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Courses » **Modern Optics**

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Unit 12 - Week 11

Government of India

Develo

Course outline

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Assignment Solution

Assignment 11

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

Due on 2018-10-17, 23:59 IST.

1) *1 point*

Questions 1 - 4 are based on the following paragraph regarding small Bragg angle diffraction.

Assume the following parameters related to a **small Bragg angle** diffraction: acoustic power = I_a , acoustic velocity = v_a , optical frequency = ω, the RI of medium = n , density of the medium = ρ , the Bragg angle = θ_B , the strain-optic coefficient = $\overline{p}$, the strain coefficient = $\overline{S}$ and speed of light in free-space = C . The coupling coefficient κ measures the strength of coupling optical power between 0th order and the +order. α's represent the x −components of propagation constant, β's represent the z −components of propagation constant of respective optical beams and K is that of acoustic wave along z.

Small angle Bragg diffraction corresponds to

(A) the light wave travels **almost** parallel to the direction of acoustic wave

(B) $\beta_+ = \beta + K$ or $\beta_- = \beta - K$ as the Bragg condition (+/− corresponds to respective orders)

(C) optical power in the **+** order diffracted beam is a $\sin^2$ function of the quantity proportional to the interaction length of optical beam with the acoustic wave

(D) the total diffracted optical power (**0th** order and **+** order) is the same as incident power

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0

Accepted Answers:
B
C
D

2) *1 point*

Under the small angle Bragg diffraction of optical beam

(A) non-Bragg condition corresponds to $\Delta\alpha = 0$

(B) Bragg condition corresponds to $\Delta\alpha = 2\kappa$

(C) optical power in the **0th** order optical beam is a purely $\sin^2$ function of the product of coupling constant and interaction length of optical beam with the acoustic wave

(D) at non-Bragg condition, optical power can be completely transferred from **0th** order to the **+**order diffracted beam

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0

Accepted Answers:
C

3) *1 point*

Which of the following relations is/are correct?

(A) the change in dielectric permittivity can be represented by $\Delta\epsilon = \frac{1}{2}\epsilon_0 n^3 \overline{p}\overline{S}$

(B) the coupling coefficient can be represented by $\kappa = \frac{\omega}{4c} \frac{n^3 \overline{p}\overline{S}}{\cos\theta_B}$

(C) the coupling coefficient can be represented by $\kappa = \frac{k_0}{4} \frac{n^3 \overline{p}\overline{S}}{\cos\theta_B}$

(D) the acoustic power can be expressed in terms of $I_a = \frac{1}{2}\rho v_a^3 \overline{S}^2$

- [ ] A
- [ ] B
- [ ] C
- [ ] D

No, the answer is incorrect.
Score: 0

Accepted Answers:
B
C
D

4) *1 point*

To quantify the performance of **Bragg angle** diffraction, a figure of merit is defined as $M_2 = \frac{n^6 \overline{p}^2}{\rho v_a^3}$.

(A) In terms of M_2 , the coupling coefficient between the undiffracted and diffracted wave can be expressed as $\kappa = \frac{\pi}{\sqrt{2}\lambda\cos\theta_B}\sqrt{M_2 I_a}$

(B) A large value of M_2 implies large acoustic power

(C) A large figure of merit requires high RI of the medium in which acoustic wave is travelling

(D) A large figure of merit requires low value of photoelectric coefficient

- [ ] A
- [ ] B
- [ ] C
- [ ] D

No, the answer is incorrect.
Score: 0

Accepted Answers:
A
C

5) *1 point*

Questions 5 - 8 are based on Large Bragg angle diffraction. Assume that the parameters, directic of waves associated with this diffraction are the same as mentioned in paragraph above.

Large Bragg angle diffraction corresponds to

(A) the light wave travels **almost** perpendicular to the direction of acoustic wave

(B) a situation where both the Bragg conditions (+/− corresponds to respective orders) $\beta_+ = \beta +$ and $\beta_- = \beta - K$ cannot be satisfied simultaneously

(C) a situation where one may neglect the x dependence of field amplitudes (x is along the width acoustic wave)

(D) the light wave travels **almost** along the same direction as that of acoustic wave

- [ ] A
- [ ] B

- [ ] C
- [ ] D

No, the answer is incorrect.
Score: 0

Accepted Answers:
B
C
D

6) **1 point**

Necessary conditions related to Large Bragg angle diffraction is/are
(A) x dependent factors in the set of wave equations should cancel out
(B) Bragg condition $\beta_- = \beta - K$ corresponds to contra-directional coupling, coupling between waves travelling in opposite directions
(C) in the set of wave equations, the x −components of propagation constant should satisfy: α_+ and $\alpha_- = \alpha$ (where $+/-$ corresponds to respective orders of diffraction)
(D) condition for co-directional coupling: $\beta/\lvert\beta\rvert = 1 = \beta_+/\lvert\beta_+\rvert$, coupling between waves travell in same direction (β and β_+ correspond to z −components of propagation constant for the undiffracted and diffracted waves, z being the direction of acoustic wave propagation)

- [ ] A
- [ ] B
- [ ] C
- [ ] D

No, the answer is incorrect.
Score: 0

Accepted Answers:
A
B
C
D

7) **1 point**

In the co-directional coupling with Large Bragg angle diffraction
(A) interaction is highly wavelength selective
(B) the acousto-optic effect used for making tunable acousto-optic filters
(C) this co-directional coupling (coupling between waves travelling in the same direction) owes tc Bragg condition $\beta_+ = \beta - K$
(D) β_+ must be greater than β (where β and β_+ are the z −components of propagation constan respectively for the undiffracted and diffracted waves, z being the direction of acoustic wave propagation)

- [ ] A
- [ ] B
- [ ] C
- [ ] D

No, the answer is incorrect.
Score: 0

Accepted Answers:
A
B
D

8) **1 point**

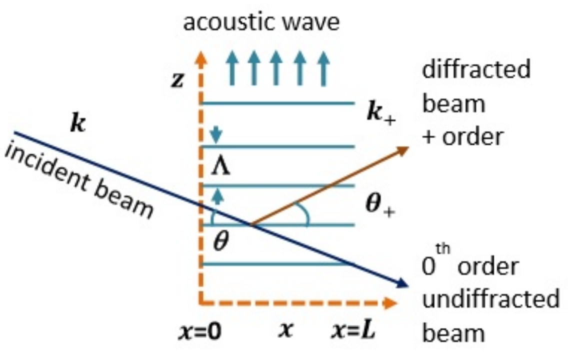
	In the contra-directional coupling with Bragg diffraction,
	(A) optical power of the diffracted wave for $\Delta\boldsymbol{\beta} = \boldsymbol{\beta} - \boldsymbol{\beta}_{-} - \boldsymbol{K}$ ($\boldsymbol{K}$ being the propagation consta acoustic wave) varies as a square of tangent hyperbolic function
	(B) establishes that a periodic RI perturbation acts as a mirror for certain wavelengths
	(C) a forward propagating light of any wavelength will be transmitted only through such a Bragg diffraction system
	(D) a forward propagating light of some wavelengths will be reflected like a mirror through such diffraction

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0

Accepted Answers:
A
B
D

9) **1 point**

	Questions 9-12 are based on the following paragraph and the figure showing acousto-optic Bra diffraction.
	Consider acousto-optic Bragg diffraction (refer to the figure). For this diffraction, assume all the u notations, and given that for the incident wave $\boldsymbol{\alpha} = \boldsymbol{k}\cos\boldsymbol{\theta}$, $\boldsymbol{\beta} = -\boldsymbol{k}\sin\boldsymbol{\theta}$ and those for diffra wave $\boldsymbol{\alpha}_{+} = \boldsymbol{k}_{+}\cos\boldsymbol{\theta}_{+}$, $\boldsymbol{\beta}_{+} = \boldsymbol{k}_{+}\sin\boldsymbol{\theta}_{+}$. 
	For this acousto-optic Bragg diffraction, choose the correct option/s.
	(A) The incident optical beam (electric field) can be expressed as $\vec{E} = \hat{\imath}\, A_0 e^{i(\omega t - \alpha x - \beta z)}$
	(B) The electric field of the **+** order diffracted wave can be expressed as $\vec{E}_{+} = \hat{k}\, A_{+} e^{i(\omega t - \alpha_{+} x + \beta_{+} z}$
	(C) The direction of incident wave (given by $\boldsymbol{\theta} = \boldsymbol{\theta}_B$) must be such that $\sin\boldsymbol{\theta}_B = \frac{K}{2k}$
	(D) The diffracted wave has a frequency $\omega_{+} = \omega - \Omega$, where Ω is the acoustic wave frequency

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0

Accepted Answers:
A

10) *1 point*

Choose the correct relation/s that correspond/s to this acousto-optic Bragg diffraction.

(A) $k_+^2 = \alpha_+^2 + \beta_+^2$	(B) $\alpha^2 + \beta^2 = k^2$
(C) $k_+ \sin\theta_+ = 2k\sin\theta + K$	(D) $\vec{k} + \vec{K} = \vec{k}_+$

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0

Accepted Answers:
A
B
D

11) *1 point*

Choose the correct relation/s that correspond/s to this acousto-optic Bragg diffraction

(A) $\beta + \alpha + K = \beta_+ + \alpha_+$	(B) $\beta_+ - \beta = K$
(C) $2K\, sin\,\theta' = k$, where $2\theta' = \theta + \theta_+$	(D) $2\Lambda\, sin\,\theta' = n/\lambda$, λ = incident light waveleng

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0

Accepted Answers:
A
B
D

12) *1 point*

Consider the above Bragg angle diffraction in the light of **Doppler frequency shift**. Take velocity o acoustic wave as v_s. Then

(A) the **Source** moves with **velocity** $= 2v_s \sin\theta$
(B) the Doppler frequency shift of the optical wave of wavelength λ is $\Delta\nu = \frac{v_s \sin\theta}{2\lambda}$
(C) the **Image** moves with **velocity** $= \frac{1}{2} v_s \sin\theta$
(D) the **Mirror** moves with **velocity** $2v_s$

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0

Accepted Answers:
A

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