Unit 8 - Week 7

Week 7 Assignment 7

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

1) MULTIPLE correct option type (Q.1 – Q.2)

Which of the following is/are not true about KDP, KD\(^{+}\)P, ADP (Crystal class 42m)
(A) Crystals possess one 4-fold axis of symmetry, a rotation of the crystal about this axis
by \(\frac{2\pi}{4}\) leaves it invariant
(B) Crystals possess 2 mutually orthogonal axes of symmetry (x, y) crystals exhibit invariance rotation of \(\pi\)
(C) In absence of field crystals are naturally isotropic
(D) In presence of the field crystals become anisotropic

No, the answer is incorrect.
Score: 0
Accepted Answers:
(C)

2) KDP (KH\(_2\)PO\(_4\)) is an important and widely used electro-optic crystal for light modulators. Which following is/are true about this crystal?
(A) It has only 6 non-zero electro-optic tensor elements
(B) In presence of an applied electric field the crystals becomes biaxial
(C) Crystal structure is cubic
(D) Optical transmission range is 200-1500nm

No, the answer is incorrect.
Score: 0
Accepted Answers:
(B)

Read the following paragraph and answer the following questions (Q.3 - Q.9).

MULTIPLE correct option type.

Consider longitudinal configuration of KDP crystal under an applied electric field $E$. The length of crystal travelled by light is $L$, the relevant EO coefficient of KDP is $r_{63}$.

For above configuration of KDP crystal, what happens to RI's, birefringence and phase change in presence of applied $E$-field?

(A) The new RI's become $n_{x'} = n_0 - \frac{n_0^3}{2} r_{63} E$ and $n_{y'} = n_0 + \frac{n_0^3}{2} r_{63} E$

(B) Induced birefringence between $x'$ and $y'$ polarised light becomes $\Delta n_{x'y'} = \frac{1}{2} n_0^3 r_{63} E$

(C) Induced phase change between $x'$ and $y'$ polarised light becomes $\Delta \phi_{x'y'} = k_0 L n_0^3 r_{63} E$

(D) For equal excitation of $x'$ and $y'$ polarised input light, this configuration can be used as a phase modulator.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(C) (D)

4) For setting up amplitude modulation using this longitudinal configuration of KDP crystal which following is/are the key requirement/s?

(A) a linearly polarised light will be propagating through the crystal along the $z$-direction

(B) the input light will be polarised along $x'$-axis or along $y'$-axis (principal axes in absence of $E$)

(C) the emergent light from crystal must pass through a crossed (w.r.t. input) polariser (analysis)

(D) a voltage of $V = \frac{A}{2n_0^3 r_{63}}$ has to be applied to make the output intensity of modulated optic a minimum.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(A) (B) (C)

5) Which of the following about the input light is/are the correct requirement/s so as to achieve modulation?

(A) a linearly polarised light will be propagating through the crystal along the $z$-direction

(B) the input light will be polarised making an angle of $45^0$ with $x$-axis (old coordinate system without electric field)

(C) the input light will be polarised along new $x'$-axis (in presence of electric field)

(D) the input light will be polarised along $y'$-axis (old coordinate system without electric field)

No, the answer is incorrect.
Score: 0
Accepted Answers:
(A) (B) (C)
6) In case of phase modulation of an optical beam using the above configuration of KDP crystal, one/ones is/are not correct?
(A) For a given applied voltage, the phase change of the optical beam is proportional to the length crystal travelled by optical beam
(B) For a given travel-length of light beam in the crystal, the phase change suffered by the output is linearly proportional to the voltage applied across the crystal
(C) The input light should be x'- or y'-polarized (i.e., along one of the new principal axes)
(D) The input light is x- or y-polarized (principal axes without voltage), i.e., the polarization of light makes 45° with x'- or y'- (principal axes in presence of applied voltage)

No, the answer is incorrect.
Score: 0
Accepted Answers:
(A)
(D)

7) For KDP crystal in the longitudinal configuration having equal excitation of x' and y' polarize light, the modulator half voltage \(V_m\):
(A) does not depend on the length of the crystal travelled by optical beam
(B) does not depend on the transverse width of the crystal modulator
(C) corresponds to a phase change of \(\pi/2\)
(D) is such that the KDP crystal behaves as a \(\lambda/4\) wave plate

No, the answer is incorrect.
Score: 0
Accepted Answers:
(B)

8) If a sinusoidal modulating voltage \(V = V_0 \sin \omega_m t\) is applied to the KDP crystal in this configuration for phase modulation, then the output light:
(A) varies sinusoidally with peak value \(p\) that is proportional to the peak value of applied voltage
(B) consists of light at fundamental frequency \(\omega\) with amplitude \(J_0(p)\)
(C) has a phase modulation index that is independent of applied peak voltage \(V_0\)
(D) contains various side-bands at frequencies \(\omega \pm \omega_m, \omega \pm 2\omega_m\ ...\) with respective amplitudes \(J_1(p), J_2(p), J_3(p)\ ...\)

No, the answer is incorrect.
Score: 0
Accepted Answers:
(A)
(B)
(D)
Assume typical values for KDP crystal: \( r_{63} = 10.5 \times 10^{-12} \text{ m/V} \), \( n_0 = 1.512 \). In the longi configuration, an optical beam at operating wavelength \( \lambda = 0.5 \mu \text{m} \) and polarized along y-c travels a length \( l = 1 \text{ cm} \) of the crystal under an applied voltage of \( V = 10 \text{ kV} \).

(A) The induced birefringence between x' and y' polarised light \( \approx 2 \times 10^{-5} \)

(B) Between x' and y' polarised light a phase change \( \approx 0.8 \text{ Br } \) is developed

(C) At applied voltage \( \approx 8.3 \text{ kV} \), the KDP crystal under this condition for light of \( \lambda = 0.6 \mu \text{m} \) as a quarter-wave plate

(D) under exactly same configuration, if the crystal is replaced by KD\(^{+}\)P (KD\(_2\)PO\(_4\)) with \( r_{63} = \frac{1}{2} \times 10^{-12} \text{ m/V} \) for light of \( \lambda = 0.6 \mu \text{m} \), the required half voltage is \( \approx 4.3 \text{ kV} \)

Read the following paragraph and answer the following questions (Q. 10 - Q. 12).

MULTIPLE correct option type.

Consider transverse configuration of KDP crystal. Under an applied electric field \( E \) applied at light beam propagates along y'-axis (principal axis in presence of field). The length of the crystal travelled by light is \( l \), and the width of crystal is \( d \) across which the voltage is applied; the real coefficient of KDP is \( r_{63} \). Also \( n_0 \) is the RI of polarisation parallel to xy plane (ordinary RI's).

Which of the following correspond/s to an amplitude modulation setup using this transverse configuration of KDP crystal?

(A) Incident light should be polarised at 45\(^{0}\) to x' in x'y' plane

(B) The emergent light from crystal must pass through an analyser which will be at crossed pc w.r.t. the input polariser.

(C) the net birefringence between the x' and z polarised light at the output of the crystal will be \( \frac{1}{2} n_0^2 r_{63} E \)

(D) The principal RI of the z-polarised light (in presence of electric field) should be electric field dependent
In amplitude modulation setup using this transverse configuration of KDP crystal
(A) the half-voltage is inversely proportional to width \( d \) of the crystal
(B) for high performance of the transverse modulator, \( d \) should be linearly proportional to \( l \)
(C) the half-voltage for transverse modulator is much greater than that for longitudinal modulator
(D) a voltage of \( V = \frac{d}{n_0 \gamma_{63}} (d/l) \) is needed to make the output intensity of modulated optical maximum

No, the answer is incorrect.
Score: 0
Accepted Answers:
(A)
(B)
(C)
(D)