GUIDED REVISION

SECTION-I

Single Correct Answer Type 10 Q. [3 M (–1)]

1. If the differential equation given by

$$\frac{d^2y}{dt^2} + 2k\frac{dy}{dt} + \omega^2 y = F_0 \sin \pi t$$

describes the oscillatory motion of body in a dissipative medium under the influence of a periodic force, then the state of maximum amplitude of the oscillation is a measure of

(A) free vibration (B) damped vibration

(C) forced vibration (D) resonance

2. On passing through a telescope a flux of light increases its intensity $\eta = 4.0 \times 10^4$ times. Find the angular dimension of a distant object if its image formed by that telescope has an angular dimension $\psi' = 2.0°$.

(A) 0.6' (B) 0.7' (C) 0.4' (D) 1.2'

3. A microscope is having objective of focal length 1 cm and eye-piece of focal length 6 cm. If tube length is 30 cm and image is formed at the least distance of distinct vision, what is the magnification produced by the microscope ? Take D = 25 cm.

(A) 6 (B) 150 (C) 25 (D) 125

4. An RLC series circuit is driven by a sinusoidal emf with angular frequency ω_d. If ω_d is increased without changing the amplitude of the emf, the current amplitude increases. If L is the inductance, C is the capacitance, and R is the resistance, this means that

(A) $\omega_d L < \frac{1}{\omega_d C}$ (B) $\omega_d L > \frac{1}{\omega_d C}$

(C) $\omega_d L = \frac{1}{\omega_d C}$ (D) $\omega_d L > R$

5. Damped harmonic oscillator consists of a block (m = 2 kg), a spring ($k = 8\pi^2$ N/m), and a damping force (F = –bv). Initially, it oscillates with an amplitude of 25 cm. Because of the damping, the amplitude falls to three-fourths of this initial value at the completion of four oscillations. What is the value of b? (Assume small damping and take : $\ell n\left(\frac{3}{4}\right) = -0.28$)

(A) 0.36 kg/s (B) 0.9 kg/s (C) 0.28 kg/s (D) 0.54 kg/s

6. A far sighted person cannot see objects closer to eye than 100cm. The power of lens which will enable him to read at a distance of 25cm will be

(A) 3D (B) 1D (C) 4D (D) 2D

7. Chromatic aberration of a lens can be corrected by :

(A) providing different suitable curvature of its two surfaces

(B) proper polishing of its two surface

(C) suitably combining it with another lens

(D) reducing its aperture

8. Angular magnification for an astronomical telescope is 5 and the tube length for image at infinity is 36cm. Then find tube length for image formed at least distance of distinct vision for nomal eye (25 cm)

(A) 36.4 cm (B) 34.8 cm (C) 30.2 cm (D) 38 cm

9. A simple telescope consisting of an objective of focal length 60 cm and a single eye lens of focal length 5 cm is focussed on a distant object in such a way that parallel rays emerge from the eye lens. If the object subtend an angle of 2° at the objective then the angular width of the image is :-

(A) 10° (B) 24° (C) 50° (D) 36°

10. The primary purpose of using a parabolic mirror in a reflecting telescope is

(A) To collect more light from a distant galaxy

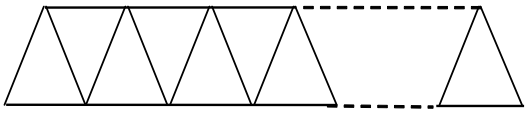
(B) To increase the magnification

(C) To over come diffraction effects

(D) To correct spherical aberration

Multiple Correct Answer Type 3 Q. [4 M (–1)]

11. n number of identical equilateral prism are kept in contact as shown in figure. If deviation through a single prism is δ. Then- (n, m are integers)



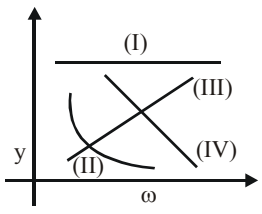
(A) If n = 2m, deviation through n prisms is zero

(B) If n = 2m + 1, deviation through system of n prisms is δ

(C) If n = 2m, deviation through system of n prisms is δ

(D) If n = 2m + 1, deviation through system of n prisms is zero

12. In a series LCR circuit, different physical quantities vary with frequency ω. Which of the following curves represent correct frequency variation of the corresponding quantity ?



(A) Curve I for R (B) Curve II for current I

(C) Curve III for X_L (D) Curve IV for X_C

13. In a series LCR circuit, when an alternating voltage of peak value 500 V and angular frequency 100 rad/s is applied, the peak voltage drops across L, C and R can be respectively

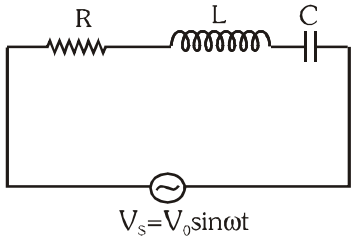
(A) 200 V, 300 V, 0 (B) 800 V, 500 V, 400 V

(C) 600 V, 200 V, 300 V (D) 1200 V, 1600 V, 0 V

Linked Comprehension Type (2 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

Paragraph for Questions no. 14 to 16

Many ac circuits used in practical electronic systems involve resistance, inductive reactance, and capacitive reactance. A simple example is a series circuit containing a resistor, an inductor, a capacitor, and an ac source, as shown in figure. To analyze this and similar circuits, we will use a phasor diagram that includes the voltage and the current phasors for each of the components. In this circuit, because of Kirchhoff's loop rule, the instantaneous total voltage V_{ad} across all the three components is equal to the source voltage at that instant. We will show that the phasor representing this total voltage is the vector sum of the phasors for the individual voltages.



Impedance of circuit $Z=\sqrt{R^2+X^2}=\sqrt{R^2+\left(\omega L-\frac{1}{\omega C}\right)^2}$

14. If ω is small then impedance will be mainly decided by

(A) R and ωL (B) R and $\frac{1}{\omega C}$ (C) ωL and $\frac{1}{\omega C}$ (D) None of these

15. If ω is large then impedance will be mainly decided by

(A) R and ωL (B) R and $\frac{1}{\omega C}$ (C) ωL and $\frac{1}{\omega C}$ (D) None of these

16. If $V_s = 200 \sin 100t$, R= 500 Ω, L = 10 H and C = 20 μF, find the value of impedance of circuit.

(A) 500 Ω (B) $500\sqrt{2}\Omega$ (C) 1000 Ω (D) 825 Ω

Paragraph for Question 17 to 19

Compound microscope & refracting type astronomical telescope, both utilise two convex lens in general arranged at the ends of a co–axial tube but one of them is used to see small objects while the other is used to see distant large objects. For both the instruments resolving power varies inversely with wavelength of light used & magnifying powers : $M.P._{Telescope}=\frac{f_o}{f_e}$, $M.P._{microscope}=\frac{-L}{f_o}\left(1+\frac{D}{f_e}\right)$

17. You are given four convex lenses 1, 2, 3 & 4 having powers P_1 = 2D, P_2 = 5D, P_3 = 6D & P_4 = 1D respectively.
Choose two appropriate lens to make telescope.

(A) 1, 2 (B) 2,3 (C) 3,4 (D) 4,1

18. Using the data given in above question choose appropriate lens for making microscope.

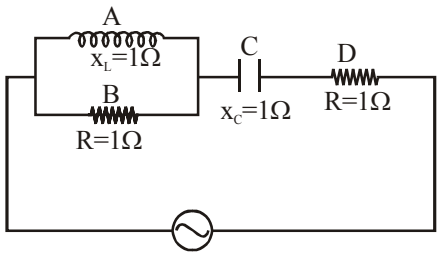
(A) 1,2 (B) 2,3 (C) 3,4 (D) 4,1

19. If the object viewed by above instruments changes color from red to blue, then

(A) resolving power of microscope increases but for telescope, it decreases
(B) resolving power of telescope increases but for microscope, it decreases
(C) resolving power for both instruments decreases
(D) resolving power for both instruments increases

Matching List Type (4 × 4) 1 Q. [3 M (–1)]

20.



List-I	List-II
(P) Phase of current in B leads voltage of A by a phase θ	(1) $0 < \theta < \frac{\pi}{2}$
(Q) Phase of current in D leads voltage of C by phase θ	(2) $-\frac{\pi}{2} < \theta < 0$
(R) Phase of voltage in D leads current of B by phase θ	(3) $\theta = 0$
(S) Phase of current in C leads current of A by phase θ	(4) $\theta = +\frac{\pi}{2}$

Code :

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

SECTION-II

Numerical Answer Type Question (upto second decimal place) 1 Q. [3(0)]

1. An LCR series circuit with 100Ω resistance and $\frac{1}{\sqrt{3}}$ H inductance is connected to an AC source of 200V and angular frequency 300 rad/s. When the inductor is removed, the current leads the voltage by 60°. The current in the circuit when all the components are present is I amp and power dissipated in LCR circuit is P watt. Fill the value of P × I in OMR sheet.

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) 2 Q. [4 M (0)]

1. An RLC circuit includes a 1.6 H inductor and a 250 μF capacitor rated at 400 V. The circuit is connected across a sine-wave generator whose peak voltage is 32V. What minimum resistance must the circuit have to ensure that the capacitor voltage does not exceed its rated value when the generator is at the resonant frequency? approximate your answer to neartest integer.

2. An alternating voltage of 260 volt and ω = 100 radian/second, is applied in an LCR series circuit where L = 0.01 H, C = 4×10^{-4} F and R = 10Ω. The power supplied by the source is 200 k. Find the value of k.

Subjective Type **1 Q. [4 M (0)]**

1. The eye piece of an astronomical telescope has a focal length of 10 cm. The telescope is focussed for normal vision of distant objects when the tube length is 1.0 m. Find the focal length of the objective and the magnifying power of the telescope.

ANSWER KEY	GR # DAMPED + FORCED OSCILLATION, OPTICAL INSTRUMENTS		
SECTION-I			
Single Correct Answer Type			**10 Q. [3 M (–1)]**
1. Ans. (D)	**2. Ans. (A)**	**3. Ans. (D)**	**4. Ans. (A)**
5. Ans. (C)	**6. Ans. (A)**	**7. Ans. (C)**	**8. Ans. (B)**
9. Ans. (B)	**10. Ans. (D)**		
Multiple Correct Answer Type			**3 Q. [4 M (–1)]**
11. Ans. (A, B)	**12. Ans. (A, C)**	**13. Ans. (B,C)**	
Linked Comprehension Type (Single Correct Answer Type)			**(2 Para × 3Q.) [3 M (-1)]**
14. Ans. (B)	**15. Ans. (A)**	**16. Ans. (B)**	**17. Ans. (C)**
18. Ans. (B)	**19. Ans. (D)**		
Matching List Type (4 × 4)			**1 Q. [3 M (–1)]**
20. Ans. (C)			
SECTION-II			
Numerical Answer Type Question (upto second decimal place)			**1 Q. [3(0)]**
1. Ans. 800			
SECTION-III			
Numerical Grid Type (Ranging from 0 to 9)			**2 Q. [4 M (0)]**
1. Ans. 6	**2. Ans. 5**		
Subjective Type			**1 Q. [4 M (0)]**
1. Ans. 90cm, 9			

SOLUTIONS
SECTION-I

Single Correct Answer Type **10 Q. [3 M (–1)]**

1. Ans. (D)

Sol. Here, the state of maximum amplitude of the oscillation is a measure of resonance.

2. Ans. (A)

Sol. $\frac{I_1}{I_2} = 4\times10^4 = \frac{A_1}{A_2} = \frac{d_1^2}{d_2^2}$

$\Rightarrow \frac{d_1}{d_2} = 2\times10^2$

$\Rightarrow \frac{d_1}{d_2} = \frac{\theta_1}{\theta_2} = \frac{2}{\theta_2} = 2\times10^2$

$\Rightarrow \theta_2 = \left(\frac{1}{10^2}\right)^0 = \left(\frac{60}{100}\right)' = 0.6'$

3. Ans. (D)

Sol. $m = \left|\frac{v_0}{u_0}\right| \times \left(\frac{D}{f_e}+1\right)$ $\qquad v_e = -D$

$-\frac{1}{D} - \frac{1}{u_e} = \frac{1}{f} \Rightarrow \frac{1}{u_e} = -\frac{1}{25} - \frac{1}{6} = -\frac{31}{150}$

$v_0 = \ell - |u_e| = 30 - \frac{150}{31} = \frac{780}{31}$

$\frac{1}{v_0} - \frac{1}{u_0} = \frac{1}{f_0} \Rightarrow 1 - \frac{v_0}{u_0} = \frac{v_0}{f_0}$

$\frac{v_0}{u_0} = 1 - \frac{v_0}{f_0} = -\frac{749}{31}$

$m = \left(\frac{749}{31}\right)\left(\frac{31}{6}\right) \approx 125$

4. Ans. (A)

Sol. since peak current is increasing on increasing $\Rightarrow \left|\omega h - \frac{1}{\omega C}\right|$ must decrease on increasing ω.

5. Ans. (C)

Sol. We assume that b is small compared to $\sqrt{\frac{k}{m}}$ and we take $T = 2\pi\sqrt{(m/k)} = 1\,s$. It is given that at t = 4T, the amplitude falls to 3A/4, i.e.

$e^{-bt/2m} = 3/4$

$-2bT/m = \ln(3/4)$

or b = 0.28 kg/s.

6. Ans. (A)

Sol. We have to make image of object at 25 cm at 100 cm

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}\Rightarrow -\frac{1}{100}+\frac{1}{25}=\frac{1}{f}$$

$$\Rightarrow \frac{1}{f}=\frac{3}{100}\Rightarrow \text{Power} = 3\text{D}$$

7. Ans. (C)

Sol. Chromatic aberration are fixed by combining lenses of different focal lengths.

8. Ans. (B)

Sol. $M_\infty = \frac{f_0}{f_e}$ and tube length $= f_0 + f_e$

$$\frac{f_0}{f_e} = 5,\ f_0 + f_e = 36 \Rightarrow 6f_e = 36$$

$f_e = 6\text{cm}$ .... (1)

$f_0 = 30\text{ cm}$ .... (2)

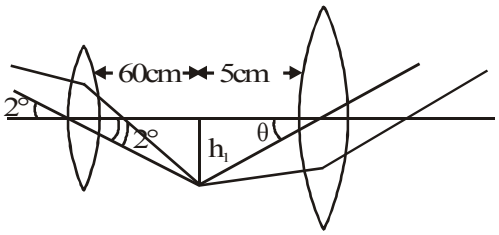
tube length for image at D

$$L = f_0 + \frac{Df_e}{D+f_e} = 30 + 4.8$$

$= 34.8$ cm

9. Ans. (B)

Sol.



$$2° = \frac{h_1}{60} \quad \text{... (1)}$$

$$\theta = \frac{h_1}{5} \quad \text{...(2)}$$

eq (2) ÷ eq (1) ...

$$\Rightarrow \frac{\theta}{2} = \frac{60}{5}$$

$\theta = 24°$

10. Ans. (D)

Sol. Paraboloid surface is used to remove spherical aberrations.

Multiple Correct Answer Type 3 Q. [4 M (–1)]

11. Ans. (A, B)

Sol. $\delta_{net} = \delta_1 + \delta_2 + ... + \delta_n$

where all have same magnitude and alternate deviations are in opposite direction.

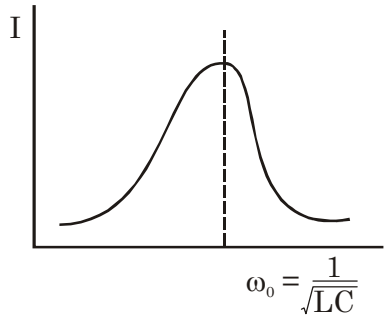
12. Ans. (A, C)

Sol. R remains constant (I)

$X_L = \omega L$ increases linearly (III)

$X_C = \dfrac{1}{\omega C}$ rectangular hyperbola (II)

I – ω graph



13. Ans. (B,C)

Sol. $\sqrt{V_R^2 + (V_C - V_L)^2} = V$

This relation is true for (B,C)

Linked Comprehension Type (2 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

14. Ans. (B)

Sol. At low frequencies $Z \approx \sqrt{R^2 + \left(\dfrac{1}{\omega C}\right)^2}$

15. Ans. (A)

Sol. At high frequencies $Z \approx \sqrt{R^2 + (\omega L)^2}$

16. Ans. (B)

Sol. $Z = \sqrt{R^2 + \left(\omega L - \dfrac{1}{\omega C}\right)^2} = \sqrt{(500)^2 + \left(100 \times 10 - \dfrac{1}{100 \times 20 \times 10^{-6}}\right)^2} = \sqrt{500^2 + (1000 - 500)^2} = 500\sqrt{2}\Omega$

17. Ans. (C)

Sol. As for telescope lenses having highest focal length & lowest focal length should be used to get highest magnification as $M = \dfrac{f_0}{f_e}$

18. Ans. (B)

Sol. As for microscope lenses having shortest focal length i.e. high powers should be used to get highest magnification, as $M = -\dfrac{L}{f_0}\left(1 + \dfrac{D}{f_e}\right)$

19. Ans. (D)

Sol. Limt of resolution $(\theta) = \dfrac{1.22\lambda}{d}$

resolving power $= \dfrac{1}{\theta} \propto \dfrac{1}{\lambda}$

Matching List Type (4 × 4) 1 Q. [3 M (–1)]

20. Ans. (C)

Sol. (P) $V_A = V_B = i_B R$ $\theta = 0$

(Q) $i_C = i_D$

in capacitor current leads by $\frac{\pi}{2}$

$\theta = +\frac{\pi}{2}$

(R) $V_A = V_B$

$R_{eq} = \frac{1 \times (j)}{(1+j)} = \frac{1+j}{2}$

In a combination of inductor & resistor, voltage will lead the current by θ where $0 < \theta < \frac{\pi}{2}$

(Phase I_B = Phase V_B) leads (Phase $I_{(A+B)}$ = Phase I_D)

(S) V_A leads I_A by $\frac{\pi}{2}$

V_A leads I_C by $0 < \theta < \frac{\pi}{2}$

hence, I_C leads I_A by $0 < \theta < \frac{\pi}{2}$

SECTION-II

Numerical Answer Type Question **1 Q. [3(0)]**

(upto second decimal place)

1. Ans. 800

Sol. $\frac{X_C}{R} = \tan 60°$ so $X_C = 100\sqrt{3}\,\Omega$

$X_L = \omega L = 300 \times \frac{1}{\sqrt{3}} = 100\sqrt{3}\,\Omega$

So resonance condition,

Z = R, power factor = 1

$I = \frac{V}{Z} = \frac{200}{R} = \frac{200}{100} = 2A$

$P = VI\cos\phi = 200 \times 2 \times 1 = 400$ watt

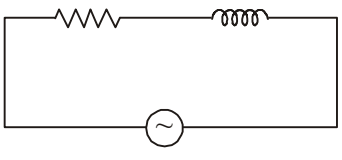
$P \times I = 400 \times 2 = 800$

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) **2 Q. [4 M (0)]**

1. Ans. 6

Sol.



$i = \frac{V_0}{Z} = \frac{V_0}{R}$

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{1.6 \times 250 \times 10^{-6}}} = 50$$

$$V_C = i \times \frac{1}{\omega_C} = \frac{V_0}{\omega CR}$$

$$400 = \frac{32}{50 \times 250 \times 10^{-6} \times R}$$

$$R = \frac{32 \times 10^{-6}}{50 \times 250 \times 400} = 6.4\Omega$$

2. Ans. 5

Sol. $P = i_{rms} V_{rms} \cos\phi$

$V_{rms} = 260$ volt

$$i_{rms} = \frac{v_{rms}}{z} = \frac{260}{26} = 10$$

$$\text{P.F.} = \cos\phi = \frac{R}{z} = \frac{10}{26}$$

$$\because\ z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega c}\right)^2} = 26$$

$$\therefore\ P = (10)\,(260)\left(\frac{10}{26}\right) = 1000\ W$$

Subjective Type

1 Q. [4 M (0)]

1. Ans. 90cm, 9

Sol. $L = f_0 + f_e$

$100 = f_0 + 10 \Rightarrow f_0 = 90$ cm

$$m = \frac{f_0}{f_e} = \frac{90}{10} = 9$$