COLLEGE OF ENGINEERING ROORKEE, ROORKEE
Autumn Semester 2014-2015

Subject: Physics **Subject Code: TPH101**
Polarisation &Magnetic properties **Tutorial Sheet: 6**

Numerical Problems:

1. Two nicols are in crossed position with respect to each other. Now one of them is rotated through 40^o. What percentage of incident unpolarised light will pass through the system? Ans. 41.32 %

2. A beam of light traveling in water strikes a glass plate which is immersed in water. When the angle is 50^o, the reflected beam is found to be plane polarized. Calculate the refractive index of the glass with respect to air if the refractive index of water with respect to air is 1.33. Ans. 1.585

3. The critical angle of light in certain substance is 50^o. Calculate the polarizing angle for it. Ans. 52.55

4. An unpolarised beam of light is incident on a group of five polarizing sheets which are lined up in such away that the characteristic direction of a sheet is rotated through 20^o with respect to the preceding one. What fraction of the incident light is transmitted? Ans. 0.304

5. Calculate the thickness of a calcite plate which would convert plane polarized light into elliptically polarized light. The principal refractive indices are μ_o= 1.66 and μ_e=1.49 for the wavelength 5890A.
Ans. 8.66×10^{-5}cm & its odd multiple.

6. Calculate the thickness of a doubly refracting crystal plate which is required to convert a clockwise circularly polarized light to anticlockwise circularly polarized light. Given μ_e = 1.5388 and μ_o= 1.5212 for the wavelength 600nm. Ans. 1.7×10^{-3}cm & its multiples

7. A phase retardation plate of quartz has thickness 0.18 mm. For what wavelength in the visible range (400-750nm) will act as (i) quarter-wave plate & (ii) half wave plate? Given μ_o= 1.5533 and μ_e=1.5443.
Ans. (i) 720nm,589nm, 498.46nm, 430nm (ii) 648nm, 540nm, 462.86nm, 405nm

8. The refractive indices of quartz for right handed and left handed circularly polarized light of wavelength 6500A are 1.53914 and 1.53920, respectively. Calculate the rotation of plane of polarization in degrees produced by a plate 1.5mm thick. Ans 24.92^o

9. On introducing a polarimeter tube 21cm long and containing a sugar solution of 7% strength, it is found that the plane of polarization is rotated through 10^o. Find the specific rotation of sugar solution.
Ans. 65^o/dm/(gm/cc)

10. A glucose solution is prepared by dissolving 25gm in 250ml of water. The solution is filled in the polarimeter tube of length 20cm. It is observed that this solution rotates the plane of polarization of a polarized light by 9.5^o. If the specific rotation of the glucose is $+52.5^o$/dm/(gm/cc), calculate the percentage purity of the glucose in the solution. Ans. 90.48%

11. 30cm length of certain solution causes right handed rotation of 32^o and 20cm of another solution causes left handed rotation of 24^o. What optical rotation will be caused by a 20cm length of a mixture of the above solutions in the volume ratio 3:2? Ans. 3.2^o clockwise

12. A monochromatic beam of light is passed through a nicol. If the intensity of light changes from I_o to $0.4I_o$on rotating the nicol by 90^o, find (i) the degree of polarization of the incident light if it is partially polarized (ii) the ratio of major and minor axis if the incident light is elliptically polarized. Ans. (i) 0.43 (ii) 1:0.632

13. A beam of light of wavelength 500nm is incident normally on a calcite plate of thickness 0.01cm with its optic axis parallel to the surface. Calculate the phase difference produced between O- and E- rays. If the wavelength of light is 600nm, and μ_o= 1.658 and μ_e=1.486. Also calculate the speeds of ordinary and extra ordinary rays. Ans. radian, x10^8 m/s, x10^8m/s

14. A plane polarized light is passed through 3 different optically active solutions of lengths 10cm, 20cm and 30cm having concentrations in ratio 1:2:3, respectively. The 3rd solution is prepared by dissolving 5gm of sugar in 200ml of water. Find the net rotation produced if the specific rotations of these solutions are +66.5,-19.7, +52.5 deg/dm/(gm/cc), respectively. Ans. +4.7^o

15. A iron road of volume 10^{-3} meter^3 and relative permeability 1200 is placed inside a long solenoid wound with 5 turns per cm. If a current of 0.5 Amp is passed through the solenoid, find the magnetic moment of the rod. Ans. 3x 10^2 A-m^2
16. A material has 10 turns per cm of the wire wound uniformly upon it which carries a current of 2.0 Amp. The flux density in the materials is 1.0 Weber/m^2. Calculate the magnetizing force and magnetization of the material. Ans. 2000 amp-turn/meter, 7.9x10^5 amp-turn/meter
17. A paramagnetic material contains 10^{28} ions/m^3 with magnetic moment of 9.28x 10^{-24} amp-m^2. Calculate the paramagnetic susceptibility and magnetization produced in a uniform magnetic field of 0.1 weber/m^2 when the temperature is 27^{0}C. Ans. 8.6x10^{-5}, 69 amp/m

Theoretical Questions

1. What is double refraction? Give the characteristics of O- and E- rays.
2. Explain the geometry of calcite crystal. Define its optic axis and principal section.
3. Describe the construction and working of Nicol prism. How it is used as a polarizer and an analyzer. What is its limitation?
4. Give the theory of superposition of two linearly polarized waves and hence show that plane polarized and circularly polarized lights are special cases of elliptically polarized light.
5. Describe the methods for the production of (i) a plane polarized light, (ii) a circularly polarized light and (iii) an elliptically polarized light.
6. How can you distinguish between (i) an elliptically polarized light and a mixture of plane polarized and unpolarised light, (ii) a circularly polarized light and an unpolarised light?
7. Explain the term optical rotation. Give Biot's laws of optical rotation and hence explain rotatory dispersion.
8. Give the Fresnel's theory of optical rotation and hence derive the expression for the rotation produced by an optically active substance.
9. Give the construction and working of (i) Biquartz polarimeter and (ii) Half shade polarimeter.
10. Write notes on (i) Quarter wave plate and (ii) Half wave plate.
11. Describe the formation and significance of hysteresis loop.
12. Show that the diamagnetic susceptibility is negative and is independent of temperature.
13. How would you use the hysteresis curves to select materials for the construction of permanent magnet.
14. Draw and explain the curve between magnetic induction and magnetic field intensity for ferromagnetic materials. Also write the important application of the curve.
15. Explain para, dia and ferromagnetism. What do you mean by diamagnetism? Explain Langevin's theory of diamagnetism