# Unit 4 - Week 3



## Week 3 Assignment 3

**The due date for submitting this assignment has passed.** **Due on 2018-09-05, 23:59 IST.**
**As per our records you have not submitted this assignment.**

1) Which of the following is not true about the continuity of electromagnetic waves at a dielelctricdielectric interface? *1 point*

- (A) normal components of $\vec{D}$
- (B) tangential components of $\vec{E}$
- (C) tangential components of $\vec{k}$
- (D) normal components of $\vec{H}$

**No, the answer is incorrect.**
**Score: 0**

**Accepted Answers:**
*(D)* normal components of $\vec{H}$

2) Which of the following is true about the $s$ −polarised wave and $p$-polarised wave when both present for reflection at dielectric-dielectric interface? *1 point*

- (A) at normal incidence, amplitude reflection coefficients $r_s$ and $r_p$ become approximately equal
- (B) for any angle of incidence, $r_p$ is always greater that $r_s$
- (c) if the direction of incidence to interface is reversed (now incidence angle $\theta_2$ that was transmitted angle before), then $r_s$ becomes $\frac{1}{2} r_s$
- (D) at Brewster's angle of incidence, the $p$-polarised wave is transmitted through the interface and the $s$-polarised wave is both reflected and refracted at the same angle

**No, the answer is incorrect.**
**Score: 0**

**Accepted Answers:**
*(A) at normal incidence, amplitude reflection coefficients $r_s$ and $r_p$ become approximately equal*
*(D) at Brewster's angle of incidence, the $p$-polarised wave is transmitted through the interface and the $s$-polarised wave is both reflected and refracted at the same angle*

3) *1 point*

**Read the following paragraph and answer the questions? (Q3-Q7)**

A plane light wave travelling in $xz$ −plane in glass (RI: $n_1 = 1.5$) hits the glass-air interface ($yz$ −plane). The incident plane light wave is given by the equation:

$$\vec{E}_{inc} = 2.0\,\hat{y}\,exp\,[i(\omega t - \frac{1}{2}k_1 x - \frac{\sqrt{3}}{2}k_1 z)] \quad V/m$$

The free space wavelength of this light is $\lambda_0 = 0.6 \times 10^{-6}$ $meter$. The free space propagation constant is $k_0$ . Take RI of air $n_2 = 1.0$.

For the incident light wave (a) the angle of incidence at glass-air interface and (b) the polarization respectively

- (A) (i) $30^0$ (ii) $p$-wave
- (B) (i) $30^0$ (ii) $s$-wave
- (C) (i) $60^0$ (ii) $p$-wave
- (D) (i) $60^0$ (ii) $s$-wave

No, the answer is incorrect.
Score: 0

Accepted Answers:
(D) (i) $60^0$ (ii) $s$-wave

4) At the glass-air interface, the light wave *1 point*

- (A) has decaying transmitted field amplitude
- (B) has decaying reflected field amplitude
- (C) undergoes complete transmission
- (D) undergoes total internal reflection

No, the answer is incorrect.
Score: 0

Accepted Answers:
*(A) has decaying transmitted field amplitude*
*(D) undergoes total internal reflection*

5) Equation of the transmitted electric field takes the form ($t$ is the amplitude transmission coefficient) *1 point*

- (A) $\vec{E}_{tr} = 2.0\,t\,\hat{y}\,e^{-\frac{\sqrt{11}}{4}k_0 x}\;e^{i\left(\omega t - \frac{3\sqrt{3}}{4}k_0 z\right)}$
- (B) $\vec{E}_{tr} = 2.0\,t\,\hat{y}\,e^{\frac{\sqrt{13}}{2}k_0 x}\;e^{i\left(\omega t - \frac{3\sqrt{3}}{4}k_0 z\right)}$
- (C) $\vec{E}_{tr} = 2.0\,t\,\hat{x}\,e^{-\frac{\sqrt{3}}{2}k_0 x}\;e^{i\left(\omega t + \frac{3\sqrt{3}}{4}k_0 z\right)}$
- (D) $\vec{E}_{tr} = 2.0\,t\,\hat{z}\,e^{\frac{2}{\sqrt{11}}k_0 x}\;e^{i\left(\omega t - \frac{3\sqrt{3}}{4}k_0 z\right)}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A) $\vec{E}_{tr} = 2.0\,t\,\hat{y}\,e^{-\frac{\sqrt{11}}{4}k_0 x}\;e^{i\left(\omega t - \frac{3\sqrt{3}}{4}k_0 z\right)}$

6) *1 point*
The depth of penetration of light wave into air region is approximately (use $\lambda_0 = 0.6 \times 10^{-6}$ $met$

- (A) $zero$
- (B) $0.115\ \mu m$
- (C) $0.261\ \mu m$
- (D) $2.611\ \mu m$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(B) $0.115\ \mu m$

7) **1 point**

If the direction of incident wave ($y$ −polarised) is **reversed**, *i.e.,* from air to glass at same angle of incidence, keeping everything same, then which of the following represent/represents the equatic incident electric field?

- (A) $\vec{E}_{inc} = 2.0\ \hat{y}\ e^{i\left(\omega t+\frac{1}{2}k_0x-\frac{\sqrt{3}}{2}k_0z\right)}$
- (B) $\vec{E}_{inc} = 2.0\ \hat{y}\ e^{i\left(\omega t+\frac{1}{2}k_0x+\frac{\sqrt{3}}{2}k_0z\right)}$
- (C) $\vec{E}_{inc} = 2.0\ \hat{y}\ e^{i\left(\omega t-\frac{\sqrt{3}}{2}k_0x-\frac{1}{2}k_0z\right)}$
- (D) $\vec{E}_{inc} = 2.0\ \hat{y}\ e^{i\left(\omega t+\frac{\sqrt{3}}{2}k_0x+\frac{1}{2}k_0z\right)}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A) $\vec{E}_{inc} = 2.0\ \hat{y}\ e^{i\left(\omega t+\frac{1}{2}k_0x-\frac{\sqrt{3}}{2}k_0z\right)}$
(B) $\vec{E}_{inc} = 2.0\ \hat{y}\ e^{i\left(\omega t+\frac{1}{2}k_0x+\frac{\sqrt{3}}{2}k_0z\right)}$

8) **1 point**

**Read the following paragraph and answer the questions?(Q8-Q12)**

Consider a thin uniform glass sheet of RI $n_3$ . An antireflection coating has to be deposited on it. Tl RI of the coating material is $n_2$ and the thickness is $d_2$ . Outside medium is air $n_1 = 1.0$ . Assume $d_2 = (2m+1)\frac{\lambda_0}{4n_2}$ where $m$ is an integer and $\lambda_0$ is the wavelength of light.

For this two-layer sheet, light falling from air normally on the coated surface will have reflectivity (energy reflection coefficient)

- (A) $R = \left(\frac{n_1-n_2}{n_1+n_2}\right)^2$
- (B) $R = \left(\frac{n_3-n_1}{n_3+n_2}\right)^2$
- (C) $R = \left(\frac{n_1n_2-n_3^2}{n_1n_2+n_3^2}\right)^2$
- (D) $R = \left(\frac{n_1n_3-n_2^2}{n_1n_3+n_2^2}\right)^2$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(D) $R = \left(\frac{n_1n_3-n_2^2}{n_1n_3+n_2^2}\right)^2$

9) **1 point**

For the above coated glass sheet, if $n_3 = 1.62$ (RI of glass sheet), then the required value of $n_2$ ( the coating material) for minimum reflection is (choose the best value from the following)

- (A) $n_2 \approx 1.732$
- (B) $n_2 \approx 1.437$

(C) $n_2 \approx \mathbf{1.273}$

(D) $n_2 \approx \mathbf{1.132}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(C) $n_2 \approx \mathbf{1.273}$

10) For the best value of $n_2$ chosen from above, obtain a thickness of the coating thickness so that the coated glass sheet acts as an antireflection element for light of wavelength $\lambda_0 = \mathbf{0.55}\ \boldsymbol{\mu m}$. Which of the following values of thickness $d_2$ gives minimum reflection? ***1 point***

(A) $d_2 = \mathbf{0.3240}\ \boldsymbol{\mu m}$

(B) $d_2 = \mathbf{0.432}\ \boldsymbol{\mu m}$

(C) $d_2 = \mathbf{0.864}\ \boldsymbol{\mu m}$

(D) $d_2 = \mathbf{1.296}\ \boldsymbol{\mu m}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A) $d_2 = \mathbf{0.3240}\ \boldsymbol{\mu m}$

11) For the best value of $n_2$ chosen from above for the coated glass sheet, if a light of wavelength $\lambda_0 = \mathbf{0.65}\ \boldsymbol{\mu m}$ is used, then the minimum possible thickness and corresponding reflectivity are ***1 point***

(A) $d_2 \approx \mathbf{0.0041}\ \boldsymbol{\mu m}$ *and* $\boldsymbol{R} \approx \mathbf{0.1889}$

(B) $d_2 \approx \mathbf{0.0106}\ \boldsymbol{\mu m}$ *and* $\boldsymbol{R} \approx \mathbf{0.0889}$

(C) $d_2 \approx \mathbf{0.046}\ \boldsymbol{\mu m}$ *and* $\boldsymbol{R} \approx \mathbf{0.0188}$

(D) $d_2 \approx \mathbf{0.1277}\boldsymbol{\mu m}$ *and* $\boldsymbol{R} \approx \mathbf{0.0034}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(D) $d_2 \approx \mathbf{0.1277}\boldsymbol{\mu m}$ *and* $\boldsymbol{R} \approx \mathbf{0.0034}$

12) ***1 point***

For this two-layer sheet, if we choose the thickness of the film as $\boldsymbol{d_2} = \frac{\lambda_0}{2n_2}$, then the reflectivity of element becomes

(A) $\boldsymbol{R} = \left(\frac{n_3 - n_1}{n_3 + n_1}\right)^2$

(B) $\boldsymbol{R} = \left(\frac{n_3 - n_2}{n_3 + n_2}\right)^2$

(C) $\boldsymbol{R} = \left(\frac{n_1 n_2 - n_3^2}{n_1 n_2 + n_3^2}\right)^2$

(D) independent of coating RI

No, the answer is incorrect.
Score: 0

Accepted Answers:

$R = \left(\frac{n_3 - n_1}{n_3 + n_1}\right)^2$

*(A)*

*(D) independent of coating RI*