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NPTEL

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Unit 10 - Week 9

Course outline

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- Lecture 42 : Acousto-optic Effect (Contd.)
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Week 9 Assignment 9

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

Due on 2018-10-03, 23:59 IST.

1) ***1 point***

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

Which of the following are related to describing the **photoelastic effect**?

(A) Elastic deformation/mechanical strain in a material medium changes photoelastic /strain-optic coefficients of the medium
(B) Changes in optical properties of the medium stays back even after the withdrawal of deformation
(C) Elastic deformation may be described by an infinitesimal strain and an infinitesimal rotation tensor
(D) Elastic strain may induce changes in refractive indices of the medium under deformation

- [ ] (A)
- [ ] (B)
- [ ] (C)
- [ ] (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(C)
(D)

2) ***1 point***

For a **longitudinal acoustic** wave traveling along x in an isotropic medium, which of the following is/are true about the **rotation tensor** associated with the medium in presence of the acoustic wave?

(A) all the off-diagonal elements of are **non-zero**
(B) all the elements of the tensor are **zero**
(C) the diagonal elements are always **zero**
(D) the tensor is an antisymmetric one

- [ ] (A)
- [ ] (B)

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(B)
(C)
(D)

3) ***1 point***

Q.3- Q.6 are based on the *following paragraph*
Consider a **transverse/shear acoustic** wave that is the travelling in a dielectric medium. The propagation of the wave is represented by the following equation expression:

$$\vec{u} = \hat{j}u_{y0}\cos(Kx - \Omega t) + \hat{k}u_{z0}\cos(Kx - \Omega t)$$

Which of the following coefficients of strain (S) tensor **is/are non-zero?**
(A) $S_1 = S_{xx}$
(B) $S_4 = S_{yx} = S_{zy}$
(C) $S_5 = S_{zx} = S_{xz}$
(D) $S_6 = S_{xy} = S_{yx}$

- [ ] (A)
- [ ] (B)
- [ ] (C)
- [ ] (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(C)
(D)

4) Which of the following coefficients of rotation (R) tensor **is/are non-zero?** ***1 point***
(A) $R_3 = R_{zz}$
(B) $R_4 = R_{yx} = R_{zy}$
(C) $R_5 = R_{zx} = R_{xz}$
(D) $R_6 = R_{xy} = R_{yx}$

- [ ] (A)
- [ ] (B)
- [ ] (C)
- [ ] (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(C)
(D)

5) ***1 point***

Which of the following **is/are** true about the strain coefficients?
(A) For this acoustic wave there are only **three non-zero** strain coefficients
(B) All **non-zero** strain coefficients are periodic in time and space same as those of the acoustic wave
(C) Each **non-zero** strain coefficient corresponds to strain along the **transverse** direction
(D) One of the **non-zero** strain coefficients corresponds to strain along the **propagation** direction

- [ ] (A)
- [ ] (B)
- [ ] (C)
- [ ] (D)

No, the answer is incorrect.

Score: 0

Accepted Answers:
(B)
(C)

6) ***1 point***

Which of the following **is/are** true about the acoustic wave of the form given above?

(A) The above description corresponds to an unpolarised traveling acoustic wave in the medium
(B) The above description corresponds to a unpolarised stationary acoustic wave in the medium
(C) The acoustic wave is traveling along the $\boldsymbol{x}$ direction
(D) The velocity with which the wave is traveling is $v = \mathrm{K}/\Omega$

- [ ] (A)
- [ ] (B)
- [ ] (C)
- [ ] (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A)
(C)

7) ***1 point***

Q.7 - Q.12 are based on the *following paragraph*

The strain-optic coefficients of an **isotropic** medium are given in the following matrix form. Assume that $\boldsymbol{n_0}$ is the refractive index of the medium in absence of any acoustic wave.

$$p = \begin{pmatrix} p_{11} & p_{12} & p_{12} & 0 & 0 & 0 \\ p_{12} & p_{11} & p_{12} & 0 & 0 & 0 \\ p_{12} & p_{12} & p_{11} & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{2}(p_{11}-p_{12}) & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{2}(p_{11}-p_{12}) & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{2}(p_{11}-p_{12}) \end{pmatrix}$$

Assume that $S_i = S_1, S_2, \ldots . S_6$ are the coefficients of the corresponding strain tensor.
Consider a plane **longitudinal** acoustic wave propagating along $\boldsymbol{z}$-direction in this medium. In presence of the acoustic wave along $\boldsymbol{z}$, which of the following represent/s the form of **new refractive index/indices** of the medium?

(A) $\frac{1}{n_x^2} = \frac{1}{n_0^2} + p_{12}S_3$
(B) $\frac{1}{n_y^2} = \frac{1}{n_x^2}$
(C) $\frac{1}{n_z^2} = \frac{1}{n_x^2}$
(D) $\frac{1}{n_y^2} = \frac{1}{n_0^2} + p_{11}S_1$

- [ ] (A)
- [ ] (B)
- [ ] (C)
- [ ] (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A)
(B)

8) ***1 point***

Now assume that the **longitudinal** plane acoustic wave is propagating along x-direction in this medium. In presence of the acoustic wave along x, which of the following represent/s the form of **new refractive index/indices** of the medium?

(A) $\frac{1}{n_x^2} = \frac{1}{n_0^2} + p_{12}S_1$

(B) $\frac{1}{n_y^2} = \frac{1}{n_z^2}$

(C) $\frac{1}{n_z^2} = \frac{1}{n_0^2} + p_{11}S_3$

(D) $\frac{1}{n_y^2} = \frac{1}{n_0^2} + p_{12}S_1$

- [ ] (A)
- [ ] (B)
- [ ] (C)
- [ ] (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(B)
(D)

9) ***1 point***

In the case of **longitudinal** acoustic wave **along** x in the above isotropic medium, the presence of the acoustic wave (of frequency Ω and propagation constant K_L)

(A) generates two non-zero strain components S_1 **and** S_3 of strain tensor
(B) induces an **optic axis** parallel to the direction of propagation
(C) the medium carries a volume-index phase grating with a grating period (pitch) $2\pi/\Omega$
(D) the presence of the acoustic wave makes the medium uniaxially anisotropic

- [ ] (A)
- [ ] (B)
- [ ] (C)
- [ ] (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(B)
(D)

10) ***1 point***

For a transverse acoustic wave propagating along x direction in an isotropic medium, there exists 2 possible degenerate orthogonal modes, one y–polarized transverse mode and the other is z–polarized transverse mode.

(A) The velocity with which these two transverse modes travel are the same
(B) The y – polarised transverse wave has of the form: $\vec{u}(x,t) = \hat{y}u\cos(K_T x - \Omega t)$
(C) In presence of this wave in the medium, two **normal strain** components are **non-zero**
(D) In presence of this wave in the medium, two **shear strain** components are **non-zero**

- [ ] (A)
- [ ] (B)
- [ ] (C)
- [ ] (D)

No, the answer is incorrect.
Score: 0

Accepted Answers:

(A)
(B)
(D)

11) ***1 point***

For the $y-$ **polarised transverse** acoustic wave propagating along x direction in isotropic medium, the index ellipsoid of the medium undergoes a rotation due to periodic strain
(A) The rotation occurs about the old principal x axis of the index ellipsoid
(B) The modified equation of index ellipsoid of the medium contains y and z terms which are symmetric (interchange does not change the equation)
(C) The strain due to this acoustic wave does not affect the n_y of the medium
(D) The new principal n_x of the medium becomes $n_x \approx n_0 - \frac{n_0^3}{4}(p_{11}-p_{12})\,S_0 \sin(K_T x - \Omega t)$, where S_0 represents the amplitude of strain wave

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

No, the answer is incorrect.
Score: 0

Accepted Answers:
(D)

12) ***1 point***

Now consider a z **−polarised** transverse acoustic wave propagating along x in isotropic medium. In this case
(A) all normal strain components of the strain tensor are **zero**
(B) only **non-zero** strain components are the shear ones represented by the xz off-diagonal elements
(C) the strain due to this acoustic wave does not affect the n_y of the medium
(D) the new principal n_x of the medium remains the same as the n_x for the y **−polarised** transverse acoustic wave case

- [ ] (A)
- [ ] (B)
- [ ] (C)
- [ ] (D)

No, the answer is incorrect.
Score: 0

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

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