# Assignment 2 – 2024 WV (PH2001) --TPS

## Maximum marks: 2x5=10

## Last date of submission: 8th April 2024 (Strictly)

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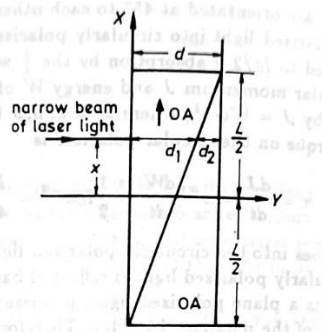
1. The dispersion relation for the gravity waves in a liquid of depth ‘h’, where ‘g’ is the acceleration due to gravity and ‘k’ is the wave number.

$$kh = \tanh^{-1}[\frac{w^2}{gk}]$$

(a) When will the phase and group velocity will be equal?
(b) If K=6.8 m/s, h=0.1 m, f=2π $s^{-1}$ . Find the phase and group velocity.

2. A partially elliptically polarized beam of light, propagating in the x direction, passes through a perfect linear polarization analyser. When the transmission axis of the analyser is along the z direction, the transmitted intensity is maximum and has the value .5 $I_0$. When the transmission axis is along the y direction, the transmitted intensity is minimum and has the value $I_0$.
   (a) What is the intensity when the transmission axis makes angle (θ) with the axis? Does your answer depend on what fraction of the light is unpolarised?
   (b) The original beam is made to pass first through a quarter-wave plate and then through the linear polarization analyser. The quarter-wave plate has its axes lined up with the x and y axes. It is now found that the maximum intensity is transmitted through the two devices when the analyser transmission axis makes an angle of 30° with the z-axis.
   Determine what is the maximum intensity is and determine the fraction of the incident intensity which is unpolarised.

3. Consider the Babinet compensator shown in the following figure.




↑ OA= Optic axis in the plane of the paper and parallel to X-axis
• OA= Optic axis perpendicular to the plane of the paper and parallel to Z-axis
$d \ll L$.

The device is constructed from two pieces of uniaxial optical material with indices $n_e$ and $n_0$ for light polarized perpendicular and parallel to the optic axis respectively. A narrow beam of light of vacuum wavelength λ is linearly polarized in the XZ plane at 45° to X and Z and propagates through the compensator from left to right along the +Y axis as shown (Fig. 2.77).

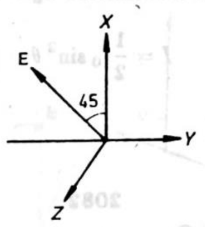



Fig. 2.77

(a) For d<<L, calculate the relative phase shift of the X and Z polarized components of the exit beam. Express your answer in terms of $n_e$, $n_0$, λ, L, d, x.

(b) For what value of x will the emerging light be

   a. Linearly polarized?

   b. Circularly polarized?

4. o Obtain a Fourier series for the function given below:

$$f(x) = \begin{cases} 0, & -\pi < x < 0 \\ 5, & x = 0 \\ \dfrac{1}{4}\pi x & 0 < x < \pi \end{cases}$$

Deduce that $\frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \cdots = \frac{\pi^2}{8}$

5. In a resonant cavity, an electromagnetic oscillation with angular frequency ω0 is given by

$$f(t) = Ae^{\frac{-w_0 t}{2\theta}} e^{-iw_0 t} \text{ ; t>0}$$

$$f(t) = 0 \text{ ; t<0}$$

Find the frequency distribution $|g(w)|^2$ of the electromagnetic oscillation.