Assignment 2 ANSWERS

1 MARKS

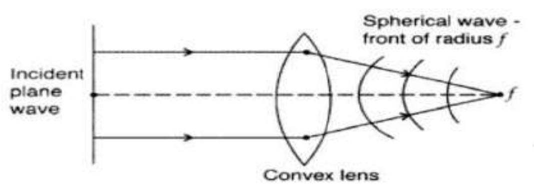
1. When two light waves of same frequency and having zero or constant phase difference travelling in the same direction superpose each other , the intensity in the region of superposition gets redistributed becoming minimum at some points and maximum at others. This phenomenon is called interference of light.

   Example :When thin soapy water films (or other thin films) are exposed to white light ,they exhibit colours due to interference.

2. Coherent sources have a constant phase difference this ensures that the position of maxima and minima do not change with time. Hence sustained interference pattern is obtained.

3. Path difference $\Delta = n\,\lambda$

   Where n = 0,1,2.....

4. 

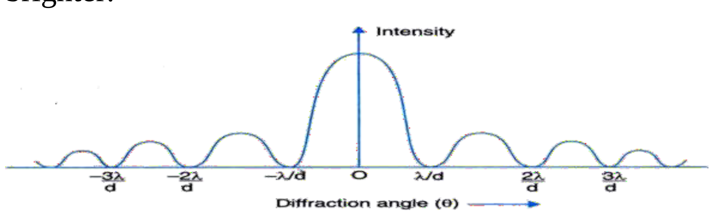
5. Angular separation $\theta = \lambda/d$ and it is independent of slit-screen separation

   ∴ There will be no change

6. If the width of the diffraction slit is doubled, the size of the central diffraction band will become half and its intensity will become four times of its original value.

7. The source which emits a light wave with the same frequency, wavelength and phase or having a constant phase difference is known as a coherent source.

8. There will be an interference pattern whose fringe width is the same as that of the original. But there will be a decrease in the contrast between the maxima and the minima, i.e. the maxima will become less bright and the minima will become brighter.

9. 

MCQ

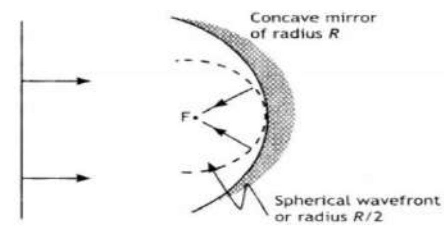
10. B
11. A
12. C
13. D
14. B
15. D
16. C
17. B
18. A
19. B

2 MARKS

20.

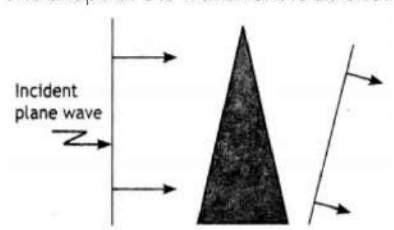
Interference	Diffraction
Interference occurs due to superposition of light coming from two coherent sources.	It is due to the superposition of the waves coming from different parts of the same wave front
All bright fringes are of equal intensity	The intensity of bright fringes decreases with increasing distance from the central bright fringes.

21.



(a)

The shape of the wavefront is as shown.



(b)

22. Sustained interference means the positions of that maxima and minima of light intensity do not change with time throughout the screen.

Conditions for sustained interference :

1The two sources should continuously emit waves of same frequency or wavelength.

2The two sources of light should be coherent.

3The two sources of light should be narrow.

4The two sources of light should be monochromatic.

5The interfering wave must travel nearly along same direction.

23. The linear width of central maxima $\beta_0 = 2D\lambda / a$

(i) It is replaced with red light the linear width of Central Maxima increases because λ red > λyellow

(ii) If D is increased linear width of Central maximum increases.

24. The linear width of central maxima $\beta_0 = 2D \lambda / a$

(i) When wavelength of light is increased the width of central maxima increases

(ii)When width of slit increase the width of central maxima decreases.

As the wavelength of light in water decreases so the width of central maxima also decreases.

3MARKS

25.

Λ = 600nm , D = 0.8m

The distance of second order maximum from the centre of the screen = 15mm = $15X10^{-3}$m

$$a = \frac{n\lambda}{\sin\theta} = \frac{n\lambda D}{x}$$

$$a = \frac{(2x600x10^{-9}x0.9)}{15x10^{-3}} = 6.4x10^{-5}m$$

26. (a) y3 = n. Dλ/d

= 3 x 1.2m x 6500 x 10-10m / 2 x 10-3m

= 0.12cm

(b) Let nth maxima of light with wavelength 6500 Å coincides with that of mth maxima of 5200Å.

m x 6500Ao x D/d = n x 5200A^{o} x D/d

m/n = 5200/6500

= 4/5

Least distance = y4 = 4.D (6500Ao)/d

= 4 x 6500 x 10-10 x 1.2/ 2 x 10-3m

= 0.16cm.

27. Given:

d = 0.3 mm = 3 x10^{-4}m

X = 1.5 mm = 1.5x10^{-3}m

D = 75 cm = 0.75 m.

To find wavelength: -

λ= X d /D

=1.5 x 10^{-3} x 3 x 10^{-4}/ 0.75

= 6 x 10^{-7}m

= 6000 A.U.

1) If distance of screen is doubled.

We have X = λ D/d and

X'= λ D'/d

$\frac{X'}{X} = \frac{D'}{D}$

$\frac{X'}{X} = \frac{2D}{D}$

$\frac{X'}{X} = 2$

= 2 x 1.5 x 10^{-3}

= 3 x 10^{-3}m

= 3 mm

2) If separation between the slits is doubled

We have X =λD/d

$$\frac{X'}{X} = \frac{d}{d'}$$

$$\frac{X'}{X} = \frac{d}{2d}$$

$$\frac{X'}{X} = 1/2$$

= X/2

= $1.5 \times 10^{-3}/2$

= 0.75×10^{-3}m

5 MARKS

28.

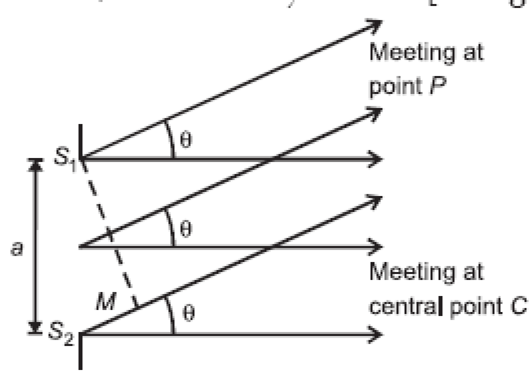
a)

We treat each point on the wavefront at the slit, as secondary sources [Using Huygen's principle].

As the incoming wavefront is parallel to the plane of the slit, these sources are in phase [using Huygen's principle]. The path difference between the waves coming out from the two edges of the slits is $S_2P - S_1P = S_2M$.

$\therefore \quad S_2M = a \sin\theta \approx a\theta$

For any two point sources, S_1 and S_2 in the plane of the slit having a separation y, the path difference would be



[We are taking parallel beam of light because angles are very small]

$$S_2P - S_1P \approx y\theta \qquad \text{i.e. } \Delta P \approx y\theta$$

As the initial phase difference is zero, the phase difference between the waves is introduced only due to this path difference.

For the central point on the screen, $\theta = 0 \Rightarrow \Delta P = 0$

i.e. $\quad \Delta\phi = 0$

All the parts of the slit contribute in phase. So, the maximum intensity is obtained at C.

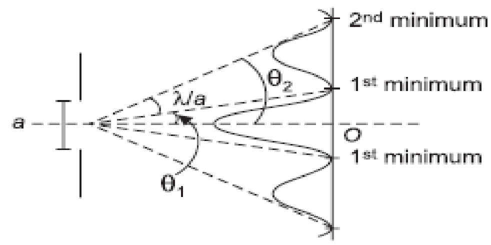
b)

$\therefore \qquad \theta_1 = \frac{\lambda}{a}$

For 2^{nd} minimum, $\theta_2 = \frac{2\lambda}{a}$

Angular width of 1^{st} secondary maximum,

$$\Delta\theta = \frac{2\lambda}{a} - \frac{\lambda}{a} = \frac{\lambda}{a}$$



The central fringe lies between 1^{st} minima on both sides of the central maximum. Hence, the angular width of central fringe is given by $2\theta = \frac{2\lambda}{a}$

Hence, the angular width of central fringe is twice the angular width of first fringe.

(c) The maxima become weaker and weaker with increasing n. This is because the effective part of the wavefront, contributing to the maxima, becomes smaller and smaller, with increasing n.

29. (a) (i) Interference is the superposition of light waves from two different wavefronts originating from the same source, while the diffraction is the interaction of light waves from different parts of the same wavefront.

(ii) In an interference pattern, fringes may or may not be of the same width, while in diffraction pattern, they are never of the same width.

(iii) In an interference pattern, bright fringes are of uniform intensity, while in diffractions pattern, they are of varying intensity.

(b) Given: $\lambda = 5 \times 10^{-7}$ m, $D = 1$ m, $y = 2.5 \times 10^{-3}$m

We know that the half of the width of the central maximum, $y = \frac{\lambda}{a}D$

$\Rightarrow 2.5 \times 10^{-3} = \frac{5 \times 10^{-7}}{a} \times 1$

$\therefore a = 2 \times 10^{-4}$ m or 200 μm

30. (a)

Interference	Diffraction
It is due to superposition of two Waves coming from coherent sources.	It is due to superposition of secondary wavelets originating from different parts of same wavefront.
Width of interference bands is equal	Width of diffraction bands is unequal
Intensity of all fringes is same	Central maxima is bright but intensity decreases with increase in order of maximum.

(b) given λ= 500 nm & a= 0.2 mm,

we have) ω = 2λ/a, ω= .005 rad