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Courses » Modern Optics

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Unit 2 - Week 1

Course outline

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Week 1

- Lecture 1 : Maxwell's equations and electromagnetic waves
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- Lecture Materials
- Quiz : Assignment

Assignment 1

The due date for submitting this assignment has passed. **Due on 2018-08-15, 23:59 IST.**
As per our records you have not submitted this assignment.

1) *1 point*

Consider an electric field of the form: $E = 0.2\cos\left(t - \frac{x}{\sqrt{2}} - \frac{y}{\sqrt{2}}\right)$. The wave propagates along

(A) $xy\ plane\ making\ an\ angle\ of\ \frac{\pi}{4}\ with\ x\ axis$

(B) $z\ direction\ making\ an\ angle\ of\ \frac{\pi}{4}\ with\ y\ axis$

(C) $xy\ plane\ making\ an\ angle\ of\ \frac{\pi}{4}\ with\ z\ axis$

(D) $xz\ plane\ making\ an\ angle\ of\ \frac{\pi}{4}\ with\ x\ axis$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$xy\ plane\ making\ an\ angle\ of\ \frac{\pi}{4}\ with\ x\ axis$

(A)

2) *1 point*

An electromagnetic wave propagating in free space is described by the following equation $E(z,t) = \hat{x}5\cos(\omega t - kz) + \hat{y}5\sin(\omega t - kz)\ \ volt/meter$. The wave is

(A) *elliptically polarised*

(B) *circularly polarised*

(C) *linearly polarised*

(D) *unpolarised*

No, the answer is incorrect.
Score: 0

Accepted Answers:
(B) circularly polarised

3) *1 point*

An electric field is given as $\vec{E} = \hat{i}E_x + \hat{j}E_y + \hat{k}E_z$. The value of $\nabla.(\nabla \times \vec{E})$ is

Week 4

Week 5

Week 6

Week 7

Week 8

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Week 12

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Assignment Solution

(D) *zero*

No, the answer is incorrect.
Score: 0

Accepted Answers:
(D) zero

4) ***1 point***

Consider the following two electric fields specified at time $t = 0$ that are respectively forward and back propagating:
$E(z,0) = \hat{x}E_0 \cos kz$ (forward) and $E(z,0) = \hat{y}E_0 \cos kz$ (backward), where k is the wave number. The corresponding fields $E(z,t)$ are

(A)
$E(z,t) = \hat{x}E_0 \cos(\omega t + kz)$ (forward) and $E(z,t) = \hat{y}E_0 \cos(\omega t - kz)$ (backward)

(B)
$E(z,t) = \hat{x}E_0 \cos(\omega t - kz)$ (forward) and $E(z,t) = \hat{y}E_0 \cos(\omega t + kz)$ (backward)

(C)
$E(z,t) = \hat{x}E_0 \cos(\omega t + kz)$ (forward) and $E(z,t) = \hat{y}E_0 \cos(\omega t + kz)$ (backward)

(D)
$E(z,t) = \hat{x}E_0 \cos(\omega t - kz)$ (forward) and $E(z,t) = \hat{y}E_0 \cos(\omega t - kz)$ (backward)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(B)
$E(z,t) = \hat{x}E_0 \cos(\omega t - kz)$ (forward) and $E(z,t) = \hat{y}E_0 \cos(\omega t + kz)$ (backward)

5) ***1 point***

The electric field of an electromagnetic wave that is traveling along x –direction in free space given by $E = E_0 \cos(kx - \omega t)$. The (i) Poynting's vector and (ii) flux density (irradiance, associated with the wave are respectively

(A) (i) $\vec{P} = c^2\varepsilon_0(\vec{E}_0 \times \vec{B}_0)\cos^2(kx - \omega t)$ and (ii) $I = \frac{1}{2}c\varepsilon_0 E_0^2$

(B) (i)$\vec{P} = c^2\varepsilon_0^2(\vec{E}_0 \times \vec{B}_0)\cos^2(kx - \omega t)$ and (ii) $I = \frac{1}{2}\varepsilon_0 c^2 E_0^2$

(C) (i)$\vec{P} = c^2\varepsilon_0(\vec{E}_0 \times \vec{B}_0)\cos^2(kx + \omega t)$ and (ii) $I = \frac{1}{2\varepsilon_0}cE_0^2$

(D) (i)$\vec{P} = \frac{c^2}{2}\varepsilon_0(\vec{E}_0 \times \vec{B}_0)\cos^2(kx - \omega t)$ and (ii) $I = \frac{1}{2}c^2\varepsilon_0^2 E_0^2$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(i) $\vec{P} = c^2\varepsilon_0(\vec{E}_0 \times \vec{B}_0)\cos^2(kx - \omega t)$ and (ii) $I = \frac{1}{2}c\varepsilon_0 E_0^2$
(A)

6) ***1 point***

If $\hat{r}$ denotes the unit vector along the position vector $\vec{r}$, then the correct value of $\nabla\vec{r}$ is

(A) $|\vec{r}|^2$

(B) $|\vec{r}|$

(C) $\hat{r}$

(D) $zero$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(C) $\hat{r}$

7) **1 point**

For a travelling plane electromagnetic wave, the energy density of electric field U_E , that of magnetic field U_H are related as

(A) $U_E > U_H$

(B) $U_E < U_H$

(C) $U_E^2 = U_H$

(D) $U_E = U_H$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(D) $U_E = U_H$

8) **1 point**

The earth's surface receives sunlight of energy/unit time/unit area (normal to direction of sunligh is 2100 $Joules/meter^2/second$. Given that the free space permeability, $\mu_0 = 4\pi \times 10^{-7}$ $Henry$ $meter$ and free space permittivity, $\varepsilon_0 = 8.85 \times 10^{-12}$ $Farad/meter$. From these data, th strength of (i) electric and (ii) magnetic field of sun's radiation on earth's surface respectively are

(A) (i) $E_0 \approx 1255\ volt/meter$ and (ii) $H_0 \approx 3.3\ Ampere-turn/meter$

(B) (i) $E_0 \approx 2502\ volt/meter$ and (ii) $H_0 \approx 4.3\ Ampere-turn/meter$

(C) (i) $E_0 \approx 623\ volt/meter$ and (ii) $H_0 \approx 5.3\ Ampere-turn/meter$

(D) (i) $E_0 \approx 186\ volt/meter$ and (ii) $H_0 \approx 6.3\ Ampere-turn/meter$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(i) $E_0 \approx 1255\ volt/meter$ and (ii) $H_0 \approx 3.3\ Ampere-turn/meter$
(A)

9) **1 point**

The conductivity of silver is $\sigma = 6.8 \times 10^7$ $Siemens/meter$ and its relative permeability is $\mu_r = 1$. Consider the propagation of an electromagnetic wave of frequency $f = 2\ MHz$ in silver. Given that the free space permeability, $\mu_0 = 4\pi \times 10^{-7}$ $Henry/meter$. (i) The skin depth δ and (ii) the phase velocity respectively are close to

(A) $(i)\ 8.6 \times 10^{-4} meter \quad and \quad (ii)\ 243\ meter/second$

(B) $(i)\ 4.3 \times 10^{-5} meter \quad and \quad (ii)\ 542\ meter/second$

(C) $(i)\ 3.3 \times 10^{-6} meter \quad and \quad (ii)\ 463\ meter/second$

(D) $(i)\ 7.9 \times 10^{-5} meter \quad and \quad (ii)\ 162\ meter/second$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(B) $(i)\ 4.3 \times 10^{-5} meter \quad and \quad (ii)\ 542\ meter/second$

10) The electric field components of a plane electromagnetic wave are $E_x = \frac{1}{2} E_0 \cos(\omega t - kz)$ and $E_y = \frac{\sqrt{3}}{2} E_0 \sin(\omega t - kz)$. The state of polarization of the wave is **1 point**

(A) $right{-}elliptical$

(B) $left{-}circular$

(C) $linear$

(D) $left{-}elliptical$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(D) $left{-}elliptical$

11) **1 point**

Which of the following about the Maxwell's equations is true? Symbols $\vec{J}_d, \vec{J}_c$, ρ, $\vec{D}$ have their usual meaning.

(A) $\nabla . \vec{J}_d = \partial \rho / \partial t$

(B) $\nabla . \vec{J}_c = \partial \rho / \partial t$

(C) $\vec{J}_d = -\partial \vec{D} / \partial t$

(D) $\vec{J}_c = \partial \vec{D} / \partial t$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(A) $\nabla . \vec{J}_d = \partial \rho / \partial t$

12) The field is specified in the following complex (phasor) form: $E(z) = -3j\hat{x}e^{-jkz}$. The corresponding real-valued electric and magnetic field components are **1 point**

(A)

$E_x(z,t) = -3\cos(\omega t - kz - \pi/2)$; $E_y(z,t) = 0$; $H_x(z,t) = -(1/\omega\mu_0)E_x(z,t)$; $H_y(z,t) = 0$

(B)
$E_x(z,t) = 0$; $E_y(z,t) = 3\cos(\omega t - kz - \pi/2)$; $H_x(z,t) = (1/\omega\mu_0)E_x(z,t)$; $H_y(z,t) = 0$;

(C)
$E_x(z,t) = -3\cos(\omega t - kz + \pi/2)$; $E_y(z,t) = 0$; $H_x(z,t) = 0$; $H_y(z,t) = (1/\omega\mu_0)E_x(z,t)$

(D)
$E_x(z,t) = 3\cos(\omega t - kz - \pi/2)$; $E_y(z,t) = 0$; $H_x(z,t) = 0$; $H_y(z,t) = (1/\omega\mu_0)E_x(z,t)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
(D)
$E_x(z,t) = 3\cos(\omega t - kz - \pi/2)$; $E_y(z,t) = 0$; $H_x(z,t) = 0$; $H_y(z,t) = (1/\omega\mu_0)E_x(z,t)$

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