STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2015-16 and thereafter)

SUBJECT CODE : 15PH/MC/OS34

B.Sc. DEGREE EXAMINATION NOVEMBER 2018
BRANCH III - PHYSICS
THIRD SEMESTER

COURSE : MAJOR – CORE
PAPER : OPTICS AND SPECTROSCOPY
TIME : 3 HOURS **MAX. MARKS : 100**

SECTION – A

ANSWER ALL QUESTIONS: **(30 x 1 = 30)**

I CHOOSE THE CORRECT ANSWERS:

1. A slide projector has a converging lens of focal length 15 cm is used to magnify the area of a slide 15 cm^2 to 2.4 m^2 on a screen. The Linear magnification of the projector is
   a) 160 b) 40 c) 36 d) 0.16
2. The time taken by light to cross a glass slab of thickness 4 cm and refractive index 1.5 is
   a) $3x10^{-10}$ s b) $1.8x10^{7}$ s c) $2x10^{-10}$ s d) $1.33x10^{-8}$ s
3. A ray of light of wavelength λ in air with velocity v and frequency f enter into water with wavelength λ', velocity v' and frequency f', then
   a) f = 2f' b) f =f' c) λ = 2 λ' d) v = v'
4. When white light is incident on a thin film, the interference color depends upon
   a) thickness and angle of incidence b) thickness and wavelength
   c) intensity and wavelength d) intensity of incident light
5. The diameter of 8^{th} ring changes from 18.4 mm to 16.5 mm when a liquid is introduced between the lens and the glass plate of Newton's ring setup. The refractive index of the liquid is
   a) 1.321 b) 1.341 c) 1.221 d) 1.243
6. The phase difference between two monochromatic light waves of wavelength 4000 Å is π. The path difference is
   a) $2x10^{-7}$ m b) $4.7x10^{-3}$ m c) $1.27x10^{-7}$ m d) $1.25x10^{-3}$ m
7. A grating 5 cm wide with 3000 lines per cm is used to resolve two wavelengths in a spectral line. The resolving power of the same grating will be _____if the spacing is 2.5 cm wide is
   a) remains same b) ¼ times c) twice d) ½ times
8. The radius of the first zone in a zone plate of focal length 18 cm for light of wavelength 560 nm is
   a) 31.7 mm b) 0.317 mm c) 10.2 mm d) 3.11 μm
9. The smallest value of θ just resolved by telescope objective of diameter D is
   a) $\theta = \frac{12.2\ \lambda}{D}$ b) $\theta = \frac{12.2\ D}{\lambda}$ c) $\theta = \frac{1.22\ D}{\lambda}$ d) $\theta = \frac{1.22\ \lambda}{D}$
10. A parallel beam of natural light is incident at an angle 58˚ on a plane glass surface; the reflected ray is completely polarized. The angle of refraction of the transmitted light is
    a) 90˚ b) 32˚ c) 122˚ d) 148˚
11. The refractive index of Canada balsam is
    a) 1.5 b) 1.55 c) 1.38 d) 2.5
12. When a ray of light is incident perpendicular to the optic axis on the calcite crystal, the ordinary and extraordinary rays travel in the
    a) same velocities with different direction b) same velocities with same direction
    c) same direction with different velocities d) same direction with same velocities

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13. In IR spectrum symmetric bending mode of vibration of CO_2 molecule is
    a) 1330 cm^{-1} b) 1670 cm^{-1} c) 667 cm^{-1} d) 2349 cm^{-1}
14. Irradiation of $NaCl_2$ by 4352 Å radiation gives Raman line at 4380 Å. The Raman shift in cm^{-1} is
    a) 146 cm^{-1} b) 1.46 cm^{-1} c) 457 cm^{-1} d) 28 cm^{-1}
15. Ultra-violet spectroscopy has been mainly applied for the detection of
    a) structure of compound b) mode of vibration
    c) polarizability d) functional groups

II FILL IN THE BLANKS:

16. Eyepiece which cannot be used in telescope for measuring angels is _____
17. Material whose index of refraction is greater than that of glass is deposited on glass surface, the reflectivity is _____
18. In high quality camera lenses, the resolution is determined by _____
19. In right hand quartz crystal, the clockwise component travels _____ than the anticlockwise component.
20. _____ light rays are used in procedures for the reduction of cellulite and fat digestion.

III STATE WHETHER TRUE OR FALSE:

21. Lens whose ratio of radii of curvature 1/6 is called crossed lens.
22. In thin film the visibility of the fringes is much higher in the transmitted system than in the reflected system.
23. Spherical waves can be used to understand diffraction for aperture that is relatively large compared to wavelength.
24. Light from blue sky is strongly polarized.
25. UV-vis region depends mainly on the electronic structure of the molecules.

IV ANSWER BRIEFLY:

26. Define power of lens. Give its unit.
27. Does a microscope have better resolution with red light or blue light?
28. Why is diffraction grating better than a two slit setup for measuring wavelengths of light?
29. Mention the various factors depend upon rotating the polarized light.
30. Distinguish between Stoke's and Anti-stoke's lines.

SECTION – B

ANSWER ANY FIVE QUESTIONS: (5 x 5 = 25)

31. In an eyepiece, the diameter of aperture of a plano-convex lens is 4 cm and its maximum thickness is 2 mm. Calculate the focal length of the lens, if the velocity of light in the material of the lens is $2x10^8$ ms^{-1}.

32. Explain how will you determine the wavelength of light using Fresnel's biprism?

33. Two glass plates are 15 cm long; at one end they are contact while the other ends they are separated by a thin piece of tissue paper 22 μm thick. The space between the plates contains water of refractive index 1.33. Find the spacing of 5^{th} interference fringes when a monochromatic light of wavelength 550 nm is incident on it.

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34. A plane transmission grating is ruled with 4000 line per inch. Find the angular separation in degrees for the second order spectrum between α and δ lines of atomic hydrogen whose wavelengths are 656 nm and 410 nm respectively in the normal incidence.
35. Explain how a zone plate acts as a convergent lens having multiple foci. Derive an expression for the focal length.
36. Plane polarized light of wavelength 480 nm incident on a birefringent calcite crystal. The phase difference between E and O rays emerging from the crystal is equal to 2π times the difference in the number of wavelengths in the path for the two rays. Find the minimum thickness for a quarter wave calcite crystal and phase difference between E and O rays emergent from the crystal. Given $\mu_o = 1.5442$ and $\mu_E = 1.5533$.
37. The first Stoke's line in the rotational Raman spectrum of H_2 appears at 346 cm^{-1} from the exciting line. Calculate the bond length of H_2 molecule. $^1H = 1.673 \times 10^{-27}$ kg.

SECTION – C

ANSWER ANY THREE QUESTIONS:

(3 x 15 = 45)

38.a) Explain spherical aberration produced by a lenses. Describe how you will minimize it using two Plano-convex lens separated by a distance?

b) In converging achromatic combination, a crown convex lens and a flint concave lens are in contact to produced mean focal length of 30 cm. If the dispersive powers of the convex and concave lenses are in the ratio 1:2. Find the focal length of each lens.

39.a) Describe Michelson interferometer and explain how it can be used for measuring the wavelength of any line in a spectrum.

b) In Michelson interferometer the distance through which the mirror is moved between two consecutive position giving best fringes in the case of sodium lines of wavelength 5896 Å and 5890 Å. Find the difference in wave-number of the two spectral lines of sodium.

40.a) Derive an expression for the resolving power of a telescope. Discuss the relation between the resolving power and the magnifying power.

b) A telescope is used to observe two distant point sources 1 m apart viewed using 500 nm light. The objective of the telescope is covered with a slit of width 1 mm, what is the maximum distance in metre at which the two sources may be distinguished?

41. Describe the process of production and detection of circularly and elliptically polarized light.

42. a) Explain the origin of Infra-Red spectra.

b) Describe the construction and working of a double beam IR spectrophotometer using a neat block diagram. Mention the applications of IR spectroscopy.

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