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Courses » Modern Optics Announcements **Course** Ask a Question Progress Mentor FAQ

Unit 11 - Week 10

Week 10 Assignment 10

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2018-10-10, 23:59 IST.

1) *1 point*

ALL questions in this assignment are of MULTIPLE correct option type.

Consider the propagation of a shear acoustic wave along z direction in an anisotropic medium. K_T is the propagation constant and Ω is the frequency of acoustic wave. There are two degenerate orthogonal modes possible in this situation.

(A) one such mode can be represented by $\vec{u}(z,t) = \hat{x}u\,cos(K_T z - \Omega t)$
(B) one such mode can be represented by $\vec{u}(z,t) = \hat{z}u\,cos(K_T x - \Omega t)$
(C) in anisotropic medium the velocity of propagation of both these orthogonal modes are different
(D) in case of isotropic medium the velocity of propagation of both these orthogonal modes are same

- (A)
- (B)
- (C)
- (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A)
(D)

2) *1 point*

For a y-polarised shear acoustic wave along z direction in an anisotropic medium having K_T as the propagation constant and Ω the frequency of acoustic wave,

(A) all normal strain components are zero
(B) only non-vanishing shear strain component is $S_{yz} = S_{zy}$
(C) the velocity of propagation of the wave is given by $v_T = \frac{\Omega}{K_T}$
(D) the equation to this acoustic wave mode can be represented by $\vec{u}(z,t) = \hat{y}u\,cos(\Omega t - K_T x)$

- (A)

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Accepted Answers:
(A)
(B)
(C)

3) ***1 point***

Q.3- Q.7 are based on the *following paragraph*
Consider the propagation of a y-polarised transverse acoustic wave along z direction in $\mathbf{LiNbO_3}$ crystal. The strain-optic tensor for this crystal is given by $p_{\alpha\beta} =$

$$\begin{pmatrix} p_{11} & p_{12} & p_{13} & p_{14} & 0 & 0 \\ p_{12} & p_{11} & p_{13} & -p_{14} & 0 & 0 \\ p_{31} & p_{31} & p_{33} & 0 & 0 & 0 \\ P_{41} & -P_{41} & 0 & P_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & P_{44} & P_{41} \\ 0 & 0 & 0 & 0 & p_{14} & \frac{1}{2}(p_{11}-p_{12}) \end{pmatrix}$$

and the index ellipsoid is given by the equation $\frac{x^2}{n_o^2}+\frac{y^2}{n_o^2}+\frac{z^2}{n_e^2}=1.$

Which of the following relations yield/s non-zero strain component/s in this case

(A) $\frac{1}{2}\left(\frac{\partial u_z}{\partial z}+\frac{\partial u_y}{\partial y}\right)$
(B) $\frac{1}{2}\left(\frac{\partial u_y}{\partial x}+\frac{\partial u_x}{\partial y}\right)$
(C) $\frac{1}{2}\frac{\partial u_y}{\partial z}$
(D) $\frac{1}{2}\frac{\partial u_x}{\partial x}$

- (A)
- (B)
- (C)
- (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(C)

4) ***1 point***

Which of the following components of impermeability change ($\Delta\eta$) tensor is/are non-zero in this case?
(A) $\Delta\eta_1$
(B) $\Delta\eta_2$
(C) $\Delta\eta_3$
(D) $\Delta\eta_4$

- (A)
- (B)
- (C)
- (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A)
(B)
(D)

5) ***1 point***

Which of the following is/are correct about the elements of permittivity change ($\Delta\varepsilon$) tensor in this case?
(A) $\Delta\varepsilon_1 = -\varepsilon_0 p_{14} S_4 n_0^4$
(B) $\Delta\varepsilon_2 = -\Delta\varepsilon_1$
(C) $\Delta\varepsilon_6 = -\varepsilon_0 p_{44} S_4 n_0^2 n_e^2$
(D) $\Delta\varepsilon_5 = \varepsilon_0 p_{14} S_4 n_0^4$

- (A)
- (B)
- (C)
- (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A)
(B)

6) **1 point**

As regards the equation to the modified index ellipsoid in presence of the acoustic wave, which of the following is/are correct?

(A) The rotation angle of the ellipsoid w.r.t. old coordinate system is $\delta = \frac{1}{2} tan^{-1} 2K / \left(\frac{1}{n_z^2} - \frac{1}{n_y^2}\right)$
(B) The modified ellipsoid has undergone a rotation about the x-axis
(C) All new RI's are modified by the presence of acoustic wave
(D) The new principal RI along the x' direction is $n_{x'} \approx n_o - \frac{1}{2} p_{14} S_4 n_o^3$

- (A)
- (B)
- (C)
- (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A)
(B)
(C)
(D)

7) **1 point**

$LiNbO_3$ is a naturally uniaxial crystal. In presence of the travelling shear acoustic wave in the configuration as above, the crystal medium carries a travelling 3d volume-index grating (phase grating)
(A) In this case, the phase grating travels along the direction of polarisation, i.e., along y
(B) the **grating constant** can be expressed as $K_T = 2\pi/\Lambda$
(C) the speed with which the grating travels with in the medium is given by $v_T = \Omega/K_T$
(D) the grating is formed by a time-independent constant **strain imparted by the acoustic wave**

- (A)
- (B)
- (C)
- (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(B)

(C)

8) **1 point**

Q.8 - Q.12 are based on the ***following paragraph***

Let us consider an acoustic wave propagation along z-axis in a medium resulting moving periodic RI grating given by $n(z,t) = n_0 + \Delta n \sin(\Omega t - Kz)$. Here Ω is the angular frequency and K, the propagation constant of acoustic wave such that the wavelength of the wave is Λ. Also, n_0 represents the RI in absence of acoustic wave and Δn, the peak RI change due to acoustic wave. A light wave of wavelength λ_0 passing through this medium undergoes diffraction.

There are two possible types of diffraction of a light beam that may occur under this situation.

(A) If the length of acoustic wave over which the optical beam interacts is short, $L \ll \frac{\Lambda^2 n_0}{2\pi\lambda_0}$, then the diffraction is called Raman-Nath diffraction

(B) If the length of acoustic wave over which the optical beam interacts is large enough, $L \gg \frac{\Lambda^2 n_0}{2\pi\lambda_0}$, then the diffraction is known as Bragg diffraction

(C) The Bragg diffraction results in multiple orders symmetrically located on either side of the 0^{th} order

(D) The Raman-Nath diffraction yields only a single order either +1 or -1 order

- (A)
- (B)
- (C)
- (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A)
(B)

9) **1 point**

Which of the following about the acousto-optic diffraction for this configuration is/are true?

(A) For both Raman-Nath and Bragg diffraction, frequency of the incident wave $\neq$ frequency of the diffracted wave

(B) In Bragg diffraction, the frequency of diffracted light does not shift

(C) Raman-Nath diffraction is not associated with any Doppler-shift in frequency of the diffracted optical beams

(D) The Raman-Nath diffraction happens since the perturbed medium acts as thin phase grating

- (A)
- (B)
- (C)
- (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A)
(D)

10) **1 point**

In the design of an acousto-optic cell, consider the following parameters: frequency of piezo-electric crystal: **6 MHz**, velocity of acoustic wave in water: **1500 m/s** and the wavelength of light to be used for diffraction: $\lambda_0 = 0.6328\ \mu m$. Assume RI of water $n_0 = 4/3$. Then
(A) the value (for determining the required interaction length) of the quantity $(\Lambda^2 n_0)/(2\pi\lambda_0)$ is close to $21\ mm$
(B) the wavelength of this acoustic wave in water is $\Lambda = 250\ \mu m$
(C) if the width of the cell $L \leq 1$ **cm** then the medium forms a volume-index phase grating resulting a Bragg diffraction
(D) for cell-width of $L = 1$ **cm**, then the angle of $+1$ **order** diffracted beam is approximately $\theta_{+1} = 0.11°$

- (A)
- (B)
- (C)
- (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A)
(B)
(D)

11) ***1 point***

If the present configuration and parameters correspond to a Raman-Nath diffraction, then the diffracted beams contain
(A) electric field amplitudes that are proportional to various Bessel functions of order same as the respective order of diffraction
(B) various $+m$ orders of diffracted wave that are frequency downshifted as $\omega - m\Omega$
(C) various $+m$ orders of diffracted wave that are directed along $\sin\theta_m = \frac{m\lambda_0}{n_0\Lambda}$
(D) a **zeroth order** diffracted wave that has the same electric field amplitude as the incident wave

- (A)
- (B)
- (C)
- (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A)
(C)

12) ***1 point***

For the configuration and parameters corresponding to a Raman-Nath diffraction having a cell-width of L, when the value of $\frac{2\pi}{\lambda_0}\Delta n. L$ is
(A) 2.4048 the 1^{st} order diffraction is absent
(B) 5.520 the 0^{th} order diffraction is absent
(C) 1.85 the 1^{st} order diffraction is maximum
(D) 1.85 the 1^{st} order diffraction corresponds to highest efficiency

- (A)
- (B)
- (C)
- (D)

No, the answer is incorrect.

Score: 0

Accepted Answers:

(B)

(C)

(D)

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