Question Bank

DSC- 2B Electricity And Magnetism -II (Paper IV)

1 Select the most correct alternative.

(1) The operator j on multiplication turns a vector through ......

(a) 180° (b) 90°

(c) 45° (d) 0^0

(2) In a purely resistive circuit, the current with the applied alternating e.m.f. is ......

(a) in phase (b) out of phase

(c) lagging by $\pi/2$. (d) lagging by π

(3) In a purely inductive circuit, the phase of the alternating current, over the applied e.m.f. is ......

(a) lagging by $\frac{\pi}{2}$ (b) leading by $\frac{\pi}{2}$

(c) out of phase (d) in phase

(4) In a purely capacitive circuit, the phase of the alternating current, over the applied e.m.f. ......

(a) lags by $\frac{\pi}{2}$ (b) leads by $\frac{\pi}{2}$

(c) is out of phase. (d) is in phase.

(5) At resonance in series $L - C - R$ circuit, the circuit is ......

(a) purely resistive (b) purely reactive

(c) having high impedance. (d) inactive

(6) In a series $L - C - R$ circuit, at resonance, the current drawn is

(a) maximum (b) minimum

(c) zero (d) imaginary

(7) In a series $L - C - R$ circuit, the phase difference ϕ of the current with the applied alternating e.m.f. is ......

(a) $\tan\,\phi = \frac{x_L - X_C}{R}$ (b) $\tan\,\phi = \frac{R}{X_L - X_C}$

(c) $\tan\,\phi = R(X_L - X_C)$ (d) $\tan\,\phi = RR_L R_C$

(8) The complex impedance in L-C-R series a.c. circuit is $\mathbf{Z} = \cdots$

(a) $R + jX_L$

(b) $R + jX_C$

(c) $R + jX_L X_C$

(d) $R + j(X_L - X_C)$

(9) the SI unit of impedance is........

(a) ampere

(b) volt

(c) ohm

(d) mho

(10) The S.I. unit of admittance is......

(a) ampere

(b) volt

(c) ohm

(d) mho

(11) The S.l. unit of susceptance is.......

(a) ampere

(b) volt

(c) ohm

(d) mho

(12) The resonant frequency of $L - C - R$ series a.c. circuit $f_0 =$

(a) $2\pi\sqrt{LC}$

(b) $\sqrt{LC}$

(c) $1/2\pi\sqrt{\mathrm{LC}}$

(d) $2\pi\sqrt{LCR}$

(13) Voltage amplification in series resonant circuit is......

(a) $\frac{\omega_o R}{L}$

(b) $\frac{RL}{\omega_0}$

(c) $\frac{\omega_0 L}{R}$

(d) $\frac{\omega_0}{RL}$

(14) Q factor of a $L - C - R$ series resonant a.c. circuit is....

(a) $\frac{\omega R}{L}$

(b) $\frac{\omega L}{R}$

(c) $\frac{\omega C}{L}$

(d) $\frac{\omega}{LC}$

(15) Sharpness of resonance is given by band width $f_1 - f_2 = \cdots$

(a) $\frac{f_0}{Q_0}$

(b) $\frac{1}{Q_0}$

(c) $\frac{1}{f_0}$

(d) $f_0 Q_0$

(16) According to Biot-Savart's law, magnetic field at a point due to a small element of current carrying conductor is.............

(a) directly proportional to the current flowing through it

(b) inversely proportional to the current flowing through it

(e) inversely proportional to the length of the conductor

(d) directly proportional to the r^2

(17) According to Biot-Savart's law, magnetic field at a point due to a small element of a current carrying conductor is …..

(a) inversely proportional to the current flowing through it

(o) inversely proportional to the r^2

(c) inversely proportional to the length of the conductor

(d) directly proportional to the r^2

(18) Magnetic field due to straight current carrying conductor of infinite length at a point at a distance R is, $B = \cdots$ ……..

(a) $\frac{\mu_0 iR}{2\pi}$

(b) $\frac{\mu_0 i}{2\pi R}$

(c) $\mu_0 iR$

(d) $\frac{\mu_0 R}{2\pi i}$

(19) Magnetic field at the center of the current carrying circular coil of radius r is, $B = \cdots$ … … ….

(a) $\frac{\mu_0 i}{2r}$

(b) $\frac{\mu_0 i}{3r}$

(c) $\frac{\mu_0 ri}{2}$

(d) $2\mu_0 ri$

(20) Magnetic field at a point on the axis of a solenoid of finite length is...

(a) $B = \mu_0 ni$

(b) $B = \frac{\mu_0 ni}{2}(\cos\ \theta_2 + \cos\ \theta_1)$

(c) $\frac{\mu_0 ni}{2}$

(d) $B = \frac{\mu_0 ni}{2}(\cos\ \theta_2 - \cos\ \theta_1)$

(21) Magnetic field at a point on the axis of a solenoid of infinite length is...

(a) $B = \frac{\mu_0 ni}{2}$

(b) $B = \frac{\mu_0 ni}{2}(\cos\ \theta_2 - \cos\ \theta_1)$

(c) $B = \mu_0 ni$

(d) $B = \frac{\mu_0 ni}{3}$

(22) The line integral of the magnetic field around any closed path in the free space is equal to the absolute permeability (μ_0) times the net steady current enclosed by the path. This is………. law

(a) Biot-Savart's

(b) Ampere's circuital

(c) Gauss

(d) Stokes

(23) Integral form of the Ampere's circuital law is.

(a) $\oint \vec{B} \cdot dl = \mu_0 I$

(b) $\vec{\nabla} \cdot \vec{B} = 0$

(c) $\vec{\nabla} \times \dot{\vec{B}} = 0$

(d) $\vec{\nabla} \times \vec{B} = \mu_0 I$

(24) Divergence of magnetic field $(\vec{\nabla} \cdot \vec{B}) = \cdots$ ... ..

(a) $\mu_0 I$

(b) zero

(c) infinite

(d) $\frac{\mu_0}{4\pi}$

(25) Differential form of the Ampere's circuital law is.

(a) $\oint \vec{B} \cdot \vec{d}I = \mu_0 I$

(b) $\vec{\nabla} \times \vec{B} = 0$

(c) $\vec{\nabla} \cdot \vec{B} = 0$

(d) $\vec{\nabla} \times \vec{B} = \mu_0 I$

(26) Curl of magnetic field $\vec{\nabla} \times \vec{B}$.

(a) $\mu_0 I$

(b) zero

(c) infinite

(d) $\frac{\mu_0}{4\pi}$

(27) Magnetic vector potential $\vec{A}$ is related with magnetic field $\vec{B}$ by equation...

(a) $\vec{B} = \vec{\nabla} \cdot \vec{A}$

(b) $\vec{A} = \vec{\nabla} \times \vec{B}$

(c) $\vec{A} = \vec{\nabla} \cdot \vec{B}$

(d) $\vec{B} = \vec{\nabla} \times \vec{A}$

(28) Magnetic moment developed per unit volume is called as....

(a) magnetic induction

(b) intensity of magnetization

(c) permeability

(d) susceptibility

(29) S.I. unit of intensity of magnetization is......

(a) A-m

(b) m/A

(c) A/m

(d) $\mathrm{Wb/m^2}$

(30) S.I. unit of magnetic induction is.

(a) $A - m$

(b) $\mathrm{m/A}$

(c) A/m

(d) $\mathrm{Wb/m^2}$

(31) Permeability $\mu =$

(a) $\frac{B}{H}$

(b) $\frac{H}{B}$

(c) BH

(d) $\frac{M}{H}$

(32) S.I. unit of permeability is

(a) $\mathrm{Wb/m^2}$

(b) Wb/Am

(c) $\mathrm{WbA/m}$

(d) $AmWb$

(33) Magnetic susceptibility χ … … … ..

(a) $\frac{B}{H}$

(b) $\frac{H}{M}$

(c) MH

(d) $\frac{M}{H}$

(34) The relation between magnetic induction B, magnetizing field and intensity of magnetization is......

(a) $B = \mu_0(H + M)$

(b) $H = \mu_0(B + M)$

(c) $M = \mu_0(H + B)$

(d) $B = (H + M)$

(35) Relation between relative permeability k and susceptibility χ is.

(a) $k = 1 - \chi$

(b) $k = 1 + \chi$

(c) $k = \frac{1}{\chi}$

(d) $k = \chi$

(36) For paramagnetic materials

(a) $\mu = \mu_0$

(b) $\mu < \mu_0$

(c) $\mu > \mu_0$

(d) $\mu >> \mu_0$

(37) Susceptibility x of paramagnetic materials is........

(a) positive

(b) negative

(c) zero

(d) infinite

(38) Susceptibility of paramagnetic materials is proportional to...

(a) T

(b) $\frac{1}{T}$

(c) $\frac{1}{T^2}$

(d) T^2

(39) Susceptibility of ferromagnetic materials is.

(a) positive but small

(b) negative but small

(c) zero

(d) positive but large

(40) For ferromagnetic materials......

(a) $\mu > \mu_0$

(b) $\mu < \mu_0$

(c) $\mu \gg \mu_0$

(d) $\mu \ll \mu_0$

(41) Susceptibility of diamagnetic materials is......

(a) positive but small

(b) negative

(c) zero

(d) positive but large

(42) For diamagnetic materials....

(a) $\mu > \mu_0$

(b) $\mu < \mu_0$

(c) $\mu \gg \mu_0$

(d) $\mu \ll \mu_0$

(43) Susceptibility of.......materials is independent of temperature

(a) diamagnetic

(b) paramagnetic

(c) ferromagnetic

(d) antiferromagnetic

(44) Faraday's law gives …… of induced emf.

(a) magnitude

(b) direction

(c) both a and b

(d) unit

(45) Lenz's law gives of induced emf.

(a) magnitude

(b) direction

(c) both

(d) Unit.

(46) Self-inductance is measured in.

(a) Ohm

(b) Farad

(c) Henry

(d) Volt.

(47) Mutual inductance is measured in

(a) Ohm

(b) Farad

(c) Henry

(d) Volt.

(48) Self-inductance per unit length of a solenoid with n turns per unit length and cross-sectional area A is, ...

(a) $\mu_0 n A$

(b) $n^2 A$

(c) $\mu_0 n^2 A^2$

(d) $\mu_0 n^2$ A.

(49) Mutual inductance per unit length of two windings with $n_1 \& n_2$ turns per unit length over a frame of cross-sectional area A is

(a) $\mu_0 \frac{n_1 n_2}{A}$

(b) $\frac{\mu_0 A}{n_1 n_2}$

(c) $\mu_0 n_1 n_2 A$

(d) $\frac{n_1 n_2 A}{\mu_0}$.

(50) Energy stored per unit volume in magnetic field is.....

(a) $\frac{1}{2}\mu_0 B^2$

(b) $\frac{B^2}{2\mu_0}$

(c) $\frac{2\mu_0}{B^2}$

(d) $\frac{2}{\mu_0 B^2}$

(51) Mathematical formulations of empirical laws in electricity and magnetism are known as ....

(a) Maxwell's equations
(b) Faraday's equations
(c) Lorentz's equations
(d) Biot & Savart's equations

(52) differential form of Ampere's circuital law for steady state current is ....

(a) $\nabla \cdot \vec{J} = \mu_0$
(b) $\nabla \cdot \vec{J} = 0$
(c) $\nabla \cdot \vec{J} = -\frac{\partial \rho}{\partial t}$
(d) $\nabla \cdot \vec{J} = \epsilon_0$

(53) The equation of continuity is in accordance with the law of conservation of ....

(a) energy
(b) momentum
(c) charge
(d) mass

(54) Displacement current density in vacuum is

(a) $\frac{\partial \vec{D}}{\partial t} = 0$
(b) $\frac{\partial \vec{D}}{\partial t} = \vec{J}$
(c) $\frac{\partial \vec{D}}{\partial t} = \mu_0 \in_0$
(d) $\frac{\partial \vec{D}}{\partial t} = \phi \epsilon_0 \cdot \frac{\partial \vec{E}}{\partial t}$

(55) The statement magnetic free poles do not exist is justified by Maxwell's equation............

(a) $\nabla \cdot \vec{D} = \rho$
(b) $\nabla \cdot \vec{B} = 0$
(c) $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$
(d) $\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$

(56) The electromagnetic energy crossing unit area in unit time is called..........

(a) Poynting's vector
(b) Polarization vector
(c) Energy density
(d) Intensity.

(57) Velocity of electromagnetic wave in dielectric medium is given by ....

(a) $v = \sqrt{\mu \epsilon}$
(b) $v = \sqrt{\mu_0 \epsilon_0}$
(c) $v = \frac{1}{\sqrt{\mu \epsilon}}$
(d) $v = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$

(58) Nature of electromagnetic waves is

(a) transverse
(b) longitudinal
(c) stationary
(d) none of the above.

(59) Electric $(\vec{E})$ and magnetic $(\vec{H})$ field vectors of electromagnetic waves are mutually perpendicular to

(a) polarization vector
(b) magnetization vector
(c) electric displacement vector
(d) propagation vector

(60) For dielectric medium the electric and magnetic field waves are ......

(a) out of phase

(b) in same phase

(c) differ in phase by $\pi/2$

(d) differ in phase by $\pi/4$

(61) Transverse nature of electromagnetic waves is proved by the observation of

(a) refraction

(b) interference

(c) diffraction

(d) polarization

2. Short answer question.

1. What are complex numbers? Just mention their one application.
2. Discuss voltage amplification in series resonant circuit. Explain why it is called "acceptor circuit".
3. Define Q factor for a series $L - C - R$ circuit.
4. Define: (a) Sharpness of resonance (b) Band width for a series resonant circuit.
5. Write a note on sharpness of resonance in series L-C-R circuit.
6. Define: (i) admittance (ii) susceptance. State their units.
7. State and explain Biot-Savart's law.
8. Obtain an expression for magnetic field at the center of current carrying circular coil.
9. State and explain Ampere's circuital law.
10. Explain divergence and curl of magnetic field.
11. Explain magnetic vector potential.
12. Prove the relation $B = \mu_0(H + M)$ where symbols have their usual meaning.
13. Give comparison between paramagnetic and diamagnetic materials.
14. Give comparison between paramagnetic and ferromagnetic materials.
15. State any five properties of ferromagnetic materials.
16. Explain Faraday's laws of electromagnetic induction.
17. Discuss Lenz's law.
18. What is self-inductance of a loop? Obtain an expression for the self-inductance of a solenoid.
19. Define mutual inductance? Obtain an expression for the mutual inductance of two coils wound over a non conducting frame.
20. Explain mutual inductance and derive Newmann’s formula.

21. Write a note on electric displacement vector.

22. State Biot and Savart's law and hence show that $\nabla \cdot \vec{B} = 0$

23. Show that differential form of Ampere's circuital law for steady current is $\nabla \cdot \vec{B} = \mu_0 \vec{J}$

24. Explain Maxwell's correction for Ampere's circuital law. Why correction was needed?

25. State Maxwell's equations for linear dielectrics. Obtain wave equations and hence find an expression for phase velocity of electromagnetic waves in dielectrics.

26. Derive the expression for equation of continuity of a current.

27. Obtain the expression for mutual inductance of transformer coils.

28. In an AC circuit the resistance is 60 ohm and the reactance is 146 ohms. Calculate the impedance, admittance and susceptance of the circuit.

29. The magnetic susceptibility of the medium is 948 x 10^{-11}. Calculate permeability and relative permeability.

3. Long answer question.

1. Write the e.m.f. equation of a series $L - C - R$ circuit in which an alternating e.m.f. $\omega = \theta_0 \sin \theta t$ is applied. Write it in j operator form and solve it to obtain expression for instantaneous current in the circuit. Hence, obtain expression for the impedance of the circuit.

2. Write the e.m.f. equation of a series $L - C - R$ circuit in which an alternating e.m.f. $e = e_0 \sin \omega t$ is applied. Assume the solution as $i = i_0 \in^{j\omega t}$ in the j operator form and show that the instantaneous value of p.d.s across the inductance (L), resistance (R) and capacitance (C) are $V_L = jL\omega i; V_R = Ri$ and $V_C = \frac{-ji}{C\omega}$ respectively. Explain in brief how the j operator indicates the phase lag or lead of V_c and V_L w.r.t. current.

3. What is a series resonant circuit? Show that the impedance is minimum, hence the current is maximum and the circuit becomes purely resistive at the resonance. Show also that at the resonance p.d.s across the condenser and inductance cancel each other.

4. Explain with necessary theory how Owen's bridge allows a comparison of the inductance of an inductance coil with the capacity of a condenser. How can it be used to determine the mutual inductance of two coils?

5. Obtain an expression for magnetic field due to straight conductor of finite length. Hence obtain an expression for magnetic field due to infinite straight conductor.

6. Obtain an expression for magnetic field at a point on the axis of current carrying circular coil.

7. Obtain an expression for magnetic field at a point on the axis of solenoid of finite length. Hence find magnetic field at a point on the axis of infinite solenoid.

8. Show that $\vec{\nabla} \cdot \vec{B} = 0$ and $\vec{\nabla} \times \vec{B} = \mu_0 J$

9. Explain magnetic induction, magnetic intensity, magnetic susceptibility. State their units.

10. State properties of paramagnetic, ferromagnetic and diamagnetic materials.

11. Derive an expression for the energy stored per unit volume in magnetic field.

12. State Maxwell's equations for vacuum and derive equations giving divergence and curl of electric field.

13.State Maxwell's equations for vacuum and obtain equations giving divergence and curl of magnetic field.

14. Establish the law of conservation of energy for electromagnetic field waves and explain the meaning of Poynting's vector.

15. State Maxwell's equations for vacuum (free space). Obtain wave equations and hence find the velocity of electromagnetic waves in free space.

16. Considering the plane wave solutions for electromagnetic waves in vacuum, show that electromagnetic waves are transverse and vectors ($\vec{E}, \vec{H}$ and $\vec{k}$) are mutually orthogonal.

17. For electromagnetic waves through linear dielectrics, show that.

(i.) $\vec{E}, \vec{H}$ and $\vec{k}$ are mutually orthogonal

(ii.) $\vec{E} \& \vec{H}$ are in phase