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Courses » Introduction to Non-linear Optics and its Applications

Announcements Course Ask a Question Progress Mentor FAQ

## Unit 11 - Week 9

## Course outline

How to access the portal

Pre-requisite Assignment

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Week 9

- Lecture 41 : 3rd order nonlinear effect
- Lecture 42 : Optical Kerr effect and Self-focusing, Symmetry in 3rd order susceptibility
- Lecture 43 : Symmetry in 3rd order susceptibility (Cont), Self Phase Modulation (SPM)
- Lecture 44 : Self Phase Modulation (Cont), Frequency Shift
- Lecture 45 : Third Harmonic Generation(3HG), Energy conservation
- Quiz : Assignment 9
- Feedback for Week 9

Week 10

Week 11

Week 12

## 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

For a centrosymmetric media, if there is additional symmetry of mirror reflection

yz plane with the transformation matrix  $\begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ , then which one of

following is correct?

(a)  $\chi_{xxxxy}^{(3)} \neq 0$ ; (b)  $\chi_{xxxxy}^{(3)} = 0$ ; (c)  $\chi_{xyyy}^{(3)} \neq 0$ ; (d)  $\chi_{xyyy}^{(3)} = 0$ .

- (a)  
 (b)  
 (c)  
 (d)

No, the answer is incorrect.  
Score: 0

Accepted Answers:

(b)

2) 1 point

The relation between nonlinear index of refraction ( $n_2^I$ ) and  $\chi^{(3)}$  is (the symbols are their usual meaning)

(a)  $n_2^I = \frac{3}{8\epsilon_0 n^2 c} \chi^{(3)}$  (b)  $n_2^I = \frac{3}{4\epsilon_0 n c} \chi^{(3)}$  (c)  $n_2^I = \frac{3}{4\epsilon_0 n^2 c} \chi^{(3)}$ 

- (a)  
 (b)  
 (c)

No, the answer is incorrect.  
Score: 0

Accepted Answers:

(c)

3) 1 point

The change in refractive index ( $\Delta n$ ) due to Kerr effect when a light with power falls on a medium of cross-sectional area  $1\text{mm}^2$  ( $n_2 = 6 \times 10^{-18}\text{m}^2/\text{W}$ )

(a)  $6 \times 10^{-14}$  (b)  $6 \times 10^{-12}$  (c)  $3 \times 10^{-14}$  (d)  $3 \times 10^{-13}$ 

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No, the answer is incorrect.

Score: 0

Accepted Answers:

(b)

4)

1 point

The following equation dictates the propagation of a wave of frequency  $\omega$  driven the third order nonlinear polarization at the same frequency.  $\frac{dA}{dz} = i \frac{3\omega\chi^{(3)}}{8nc} |A|$   
If the complex amplitude  $A(z) = u(z)e^{i\varphi(z)}$  then the evolution equation for phase  $\varphi$  is

$$\begin{aligned} \text{(a)} \quad & \int_z \frac{3\omega\chi^{(3)}}{8nc} dz & \text{(b)} \quad & \int_z \frac{3\omega\chi^{(3)}}{4nc} |A| dz \\ \text{(c)} \quad & \int_z \frac{3\omega\chi^{(3)}}{4nc} |A|^2 dz & \text{(d)} \quad & \int_z \frac{3\omega\chi^{(3)}}{8nc} |A|^2 dz \end{aligned}$$

- (a)  
 (b)  
 (c)  
 (d)

No, the answer is incorrect.

Score: 0

Accepted Answers:

(d)

5)

1 point

Follow the above question (Q.4), what will be the maximum frequency shift  $\delta\omega$  due to self-phase modulation for an optical pulse that has a Gaussian temporal profile  $I(\tau)$

$$I(\tau) = I_0 e^{-\frac{2\tau}{T_0}}$$

$$\begin{aligned} \text{(a)} \quad & \frac{2n_2 I_0}{T_0} e^{-\frac{2\tau}{T_0}} & \text{(b)} \quad & \frac{2n_2 I_0 k_0 z}{T_0} e^{-\frac{2\tau}{T_0}} & \text{(c)} \quad & \frac{2n_2 I_0 k_0 z}{T_0} & \text{(d)} \quad & \frac{2n_2 I_0}{T_0} \end{aligned}$$

- (a)  
 (b)  
 (c)  
 (d)

No, the answer is incorrect.

Score: 0

Accepted Answers:

(c)

6)

1 point

Follow the above question (Q.5), the maximum frequency shift per unit length ( $H$  unit) will be (where  $T_0 = 20fs$ ,  $I_0 = 1GW/cm^2$ ,  $n_2 = 10^{-16}cm^2/W$  and the carrier frequency of the input radiation is  $10^{14}Hz$ .)

$$\begin{aligned} \text{(a)} \quad & 10^{16} & \text{(b)} \quad & 2 \times 10^{15} & \text{(c)} \quad & 2 \times 10^{13} & \text{(d)} \quad & 2 \times 10^{-15} \end{aligned}$$

- (a)  
 (b)  
 (c)  
 (d)

No, the answer is incorrect.

Score: 0

Accepted Answers:

(c)

7)

1 point

Follow the above question (Q.6), the output frequency from a 2cm long crystal is:

- (a)  $1.004 \times 10^{13}$       (b)  $1.004 \times 10^{14}$       (c)  $1.004 \times 10^{15}$

- (a)  
 (b)  
 (c)

No, the answer is incorrect.

Score: 0

Accepted Answers:

(b)

8)

1 point

The number of independent susceptibility tensor elements ( $\chi^{(3)}$ ) for centrosymmetric crystals

- (a) 1      (b) 2      (c) 3      (d) 4

- (a)  
 (b)  
 (c)  
 (d)

No, the answer is incorrect.

Score: 0

Accepted Answers:

(c)

9)

1 point

The process  $\chi_{xxyy}^{(3)}(\omega_1; \omega_2, \omega_3, \omega_4) = \chi_{yyxx}^{(3)}(\omega_1; \omega_2, \omega_3, \omega_4)$  transforms under

- (a) inversion symmetry   (b) permutation symmetry   (c) rotation-inversion symmetry

- (a)  
 (b)  
 (c)

No, the answer is incorrect.

Score: 0

Accepted Answers:

(a)

10)

1 point

The process  $\chi_{xxyy}^{(3)}(\omega_1; \omega_2, \omega_3, \omega_4) = \chi_{yyxx}^{(3)}(\omega_3; -\omega_4, \omega_1, -\omega_2)$  transforms under

- (a) inversion symmetry   (b) permutation symmetry   (c) rotation-inversion symmetry

- (a)  
 (b)  
 (c)

No, the answer is incorrect.

Score: 0

Accepted Answers:

(b)

Previous Page

End

