$ (D) nf

8. The distance between two slits in Young's experiment is 0.1 mm and the distance of the screen from the slit is 100 cm. If the wavelength of height is 5000 Å, the width of fringe is .....

(A) 5 mm (B) 5 cm

(C) 2.5 mm (D) 2.5 cm

9. When α-particles are accelerated under the p.d. of V volt, their de-Broglie's wavelength is ..... Å. Mass of α-particle is 6.4×10^{-27} kg. and its charge is 3.2×10^{-19} C.

(A) $\frac{0.287}{\sqrt{V}}$ (B) $\frac{12.27}{\sqrt{V}}$

(C) $\frac{0.103}{\sqrt{V}}$ (D) $\frac{1.22}{\sqrt{V}}$

10. Half life of a radioactive element is 5 min. In 20 min, the ..... % of the substance will remain undecayed.

(A) 25 (B) 75

(C) 93.75 (D) 6.25

11. For $N = N_0 e^{-\lambda t}$ and $t_2 > t_1$, the number of nucleii disintegrating between t_1 and t_2 is .....

(A) $N_0\left[e^{-\lambda t_1} - e^{-\lambda t_2}\right]$ (B) $N_0\left[e^{\lambda t_2} - e^{-\lambda t_1}\right]$

(C) $N_0\left[e^{-\lambda t_2} - e^{-\lambda t_1}\right]$ (D) None of these

12. The wavelength of K_α spectral line is λ for an element of atomic number 43. The wavelength of K_α spectral line for an element of atomic number 29 is ..... λ.

(A) $4/9$ (B) $\frac{42}{28}$

(C) $\frac{43}{29}$ (D) $9/4$

13. What is the minimum number of geo-stationary satellites needed to establish communication over entire surface of the Earth ?

(A) 2 (B) 3

(C) 6 (D) 4

14. In order to cover a circular region of radius 16 km, by a T.V. transmitter, what must be the height of the transmitting antenna ?

[Radius of the Earth = 6.4×10^6 m]

(A) 0.2 km (B) 2 km

(C) 0.02 km (D) 0.1 km

15. The emitter junction of the CE transistor amplifier is ..... biased while the collector junction is ..... biased.

(A) Reverse, forward (B) Forward, forward

(C) Reverse, reverse (D) Forward, reverse.

16. α = 0.99 for a CE transistor amplifier circuit. The input resistance is equal to 1 kΩ and the load resistance is equal to 10 kΩ. The voltage gain of the circuit is .....

(A) 990 (B) 9900

(C) 99 (D) 99000

SECTION - B

*Questions from sl. number **17** to **32** are short answer type questions.*
*Each carries **ONE** mark.* **16**

17. Define Static electric potential.

OR

Write a unit of electric field strength.

18. Why does the current flowing through a super conductor sustain over a long time interval ?

OR

What is Conductance ?

19. Give dimensional formula of Magnetic field intensity.

20. The current is flowing through a straight long conductor. Find the ratio of magnetic field intensities at a distance of 2.0 cm. and 5.0 cm.

21. What is intensity of magnetization ?

22. What is the value of power factor of series L–C–R AC circuit at resonance ?

OR

What is Wattless current ?

23. What are inductive components in electro-magnetic waves ?

24. Which physical quantity does not change when a ray of light travels from one medium to another medium ?

OR

Give a method to obtain plane polarised light.

25. What is meant by Critical angle ?

26. What is Characteristic impedence (Z_0) ?

27. What is Integrated Circuit (I.C.) ?

28. Draw the circuit symbols of NPN transistors.

29. Name any two donor impurities in semiconductors.

30. What is average life time of a radio active element ?

OR

What is the use of moderator in nuclear reactor ?

31. The radius of electron's second stationary orbit in Hydrogen atom is R. Find the radius of third orbit in terms of R.

32. What is slope of graph of $V_0 \rightarrow f$ for photo electric effect ?

SECTION - C

*Questions from sl. number **33** to **48** are short answer type questions.*
*Each question carries **TWO** marks.* **32**

33. Mention any four characteristics of electric field lines.

34. Derive the formula of capacitance for parallel plate capacitor $C = \frac{\varepsilon_0 A}{d}$.

35. What is Relaxation time ? Accepting formula for drift velocity gained by electron in relaxation time $v_d = \frac{eE}{m}\tau$, derive the expression for resistivity :

$\rho = \frac{m}{ne^2\tau}$.

36. Define Peltier and Joule effect. Show that both are not same.

37. State and explain Ampere's circuital law.

38. What is Magnetic Susceptibility ? On which factors it depends ? Obtain expression $B = \mu_0 H$ for vacuum and write expression for permeability of the material.

39. Derive the relation $\varepsilon = -Bvl$ for motional *emf* produced in a rod of length l, moving in a uniform magnetic field B perpendicularly with velocity v.

40. Draw graphs of $I_{rms} \rightarrow \omega$ for L–C–R in series A.C. circuit for two different values of R_1 and R_2 ($R_1 < R_2$). Using it, explain Q factor.

OR

Define the term "effective power" for an L–C–R A.C. circuit. Obtain an expression for the Power.

41. What is Power Factor ? Explain experimental arrangement of Hertz experiment with necessary diagram and show that it forms an oscillator circuit.

42. For a transparent prism, obtain $i + e = A + \delta$.

43. With the help of equation $I = I_0 \cos^2\left[\frac{k(r_1 - r_2)}{2}\right]$ derive the condition for constructive interference in terms of path and phase difference.

44. Give Einstein's explanation for Photoelectric effect.

OR

Write any four properties attributed to a Photon as a result of Photoelectric and Compton effect.

45. Accepting $\frac{dN}{dt} = -\lambda N$, obtain exponential law of radioactive decay.

46. Give first hypothesis of Bohr model and using it, derive expression for radius of the orbit of electron in Hydrogen atom.

47. Explain half - wave rectifier with necessary circuit and graphs.

OR

Draw Input and Output characteristics for CE transistor circuit.

Write the formula for input resistance (r_i) and output resistance (r_0).

48. Explain Analogy and Digital communication.

OR

On one particular day, maximum value of the frequency of waves reflected by the ionosphere is 3.3 MHz. On some other day it is 3 MHz. Find the ratio of maximum electron densities for these days.

SECTION - D

*Questions from sl. number **49** to **60** are short answer type questions.*
*Each question carries **THREE** marks.* **36**

49. An electric dipole of moment $\vec{P}$ is placed in a uniform electric field $\vec{E}$. The dipole is rotated through a very small angle θ from equilibrium and is released.

Prove that it executes simple harmonic oscillation with frequency $f = \frac{1}{2\pi}\sqrt{\frac{PE}{I}}$, where I= Moment of inertia of the dipole.

50. A spherical drop of water has 3×10^{-10} C amount of charge residing on it. 500 V electric potential exists on its surface. Calculate the radius of this drop. Two such identical drops combine to form a new drop. Calculate the electric potential on the surface of the new drop, where K = 9×10^9 SI.

51. A thin layer of 0.001 cm of Copper is to be deposited on a plate of copper of 10 cm^2 through electrolysis. Calculate the amount of energy used if a battery of 12 V is connected. Density of Copper = 9 g cm^{-3}, Electro chemical equivalent of Copper = 0.0003 g mol^{-1}.

52. An electron in the Hydrogen atom is revolving around a Proton with a speed of $e^2/\hbar$. The radius of the electron orbit is equal to $\hbar^2/me^2$. Obtain the formula for the electric current in the above case.

Mass of electron = m, Charge on electron = e, where $\hbar = h/2\pi$.

53. A circular coil having N turns is made from a wire of L meter length. If a current of I amp. is passed through the coil, which is suspended in a uniform magnetic field of B Tesla, find the maximum torque that can act on the coil.

OR

A toroidal core with 3000 turns has inner and outer radii of 11 cm and 12 cm respectively. When a current of 0.70 A is passed, then the magnetic field produced in the core is 2.5 T. Find the relative permeability of the core.
$\left(\mu_0 = 4\pi \times 10^{-7} \text{TmA}^{-1}\right)$.

54. Two long solenoids are of equal length l and the smaller solenoid having a cross sectional area a is placed within the larger solenoid in such a way that their axes coincide. Find the mutual inductance of the system.

OR

A U shaped conducting frame is placed in a uniform magnetic field B in such a

way that the plane of frame is perpendicular to the field lines. A conducting rod is supported on the parallel arms of the frame, perpendicular to them and is given a velocity v_0 at time $t = 0$. Prove that the velocity of the rod at time t will be given by $v_t = v_0 \exp\left(\frac{-B^2 l^2}{mR} \cdot t\right)$,

where R = resistance of circuit, m = mass of rod, l = perpendicular distance between two arms.

55. One inductor of 0.50 H and a resistor of 100 Ω are connected in series with an a.c. source of 240 V and 50 Hz, then calculate the following quantities :

(a) The maximum current flowing through the inductor.

(b) Phase difference and time difference between current and voltage.

56. A real image formed by a concave mirror is four times the object size. If object is taken 3 cm away, the image is 3 times enlarged.

Calculate the focal length of the mirror.

57. In Young's experiment, the distance between third bright and fifth dark fringe is 1.5 mm. The distance between source and screen is 100 cm and wavelength of light is 5000 Å. Find the distance between two slits.

58. Wavelength of light incident on a photosensitive surface is reduced from 4000 Å to 360 nm. Find the change in stopping potential. $h = 6.625 \times 10^{-34}$ Js.

OR

Compare energy of a photon of X-rays having 1 Å wavelength with the energy of an electron having same de-Broglie wavelength.

$h = 6.6 \times 10^{-34}$ Js ; $c = 3 \times 10^8$ ms^{-1} ; $m_e = 9.1 \times 10^{-31}$ kg.

59. In an X-ray tube, the p.d. between the anode and the cathode is 12.4 kV and current flowing is 2 mA, then find

(1) the number of electrons striking the anode in 1 sec.

(2) the speed of electrons while striking the anode.

(3) minimum wavelength (λ_{min}) emitted.

OR

In a mixture of two radioactive elements A and B, the decay constant of A is 0.1 (day)$^{-1}$ and that of B is 0.2 (day)$^{-1}$. The initial activity of A is twice that of B. Find the activity of this mixture after 10 days. Initial activity of the mixture is 2 μCi.

60. Two amplifier circuits are connected in series. The voltage gain of the first amplifier is equal to 15 and that of the second amplifier is equal to 10. If a 10 mV signal is applied at the input of the amplifier, then what will be the output signal ?