Unit 2 - Week 1

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) Consider an electric field of the form: \( \mathbf{E} = 0.2 \cos \left( t - \frac{x}{c} - \frac{y}{c} \right) \). 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:
- (A) \( xy \) plane making an angle of \( \frac{\pi}{4} \) with \( x \) axis

2) An electromagnetic wave propagating in free space is described by the following equation

\[ E(z, t) = 55 \cos(\omega t - kz) + 55 \sin(\omega t - kz) \text{ volt/meter} \]

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) An electric field is given as \( \mathbf{E} = \mathbf{E}_x + j\mathbf{E}_y + k\mathbf{E}_z \). The value of \( V \), \((\nabla \times \mathbf{E})\) is

1 point
Consider the following two electric fields specified at time $t = 0$ that are respectively forward and back propagating:

$E(z, 0) = \hat{\imath}E_0 \cos k z$ (forward) and $E(z, 0) = \hat{\jmath}E_0 \cos k z$ (backward), where $k$ is the wave number. The corresponding fields $E(z, t)$ are

(A) $E(z, t) = \hat{\imath}E_0 \cos(\omega t + k z)$ (forward) and $E(z, t) = \hat{\jmath}E_0 \cos(\omega t - k z)$ (backward)

(B) $E(z, t) = \hat{\imath}E_0 \cos(\omega t - k z)$ (forward) and $E(z, t) = \hat{\jmath}E_0 \cos(\omega t + k z)$ (backward)

(C) $E(z, t) = \hat{\imath}E_0 \cos(\omega t + k z)$ (forward) and $E(z, t) = \hat{\jmath}E_0 \cos(\omega t - k z)$ (backward)

(D) $E(z, t) = \hat{\imath}E_0 \cos(\omega t - k z)$ (forward) and $E(z, t) = \hat{\jmath}E_0 \cos(\omega t + k z)$ (backward)

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

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

(i) $\vec{P} = c^2 \epsilon_0 (\vec{E}_0 \times \vec{B}_0) \cos^2(kx - \omega t)$
(ii) $I = \frac{1}{2} c \epsilon_0 E_0^2$

(A) $\vec{P} = c^2 \epsilon_0 (\vec{E}_0 \times \vec{B}_0) \cos^2(kx - \omega t)$
(ii) $I = \frac{1}{2} c \epsilon_0 E_0^2$

(B) $\vec{P} = c^2 \epsilon_0 (\vec{E}_0 \times \vec{B}_0) \cos^2(kx + \omega t)$
(ii) $I = \frac{1}{2} c \epsilon_0 E_0^2$

(C) $\vec{P} = \frac{c^2 \epsilon_0}{2} (\vec{E}_0 \times \vec{B}_0) \cos^2(kx - \omega t)$
(ii) $I = \frac{1}{2} c \epsilon_0 E_0^2$

(D) $\vec{P} = \frac{c^2 \epsilon_0}{2} (\vec{E}_0 \times \vec{B}_0) \cos^2(kx - \omega t)$
(ii) $I = \frac{1}{2} c \epsilon_0 E_0^2$

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

(i) $\vec{P} = c^2 \epsilon_0 (\vec{E}_0 \times \vec{B}_0) \cos^2(kx - \omega t)$
(ii) $I = \frac{1}{2} c \epsilon_0 E_0^2$

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

- (A) \( |\vec{r}| \)
- (B) \( |\hat{r}| \)
- (C) \( \hat{r} \)
- (D) zero

No, the answer is incorrect.
Score: 0
Accepted Answers:
(C) \( \hat{r} \)

8) 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) \( U_E = U_H \)

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

- (A) (i) \( E_0 \approx 1255 \text{ volt/meter} \) and (ii) \( H_0 \approx 3.3 \text{ Ampere – turn/meter} \)
- (B) (i) \( E_0 \approx 2502 \text{ volt/meter} \) and (ii) \( H_0 \approx 4.3 \text{ Ampere – turn/meter} \)
- (C) (i) \( E_0 \approx 623 \text{ volt/meter} \) and (ii) \( H_0 \approx 5.3 \text{ Ampere – turn/meter} \)
- (D) (i) \( E_0 \approx 186 \text{ volt/meter} \) and (ii) \( H_0 \approx 6.3 \text{ Ampere – turn/meter} \)

No, the answer is incorrect.
Score: 0
Accepted Answers:
(A) (i) \( E_0 \approx 1255 \text{ volt/meter} \) and (ii) \( H_0 \approx 3.3 \text{ Ampere – turn/meter} \)
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 \( \delta \) and (ii) the phase velocity respectively are close to

(A) (i) 8.6 \times 10^{-4} \text{meter} \quad \text{and} \quad \text{(ii) 243 meter/second}
(B) (i) 4.3 \times 10^{-5} \text{meter} \quad \text{and} \quad \text{(ii) 542 meter/second}
(C) (i) 3.3 \times 10^{-6} \text{meter} \quad \text{and} \quad \text{(ii) 463 meter/second}
(D) (i) 7.9 \times 10^{-5} \text{meter} \quad \text{and} \quad \text{(ii) 162 meter/second}

No, the answer is incorrect.
Score: 0
Accepted Answers:
(B) (i) 4.3 \times 10^{-5} \text{meter} \quad \text{and} \quad \text{(ii) 542 meter/second}

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

(A) right-elliptical
(B) left-circular
(C) linear
(D) left-elliptical

No, the answer is incorrect.
Score: 0
Accepted Answers:
(D) left-elliptical

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

(A) \( \nabla \cdot \vec{J}_d = \partial \rho / \partial t \)
(B) \( \nabla \cdot \vec{J}_c = \partial \rho / \partial t \)
(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) \( \nabla \cdot \vec{J}_d = \partial \rho / \partial t \)

The field is specified in the following complex (phasor) form: \( \vec{E}(z) = -3j\delta e^{-j\omega z} \). The corresponding real-valued electric and magnetic field components are

(A) \( E_x(z,t) = -3 \cos(\omega t - k_z - \pi/2) \); \( E_y(z,t) = 0 \); \( H_x(z,t) = -(1/\omega \mu_0) E_y(z,t) \); \( H_y(z,t) = 0 \)
(B) 
\[ E_x(z,t) = 0 ; E_y(z,t) = 3 \cos(\omega t - kz - \pi/2) ; H_z(z,t) = (1/\omega \mu_0) E_z(z,t) ; H_y(z,t) = 0 ; \]

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

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

No, the answer is incorrect.
Score: 0
Accepted Answers:
(D) 
\[ E_x(z,t) = 3 \cos(\omega t - kz - \pi/2) ; E_y(z,t) = 0 ; H_z(z,t) = 0 ; H_y(z,t) = (1/\omega \mu_0) E_y(z,t) \]