

TEST INFORMATION

TEST : PART TEST (PT)-2 (3 hours)

Test Date : 22-04-2015

Syllabus : Current electricity, Capacitor, Magnetic field and force, Work, power, energy, Circular motion, Centre of mass complete

This DPP is to be discussed (24-04-2015)

PT-2 to be discussed (24-04-2015)

DPP No. # 05

Total Total Marks : 150

Max. Time : 117 min.

Single choice Objective (–1 negative marking) Q. 1 to 15

(3 marks 2½ min.) [45, 37½]

Multiple choice objective (–1 negative marking) Q. 16 to 21

(4 marks, 3 min.) [24, 18]

Single Digit Subjective Questions (no negative marking) Q.22 to Q.29

(4 marks 2½ min.) [32, 20]

Double Digits Subjective Questions (no negative marking) Q. 30

(4 marks 2½ min.) [4, 2½]

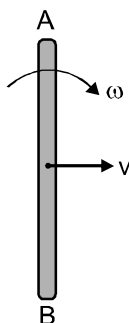
Comprehension (–1 negative marking) Q.31 to 42

(3 marks 2½ min.) [36, 30]

Match Listing (–1 negative marking) Q.43 to Q.45

(3 marks, 3 min.) [9, 9]

1. A metal rod of length ℓ , moving with an angular velocity ω and velocity of its centre is v . Find potential difference between points A and B at the instant shown in figure. A uniform magnetic field of strength B exist perpendicular to plane of paper :



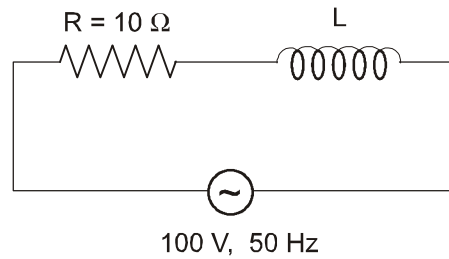
(A) $Bv\ell$

(B) $Bv\ell + \frac{1}{2} B\omega\ell^2$

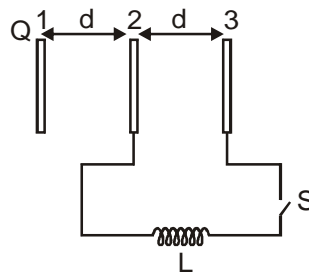
(C) $B\omega\ell - \frac{1}{2} B\omega\ell^2$

(D) $Bv\ell + B\omega\left(\frac{\ell}{2}\right)^2$

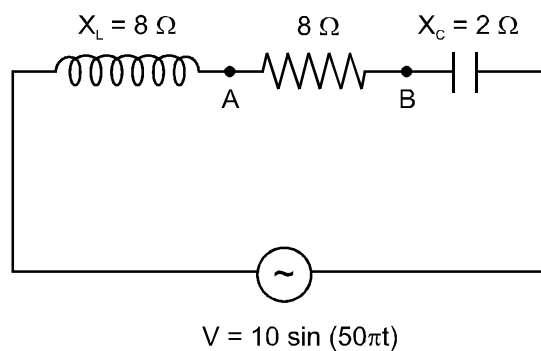
2. In LR circuit (shown in figure), current is lagging by $\frac{\pi}{3}$ in phase with applied voltage, then select correct alternative :



- (A) $L = \frac{10}{\sqrt{3}\pi}$ H, $i = 10$ A (B) $L = \frac{10}{\pi}$ H, $i = 5$ A
- (C) $L = \frac{10}{\sqrt{3}\pi}$ H, $i = 5$ A (D) $L = \frac{\sqrt{3}}{10\pi}$ H, $i = 5$ A
3. Three identical large plates are fixed at separation of d from each other as shown. The area of each plate is A . Plate 1 is given charge $+Q$ while plates 2 and 3 are neutral and are connected to each other through coil of inductances L and switch S . If resistance of all connected wires is neglected the maximum current flow through coil after closing switch is ($C = \epsilon_0 A/d$) (neglect fringe effect)

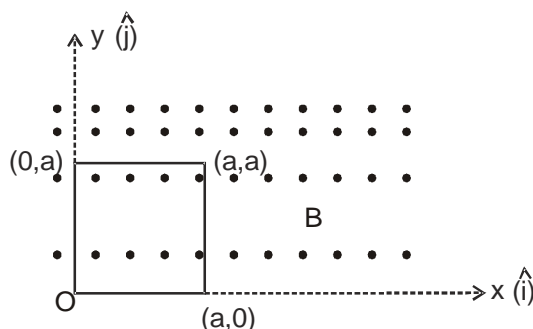


- (A) $\frac{Q_0}{\sqrt{LC}}$ (B) $\frac{Q_0}{\sqrt{2LC}}$ (C) $\frac{2Q_0}{\sqrt{LC}}$ (D) $\frac{Q_0}{2\sqrt{LC}}$
4. The instantaneous potential difference between points. A and B is :



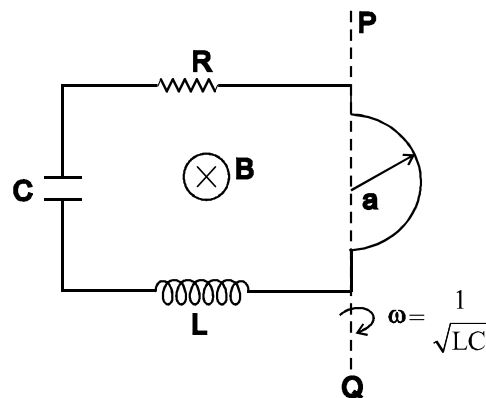
- (A) $8 \sin (50\pi t + 37 \frac{\pi}{180})$ (B) $8 \sin (50\pi t - 37 \frac{\pi}{180})$
- (C) $10 \sin (50\pi t)$ (D) $10 \cos (50\pi t)$

11. A square loop of side 'a' is placed in x – y plane as shown in figure. In this region there is non-uniform time dependent magnetic field $\vec{B} = (cy^3t^2)\hat{k}$. [where t is time and c is constant] then magnitude of emf induced in loop is



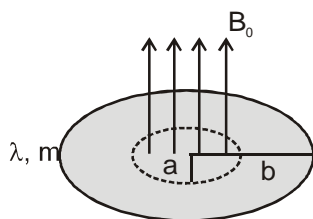
- (A) Zero (B) $\frac{ca^4t^2}{5}$ (C) $\frac{ca^5t}{2}$ (D) data is insufficient
12. In a YDSE, distance between the slits and the screen is 1m, separation between the slits is 1mm and the wavelength of the light used is 5000nm. The distance of 100th maxima from the central maxima is:
 (A) 0.5 m (B) 0.577 m (C) 0.495 m (D) does not exist
13. A rectangular loop of sides of length ℓ and b is placed in x–y plane. A uniform but time varying magnetic field of strength $\vec{B} = 20 t \hat{i} + 10 t^2 \hat{j} + 50 \hat{k}$ where t is time elapsed. The magnitude of induced e.m.f. at time t is:
 (A) $20 + 20 t$ (B) 20 (C) $20 t$ (D) zero
14. Assume Earth's surface is a conductor with a uniform surface charge density σ . It rotates about its axis with angular velocity ω . Suppose the magnetic field due to Sun at Earth at some instant is a uniform field B pointing along earth's axis. Then the emf developed between the pole and equator of earth due to this field is. (R_e = radius of earth)
 (A) $\frac{1}{2}B\omega R_e^2$ (B) $B\omega R_e^2$ (C) $\frac{3}{2}B\omega R_e^2$ (D) zero
15. A series RLC circuit is connected to an ac generator. The instant at which current in the circuit is zero, the energy stored in the capacitor & inductor are :
 (A) zero in both
 (B) maximum in both
 (C) zero & maximum respectively
 (D) maximum & zero respectively

16. A wire shaped as a semicircle of radius a , is rotating about an axis PQ with a constant angular velocity $\omega = \frac{1}{\sqrt{LC}}$, with the help of an external agent. A uniform magnetic field B exists in space and is directed into the plane of the figure. (circuit part remains at rest) (left part is at rest)

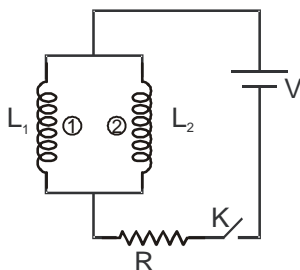


- (A) The rms value of current in the circuit is $\frac{\pi Ba^2}{R\sqrt{2LC}}$
- (B) The rms value of current in the circuit is $\frac{\pi Ba^2}{2R\sqrt{2LC}}$
- (C) The maximum energy stored in the capacitor is $\frac{\pi^2 B^2 a^4}{8R^2 C}$
- (D) The maximum power delivered by the external agent is $\frac{\pi^2 B^2 a^4}{4LCR}$
17. Consider a series LCR circuit connected to an AC supply of 220 V. If voltage drop across resistance R is V_R , voltage drop across capacitor is $V_C = 2V_R$ and that across inductor coil is $V_L = 3V_R$ then choose correct alternative(s)
- (A) $V_R = 220\sqrt{2}$ V
- (B) Power factor of circuit is $\frac{1}{\sqrt{2}}$
- (C) $V_R = 156$ V
- (D) Phase difference between current and source voltage is $\frac{\pi}{4}$
18. If the two slits of double slit experiment were moved symmetrically apart with small relative velocity v and the distance between screen and mid-point of slits is fixed and equal to D . Consider a point P on the screen at a distance x from central maxima then ($x \ll D$):
- (A) Rate of change of number of fringes between central maxima and point P changes with respect to time is $\frac{xv}{\lambda D}$
- (B) number of fringes contained between central maxima and point P increases with time
- (C) fringe width decreases as time passes
- (D) fringe width increases as time passes

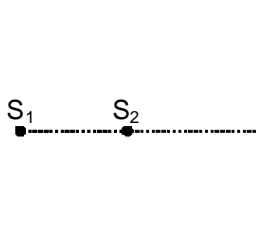
19. A nonconducting ring of uniform mass m , radius b and uniform linear charge density ' λ ' is suspended as shown in figure in a gravity free space. There is uniform coaxial magnetic field B_0 , pointing up in a circular region of radius ' a ' ($<b$). Now if this field is switched off, then :-



- (A) There will be induced electric field on periphery of ring, in anticlockwise sense when seen from above
 (B) Induced electric field imparts angular momentum of magnitude $\lambda\pi a^2b B_0$
 (C) Final angular velocity of ring will be more if time taken to switch of the field (B_0) is small
 (D) Final angular velocity will always be independent of time taken to switch off the field (B_0).
20. In the figure shown the key is switched on at $t = 0$. Let I_1 and I_2 be the currents through inductors having self inductances L_1 & L_2 at any time t respectively. The magnetic energy stored in the inductors 1 and 2 be U_1 and U_2 . Then $\frac{U_1}{U_2}$ at any instant of time is :

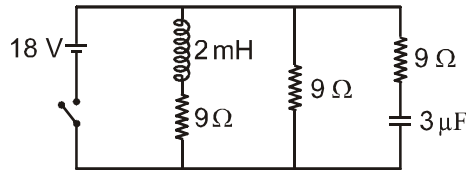


- (A) $\frac{L_1}{L_2}$ (B) $\frac{L_2}{L_1}$ (C) $\frac{I_1}{I_2}$ (D) $\frac{I_2}{I_1}$
21. In a Young's Double Slit experiment, films of thickness t_A and t_B and refractive indices μ_A and μ_B are placed in front of slits A and B respectively. If $\mu_A t_A = \mu_B t_B$, then the central maxima may
 (A) not shift (B) shift towards A (C) shift towards B (D) None of these
22. Two coherent monochromatic point sources S_1 and S_2 are placed in front of an infinite screen as shown in figure. Wavelength of the light emitted by both the sources is λ . Initial phase difference between the sources is zero.

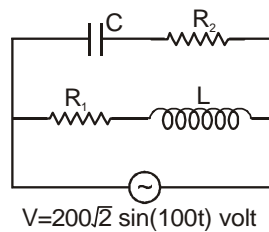


Initially $S_1S_2 = 2.5\lambda$ and the number of bright circular rings on the screen in n_1 . If the distance S_1S_2 is increased and made 5.7λ , the number of bright circular rings becomes n_2 . The difference $n_2 - n_1$ is :

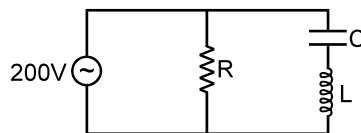
23. A conducting circular loop having a radius of 1.0 cm, is placed perpendicular to a magnetic field of 0.50 T .It is removed from the field in 0.50 s. The average emf produced in the loop during this time is $x\pi \times 10^{-4} V$.then find out value of x
24. In circuit,initially capacitor and inductor do not have any energy, Then find current through the battery in Ampere just after switch is closed



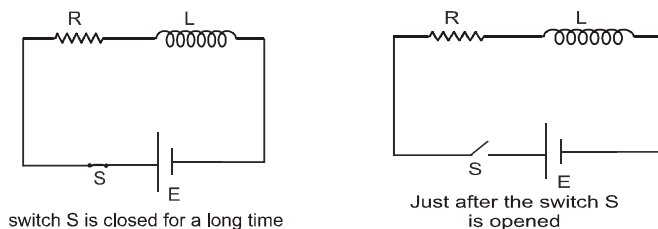
25. In the shown circuit, $R_1 = 10\Omega$, $L = \frac{\sqrt{3}}{10}H$, $R_2 = 20\Omega$, $C = \frac{\sqrt{3}}{2}$ milli-farad and t is time in seconds. Then at the instant current through R_1 is $10\sqrt{2}A$; find the current through resistor R_2 in amperes.



26. What is the ratio of powers delivered by 20 V dc and 20 V peak ac to the same load resistance?
27. In the circuit diagram shown, $X_C = 100\Omega$, $X_L = 200\Omega$ & $R = 100\Omega$. The effective current through the source is \sqrt{X} then find out value of X :



28. In the LR circuit the switch S was closed for a long time. The ideal cell in the circuit has emf E volts.Later on the switch is opened. The current in the resistor of resistance R ohms just after the switch was opened is $\frac{XE}{4R}$, then x is

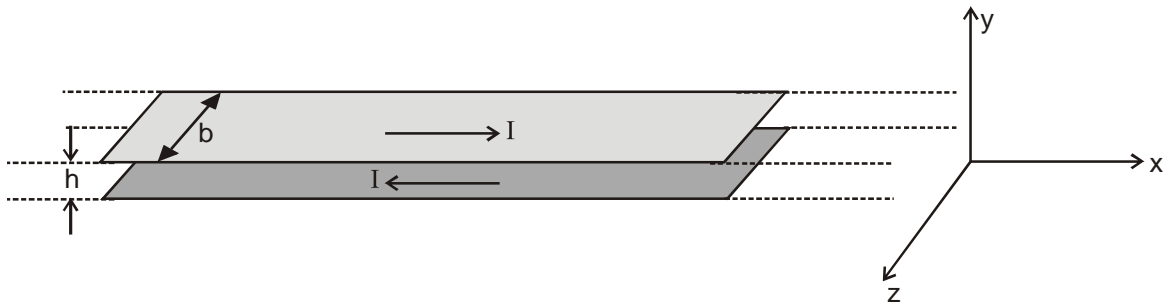


29. In YDSE with monochromatic light, fringes are obtained on the screen placed at some distance from the slits. If screen is moved by $5 \times 10^{-2}m$ towards the slits, fringe width changes by $3 \times 10^{-5} m$. If separation between the slits is $10^{-3} m$, if wavelength of light used is 1000 \AA , then y is : (Assume distance between the two slits is very small than the distance between the slits and screen)

30. Interference fringes were produced using white light in a double slit arrangement. When a mica sheet of uniform thickness of refractive index 1.6 (relative to air) is placed in the path of light from one of the slits, the central fringe moves through some distance. This distance is equal to the width of 30 interference bands if light of wavelength 4800 \AA is used. The thickness (in μm) of mica is:

COMPREHENSION-1 :

A certain transmission line (very long) is constructed from two thin metal plates (parallel to each other) of width b , which are separated by a very small distance ' h ' $<$ ' b '. The current travels down one strip and back along the other, and it is distributed uniformly over the surface of the plates as shown in figure. Neglect fringing field at ends of plates.



31. Capacitance per unit length of this combination is
 (A) Infinite (B) $\frac{\epsilon_0 h^2}{b}$ (C) $\frac{\epsilon_0 b^2}{h^2}$ (D) $\frac{\epsilon_0 b}{h}$
32. Magnetic field between the space of two plates is
 (A) $\frac{\mu_0 I}{2h}(\hat{k})$ (B) $\frac{\mu_0 I b}{2h^2}(\hat{k})$ (C) $\frac{\mu_0 I}{b}(-\hat{k})$ (D) $\frac{\mu_0 I h}{b^2}(-\hat{k})$
33. Self inductance per unit length of combination is (c is speed of light)
 (A) $\frac{b}{\epsilon_0 c^2 h}$ (B) $\frac{c^2 h}{\epsilon_0 b}$ (C) $\frac{h}{\epsilon_0 c^2 b}$ (D) $\frac{c^2 b}{\epsilon_0 h}$

COMPREHENSION-2 :

A fan operates at 200 volt (DC) consuming 1000 W when running at full speed. It's internal wiring has resistance 1Ω . When the fan runs at full speed, its speed becomes constant. This is because the torque due to magnetic field inside the fan is balanced by the torque due to air resistance on the blades of the fan and torque due to friction between the fixed part and the shaft of the fan. The electrical power going into the fan is spent (i) in the internal resistance as heat, call it P_1 (ii) in doing work against internal friction and air resistance producing heat, sound etc., call it P_2 . When the coil of fan rotates, an emf is also induced in the coil. This opposes the external emf applied to send the current into the fan. This emf is called back-emf, call it 'e'. Answer the following questions when the fan is running at full speed.

34. The current flowing into the fan and the value of back emf 'e' is :
 (A) 200 A, 5 volt (B) 5 A, 200 volt (C) 5 A, 195 volt (D) 1 A , 0 volt
35. The value of power ' P_1 ' is
 (A) 1000 W (B) 975 W (C) 25 W (D) 200 W
36. The value of power ' P_2 ' is
 (A) 10000 W (B) 975 W (C) 25 W (D) 200 W

COMPREHENSION-3 :

Consider a conducting circular loop placed in a magnetic field as shown. When magnetic field changes with time, magnetic flux also changes and emf is induced.

$$e = - \frac{d\phi}{dt}$$

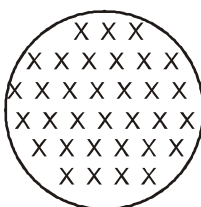
If resistance of loop is R then induced current .

$$i = \frac{e}{R}$$

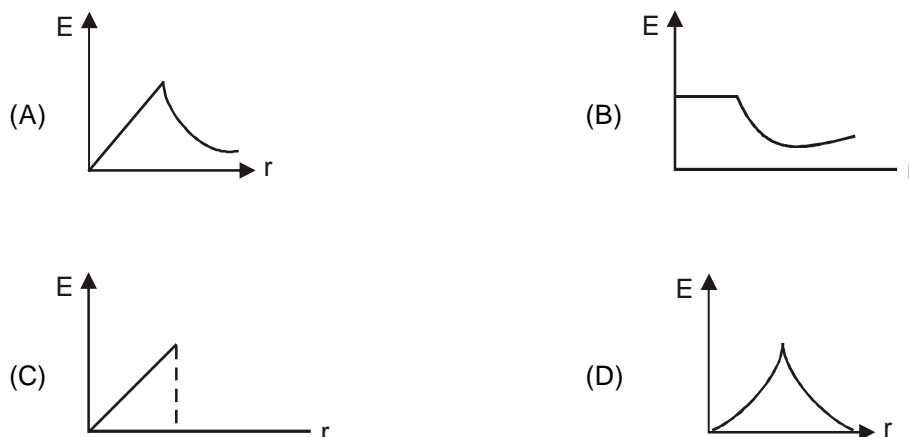
For Current, charge must have come into motion. Magnetic force cannot make the stationary charges to move. Actually there is an induced electric field in the conductor caused by changing magnetic flux, which make the charge to move

$$\int \vec{E} \cdot d\vec{\ell} = e = - \frac{d\phi}{dt}$$

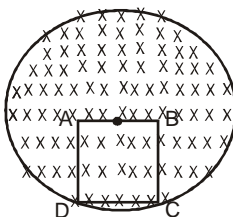
This induced electric field is non- electrostatic by nature. Line integral of \vec{E} around a closed path is non - zero



37. The magnetic field within cylindrical region whose cross - section is indicated starts increasing at a constant rate α tesla/sec The graph showing the variation of induced electric field with distance r from the axis of cylinder is :



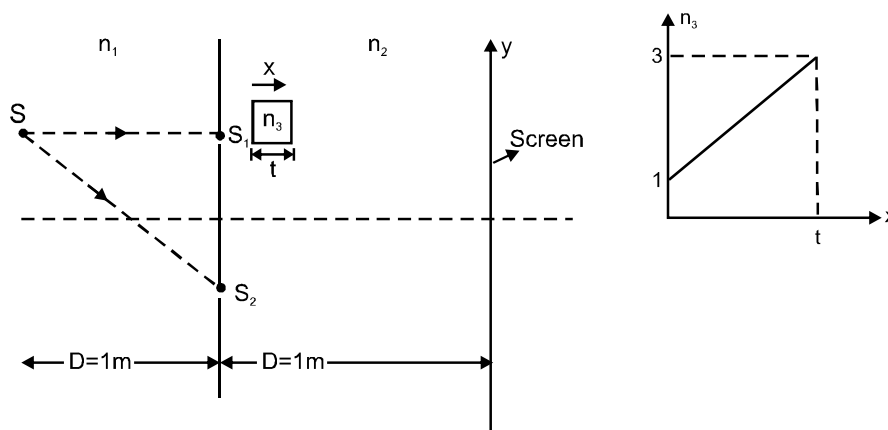
38. A square non-conducting loop 20 cm on a side is placed in a magnetic field. The centre of side AB coincides with the centre of magnetic field. The magnetic field is increasing at the rate of 2T/s. Find the magnitude of line integral of induced electric field along path BC.



- (A) 10 mV (B) 20 mV (C) 30 mV (D) zero
39. Refer to above questions, Find the magnitude of line integral of induced electric field along path CD.
 (A) 40 mV (B) 60 mV (C) 80 mV (D) zero

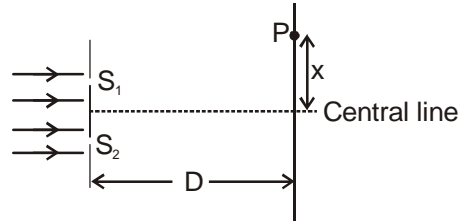
COMPREHENSION-4:

In YDSE arrangement as shown in figure, fringes are seen on screen using monochromatic source S having wavelength 3000 \AA (in air). S_1 and S_2 are two slits separated by $d = 1 \text{ mm}$ and $D = 1 \text{ m}$. Left of slits S_1 and S_2 medium of refractive index $n_1 = 2$ is present and to the right of S_1 and S_2 medium of $n_2 = 3/2$, is present. A thin slab of thickness 't' is placed in front of S_1 . The refractive index of n_3 of the slab varies with distance from its starting face as shown in figure.



40. In order to get central maxima at the centre of screen, the thickness of slab required is :
 (A) 1 \mu m (B) 2 \mu m (C) 0.5 \mu m (D) 1.5 \mu m
41. If thickness of the slab is selected 1 \mu m , then position of central maxima will be : (y-coordinate)
 (A) $\frac{1}{3} \text{ mm}$ (B) $-\frac{1}{3} \text{ mm}$ (C) $\frac{1}{6} \text{ mm}$ (D) $-\frac{1}{6} \text{ mm}$
42. Fringe width on the screen is :
 (A) 0.4 mm (B) 0.1 mm (C) 0.2 mm (D) 0.3 mm

43. A parallel beam of light consisting of two wavelengths $\lambda_1 = 4000 \text{ \AA}$ and $\lambda_2 = 8000 \text{ \AA}$ is incident perpendicular to plane of both slits in a typical Young's double slit experiment. The separation between both slits is $d = 2\text{mm}$ and the distance between slits and screen is $D = 1$ meter. In each situation of column-I a point P on screen is specified by its distance ' ℓ ' from central bright on screen. Match the proper entries from column-2 to column-1 using the codes given below the columns,



Column-I

- (P) At P such that $\ell = 0$
 (Q) At P such that $\ell = 0.1 \text{ mm}$
 (R) At P such that $\ell = 0.2 \text{ mm}$
 (S) At P such that $\ell = 0.4 \text{ mm}$

	P	Q	R	S
(A)	3	2	4	3
(B)	1	2	3	1
(C)	1	4	4	3
(D)	3	2	1	2

Column-II

- (1) intensity is maximum for $\lambda_1 = 4000 \text{ \AA}$
 (2) intensity is minimum for $\lambda_1 = 4000 \text{ \AA}$
 (3) intensity is maximum for $\lambda_2 = 8000 \text{ \AA}$
 (4) intensity is minimum for $\lambda_2 = 8000 \text{ \AA}$

44. Time varying magnetic field is present in a circular region of radius R. Match the proper entries from column-2 to column-1 using the codes given below the columns,

Column I

- (P) An unsteady magnetic field
 (Q) Induced electric field at a point within magnetic field ($r < R$)
 (R) Induced electric field at a point outside the magnetic field ($r > R$)
 (S) If a rod is placed along the diameter of the magnetic field

Column II

- (1) Electric field is perpendicular to the length of rod
 (2) $\frac{r}{2} \frac{dB}{dt}$
 (3) $\frac{R^2}{2r} \frac{dB}{dt}$
 (4) Induced electric field.

Codes :

	P	Q	R	S
(A)	3	2	1	4
(B)	2	1	3	4
(C)	4	2	1	3
(D)	4	2	3	1

45. In a series RLC AC circuit, the frequency of source can be varied. When frequency is varied gradually in one direction from f_1 to f_2 , the power is found to be maximum at f_1 . When frequency is varied gradually at the other direction from f_1 to f_3 , the power is found to be same at f_1 and f_3 . Match the proper entries from column-2 to column-1 using the codes given below the columns, (consider $f_1 > f_2$)

Column-I

When the frequency is equal to

(AM : arithmetic mean ; GM : geometric mean)

- (P) AM of f_1 and f_2
 (Q) GM of f_1 and f_2
 (R) AM of f_1 and f_3
 (S) GM of f_1 and f_3

	P	Q	R	S
(A)	4	3	2	4
(B)	3	1	3	2
(C)	2	1	2	3
(D)	1	3	3	4

Column-II

The circuit is or can be

- (1) capacitive
 (2) inductive
 (3) resistive
 (4) at resonance

ANSWER KEY OF DPP NO. # 04

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|---------------|-----------|-------------|-------------|---|-------------|-----------|
| 1. (A) | 2. (A) | 3. (A) | 4. (C) | 5. (A) | 6. (B) | 7. (D) |
| 8. (C) | 9. (C) | 10. (B) | 11. (D) | 12. (B) | 13. (C) | 14. (C) |
| 15. (A) | 16. (B,C) | 17. (A,B,D) | 18. (A,B,C) | 19. (A,C,D) | 20. (B,C,D) | 21. (B,D) |
| 22. (A,B,C,D) | 23. (A,C) | 24. 8 | 25. 1 | 26. 1 | 27. 8 | |
| 28. 6 m/sec | 29. 7 | 30. 5 | 31. 12 | 32. 20 | 33. 2600 | |
| 34. (C) | 35. (B) | 36. (D) | 37. (A) | 38. (D) | 39. (B) | 40. (C) |
| 41. (A) | 42. (D) | 43. (B) | 44. (B) | 45. (A) – p,t ; (B) – p,q ; (C) – q,s ; (D) – p,q,r | | |