22W-PHYSICS-1C Mid-term 2

XIMENG GUO

TOTAL POINTS

28 / 28

QUESTION 1

8 pts

1.1 4 / 4

✓ **- 0 pts** Correct

- 1 pts First one is incorrect.

- 1 pts Second one is incorrect.

- 1 pts Third one is incorrect.

- 1 pts Fourth one is incorrect.

1.2 2 / 2

✓ **- 0 pts** Correct

- 1 pts Incorrect Imax

- 1 pts Incorrect omega_0

1.3 2 / 2

✓ **+ 2 pts** Correct option is selected.

+ 0 pts Incorrect option selected.

QUESTION 2

10 pts

2.1 3 / 3

✓ **+ 0.5 pts** Expression for $$B_{max}$$ is correct.

✓ **+ 0.5 pts** $$B_{max}$$ is correct.

✓ **+ 0.5 pts** $$k$$ is correct.

✓ **+ 0.5 pts** The sign on $$k$$ is correct i.e. direction of the wave is correct.

✓ **+ 0.5 pts** $$\omega$$ is correct.

✓ **+ 0.5 pts** The final expression is correct.

+ 0 pts Incorrect.

2.2 3 / 3

✓ **+ 0.5 pts** $$E_{max}$$ is correct.

✓ **+ 0.5 pts** $$k$$ is correct.

✓ **+ 0.5 pts** $$\omega$$ is correct.

✓ **+ 0.5 pts** Direction of propagation is correct.

✓ **+ 0.5 pts** Direction of $$E$$ is correct.

✓ **+ 0.5 pts** Form of the final expression is correct.

+ 0 pts Not Attempted.

2.3 2 / 2

✓ **+ 1 pts** Correct expression for intensity.

✓ **+ 1 pts** Correct answer.

+ 0 pts Not attempted.

2.4 2 / 2

✓ **+ 1 pts** Correct expression for $$U$$.

✓ **+ 1 pts** Correct final expression.

+ 0 pts Not Attempted

QUESTION 3

10 pts

3.1 3 / 3

✓ **- 0 pts** Correct

- 1 pts Wrong X_C

- 1 pts Wrong X_L

- 1 pts Wrong Z

- 0.5 pts Numerical error for X_C

- 0.5 pts Numerical error for X_L

- 0.5 pts Numerical error for Z

- 3 pts Blank

3.2 2 / 2

✓ **- 0 pts** Correct

- 1 pts Incorrect formula

- 0.5 pts Numerical error

- 2 pts Blank

- 1 pts No numerical result

3.3 3 / 3

✓ **- 0 pts** **Correct**

- 2 pts Incorrect formula

- 0.5 pts Numerical error

- 2.5 pts Incorrect argument.

- 3 pts Blank

3.4 2 / 2

✓ **- 0 pts** **Correct**

- 1 pts Incorrect formula

- 1 pts Numerical error

- 0.5 pts Numerical error

- 1.5 pts Incorrect argument

- 2 pts Blank

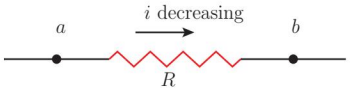
Problem 1 (8 pts)

Please ***be very careful*** in writing down your answers for these two questions. They are graded by the final answers ONLY, no partial credits for any intermediate steps.

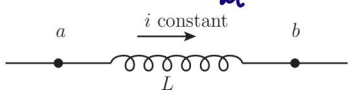
(a) (4 pts) In the following four situations, please determine the sign of potential difference V_{ab} between point a and b? For each of them, choose your answers from:

a. $V_{ab} > 0$ b. $V_{ab} < 0$ c. $V_{ab} = 0$ d. V_{ab} cannot be determined

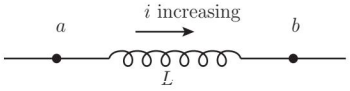
$V = iR$ $V = -L\frac{di}{dt}$



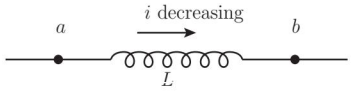
Your choice: a



Your choice: c



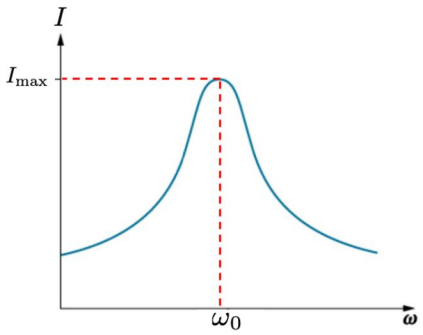
Your choice: a



Your choice: b

(b) (2 pts) We use a resistor R, an inductor L, and a capacitor C to make a series ac circuit. Assuming V and I are the amplitude for the corresponding voltage and current, now if one plots the current amplitude I as a function of angular frequency ω, one finds the behavior as shown in the figure. Please determine the value of I_{max} and ω_0 in terms of V, R, L, C and/or ω. Your answers:

LRC



$I_{max} =$ $\frac{V}{R}$ $\omega_0 =$ $\frac{1}{\sqrt{LC}}$

$\omega L = \frac{1}{\omega C}$ $\omega^2 = \frac{1}{LC}$ $\omega = \frac{1}{\sqrt{LC}}$

(c) (2 pts) An electromagnetic plane wave propagates in the vacuum. Its electric field $\vec{E}(x,t) = E_{max}\cos(kx + \omega t)\hat{j}$, please determine the direction of the Poynting vector.

Your choice: c

a. $+y$ b. $-y$ c. $-x$ d. $+x$ e. $-z$ f. $+z$

g. not enough information, cannot be determined

1.1 4 / 4

✓ **- 0 pts** **Correct**

- 1 pts First one is incorrect.

- 1 pts Second one is incorrect.

- 1 pts Third one is incorrect.

- 1 pts Fourth one is incorrect.

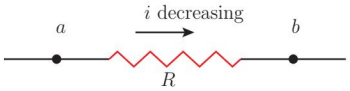
Problem 1 (8 pts)

Please ***be very careful*** in writing down your answers for these two questions. They are graded by the final answers ONLY, no partial credits for any intermediate steps.

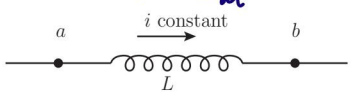
(a) (4 pts) In the following four situations, please determine the sign of potential difference V_{ab} between point a and b? For each of them, choose your answers from:

a. $V_{ab} > 0$ b. $V_{ab} < 0$ c. $V_{ab} = 0$ d. V_{ab} cannot be determined

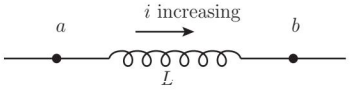
$V = iR$ $V = -L\frac{di}{dt}$



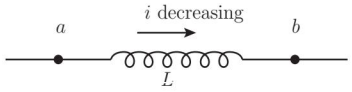
Your choice: a



Your choice: c



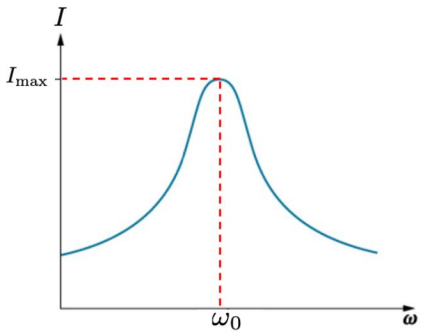
Your choice: a



Your choice: b

(b) (2 pts) We use a resistor R, an inductor L, and a capacitor C to make a series ac circuit. Assuming V and I are the amplitude for the corresponding voltage and current, now if one plots the current amplitude I as a function of angular frequency ω, one finds the behavior as shown in the figure. Please determine the value of I_{max} and ω_0 in terms of V, R, L, C and/or ω. Your answers:

LRC



$I_{max} =$ $\frac{V}{R}$ $\omega_0 =$ $\frac{1}{\sqrt{LC}}$

$\omega L = \frac{1}{\omega C}$ $\omega^2 = \frac{1}{LC}$ $\omega = \frac{1}{\sqrt{LC}}$

(c) (2 pts) An electromagnetic plane wave propagates in the vacuum. Its electric field $\vec{E}(x,t) = E_{max}\cos(kx + \omega t)\hat{j}$, please determine the direction of the Poynting vector.

Your choice: c

a. $+y$ b. $-y$ c. $-x$ d. $+x$ e. $-z$ f. $+z$

g. not enough information, cannot be determined

1.2 2 / 2

✓ **- 0 pts** **Correct**

- 1 pts Incorrect Imax

- 1 pts Incorrect omega_0

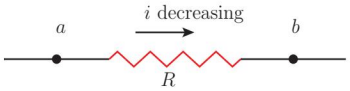
Problem 1 (8 pts)

Please ***be very careful*** in writing down your answers for these two questions. They are graded by the final answers ONLY, no partial credits for any intermediate steps.

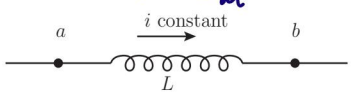
(a) (4 pts) In the following four situations, please determine the sign of potential difference V_{ab} between point a and b? For each of them, choose your answers from:

a. $V_{ab} > 0$ b. $V_{ab} < 0$ c. $V_{ab} = 0$ d. V_{ab} cannot be determined

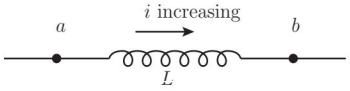
$V = iR$ $V = -L\frac{di}{dt}$



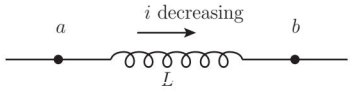
Your choice: a



Your choice: c



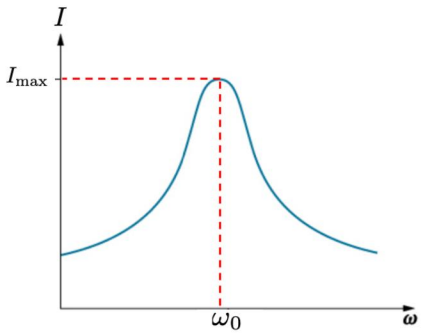
Your choice: a



Your choice: b

(b) (2 pts) We use a resistor R, an inductor L, and a capacitor C to make a series ac circuit. Assuming V and I are the amplitude for the corresponding voltage and current, now if one plots the current amplitude I as a function of angular frequency ω, one finds the behavior as shown in the figure. Please determine the value of I_{max} and ω_0 in terms of V, R, L, C and/or ω. Your answers:

LRC



$I_{max} =$ $\frac{V}{R}$ $\omega_0 =$ $\frac{1}{\sqrt{LC}}$

$\omega L = \frac{1}{\omega C}$ $\omega^2 = \frac{1}{LC}$ $\omega = \frac{1}{\sqrt{LC}}$

(c) (2 pts) An electromagnetic plane wave propagates in the vacuum. Its electric field $\vec{E}(x,t) = E_{max}\cos(kx + \omega t)\hat{j}$, please determine the direction of the Poynting vector.

Your choice: c

a. $+y$ b. $-y$ c. $-x$ d. $+x$ e. $-z$ f. $+z$

g. not enough information, cannot be determined

1.3 **2 / 2**

✓ **+ 2 pts** **Correct option is selected.**

+ 0 pts Incorrect option selected.

Problem 2 (10 pts)

Please make sure to write down ***intermediate steps*** of your calculations, for partial credits.

A carbon dioxide laser emits a sinusoidal electromagnetic wave that travels in $-x$ direction in vacuum. The wavelength is given by $\lambda = 6.28 \times 10^{-6}$ m. The electric field associated with such an electromagnetic wave is parallel to the $+z$ direction with an amplitude $E_{max} = 1.5 \times 10^{6}$ V/m. Note for the vectors below, your expression should reflect the direction.

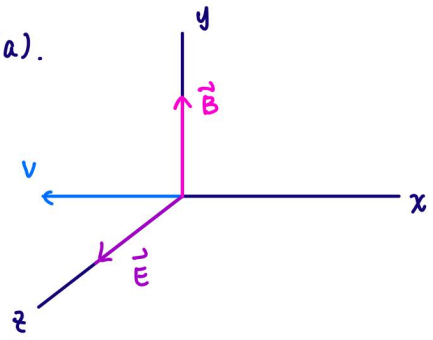
(a) (3 pts) Please derive the expression for the wave corresponding to the magnetic field $\vec{B}$.

(b) (3 pts) Please derive the expression for the wave corresponding to the electric field $\vec{E}$.

(c) (2 pts) Please derive the expression for the intensity I.

(d) (2 pts) Find the instantaneous values of the total energy density u.

(a).



By right hand rule, $\vec{B}$ travels in $+y$ direction

$\hat{k} \times \hat{j} = -\hat{i}$

$\therefore \vec{B}(x,t) = \hat{j}\, B_{max} \cos(kx + \omega t)$

$B_{max} = \frac{E_{max}}{c} = \frac{1.5 \times 10^{6}}{3.0 \times 10^{8}} T = 5.0 \times 10^{-3} T$

$k = \frac{2\pi}{\lambda} = \frac{2\pi}{6.28 \times 10^{-6}} = 1.0 \times 10^{6}\ m^{-1}$

$\omega = kc = 1.0 \times 10^{6} \times 3.0 \times 10^{8}\ s^{-1} = 3.0 \times 10^{14}\ s^{-1}$

$\therefore \vec{B}(x,t) = 5.0 \times 10^{-3} \cos(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)\, \hat{j}$

(b). $\vec{E}$ travels in $+z$ direction

$\vec{E}(x,t) = \hat{k}\, E_{max} \cos(kx + \omega t)$

$= 1.5 \times 10^{6} \cos(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)\, \hat{k}$

(c). $I = \frac{1}{2} \epsilon_0 c E_{max}^{2} = \frac{1}{2} \times 8.85 \times 10^{-12} \times 3.0 \times 10^{8} \times (1.5 \times 10^{6})^{2} = 3.0 \times 10^{9}\ \frac{W}{m^2}$

(d). $u = \epsilon_0 E^{2} = \epsilon_0 \cdot (1.5 \times 10^{6})^{2} \times \cos^{2}(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)$

$= 8.85 \times 10^{-12} \times (1.5 \times 10^{6})^{2} \times \cos^{2}(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)$

$= 19.9 \cos^{2}(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)$

2.1 3 / 3

✓ **+ 0.5 pts** Expression for $$B_{max}$$ is correct.

✓ **+ 0.5 pts** $$B_{max}$$ is correct.

✓ **+ 0.5 pts** $$k$$ is correct.

✓ **+ 0.5 pts** The sign on $$k$$ is correct i.e. direction of the wave is correct.

✓ **+ 0.5 pts** $$\omega$$ is correct.

✓ **+ 0.5 pts** The final expression is correct.

+ 0 pts Incorrect.

Problem 2 (10 pts)

Please make sure to write down ***intermediate steps*** of your calculations, for partial credits.

A carbon dioxide laser emits a sinusoidal electromagnetic wave that travels in $-x$ direction in vacuum. The wavelength is given by $\lambda = 6.28 \times 10^{-6}$ m. The electric field associated with such an electromagnetic wave is parallel to the $+z$ direction with an amplitude $E_{max} = 1.5 \times 10^{6}$ V/m. Note for the vectors below, your expression should reflect the direction.

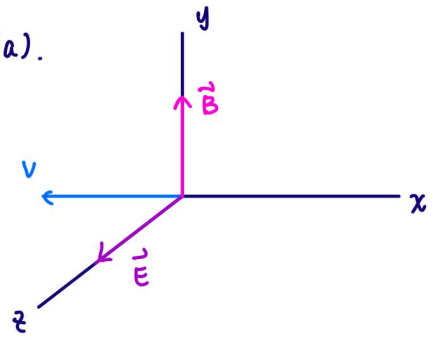
(a) (3 pts) Please derive the expression for the wave corresponding to the magnetic field $\vec{B}$.

(b) (3 pts) Please derive the expression for the wave corresponding to the electric field $\vec{E}$.

(c) (2 pts) Please derive the expression for the intensity I.

(d) (2 pts) Find the instantaneous values of the total energy density u.

(a).



By right hand rule, $\vec{B}$ travels in $+y$ direction

$\hat{k} \times \hat{j} = -\hat{i}$

$\therefore \vec{B}(x,t) = \hat{j}\, B_{max} \cos(kx + \omega t)$

$B_{max} = \frac{E_{max}}{c} = \frac{1.5 \times 10^{6}}{3.0 \times 10^{8}} T = 5.0 \times 10^{-3} T$

$k = \frac{2\pi}{\lambda} = \frac{2\pi}{6.28 \times 10^{-6}} = 1.0 \times 10^{6}\ m^{-1}$

$\omega = kc = 1.0 \times 10^{6} \times 3.0 \times 10^{8}\ s^{-1} = 3.0 \times 10^{14}\ s^{-1}$

$\therefore \vec{B}(x,t) = 5.0 \times 10^{-3} \cos(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)\, \hat{j}$

(b). $\vec{E}$ travels in $+z$ direction

$\vec{E}(x,t) = \hat{k}\, E_{max} \cos(kx + \omega t)$

$= 1.5 \times 10^{6} \cos(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)\, \hat{k}$

(c). $I = \frac{1}{2} \epsilon_0 c E_{max}^{2} = \frac{1}{2} \times 8.85 \times 10^{-12} \times 3.0 \times 10^{8} \times (1.5 \times 10^{6})^{2} = 3.0 \times 10^{9}\ \frac{W}{m^2}$

(d). $u = \epsilon_0 E^{2} = \epsilon_0 \cdot (1.5 \times 10^{6})^{2} \times \cos^{2}(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)$

$= 8.85 \times 10^{-12} \times (1.5 \times 10^{6})^{2} \times \cos^{2}(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)$

$= 19.9 \cos^{2}(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)$

2.2 3 / 3

✓ **+ 0.5 pts** $$E_{max}$$ is correct.

✓ **+ 0.5 pts** $$k$$ is correct.

✓ **+ 0.5 pts** $$\omega$$ is correct.

✓ **+ 0.5 pts** Direction of propagation is correct.

✓ **+ 0.5 pts** Direction of $$E$$ is correct.

✓ **+ 0.5 pts** Form of the final expression is correct.

+ 0 pts Not Attempted.

Problem 2 (10 pts)

Please make sure to write down ***intermediate steps*** of your calculations, for partial credits.

A carbon dioxide laser emits a sinusoidal electromagnetic wave that travels in $-x$ direction in vacuum. The wavelength is given by $\lambda = 6.28 \times 10^{-6}$ m. The electric field associated with such an electromagnetic wave is parallel to the $+z$ direction with an amplitude $E_{max} = 1.5 \times 10^{6}$ V/m. Note for the vectors below, your expression should reflect the direction.

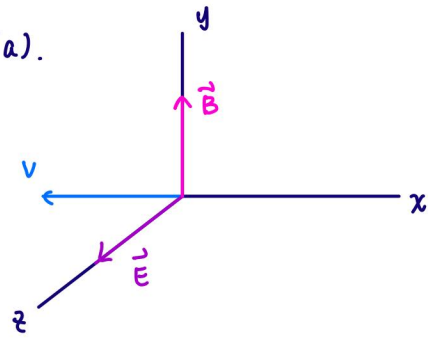
(a) (3 pts) Please derive the expression for the wave corresponding to the magnetic field $\vec{B}$.

(b) (3 pts) Please derive the expression for the wave corresponding to the electric field $\vec{E}$.

(c) (2 pts) Please derive the expression for the intensity I.

(d) (2 pts) Find the instantaneous values of the total energy density u.

(a).



By right hand rule, $\vec{B}$ travels in $+y$ direction

$\hat{k} \times \hat{j} = -\hat{i}$

$\therefore \vec{B}(x,t) = \hat{j}\, B_{max} \cos(kx + \omega t)$

$B_{max} = \frac{E_{max}}{c} = \frac{1.5 \times 10^{6}}{3.0 \times 10^{8}} T = 5.0 \times 10^{-3} T$

$k = \frac{2\pi}{\lambda} = \frac{2\pi}{6.28 \times 10^{-6}} = 1.0 \times 10^{6}\ m^{-1}$

$\omega = kc = 1.0 \times 10^{6} \times 3.0 \times 10^{8}\ s^{-1} = 3.0 \times 10^{14}\ s^{-1}$

$\therefore \vec{B}(x,t) = 5.0 \times 10^{-3} \cos(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)\, \hat{j}$

(b). $\vec{E}$ travels in $+z$ direction

$\vec{E}(x,t) = \hat{k}\, E_{max} \cos(kx + \omega t)$

$= 1.5 \times 10^{6} \cos(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)\, \hat{k}$

(c). $I = \frac{1}{2} \epsilon_0 c E_{max}^{2} = \frac{1}{2} \times 8.85 \times 10^{-12} \times 3.0 \times 10^{8} \times (1.5 \times 10^{6})^{2} = 3.0 \times 10^{9}\ \frac{W}{m^2}$

(d). $u = \epsilon_0 E^{2} = \epsilon_0 \cdot (1.5 \times 10^{6})^{2} \times \cos^{2}(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)$

$= 8.85 \times 10^{-12} \times (1.5 \times 10^{6})^{2} \times \cos^{2}(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)$

$= 19.9 \cos^{2}(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)$

2.3 2 / 2

✓ **+ 1 pts** Correct expression for intensity.

✓ **+ 1 pts** Correct answer.

+ 0 pts Not attempted.

Problem 2 (10 pts)

Please make sure to write down ***intermediate steps*** of your calculations, for partial credits.

A carbon dioxide laser emits a sinusoidal electromagnetic wave that travels in $-x$ direction in vacuum. The wavelength is given by $\lambda = 6.28 \times 10^{-6}$ m. The electric field associated with such an electromagnetic wave is parallel to the $+z$ direction with an amplitude $E_{max} = 1.5 \times 10^{6}$ V/m. Note for the vectors below, your expression should reflect the direction.

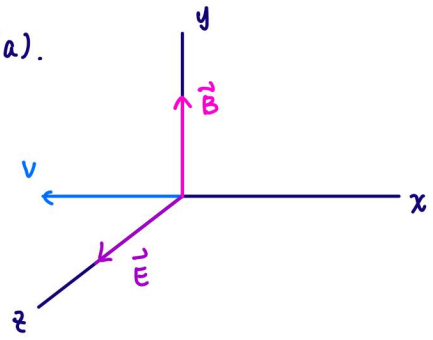
(a) (3 pts) Please derive the expression for the wave corresponding to the magnetic field $\vec{B}$.

(b) (3 pts) Please derive the expression for the wave corresponding to the electric field $\vec{E}$.

(c) (2 pts) Please derive the expression for the intensity I.

(d) (2 pts) Find the instantaneous values of the total energy density u.

(a).



By right hand rule, $\vec{B}$ travels in $+y$ direction

$\hat{k} \times \hat{j} = -\hat{i}$

$\therefore \vec{B}(x,t) = \hat{j}\, B_{max} \cos(kx + \omega t)$

$B_{max} = \frac{E_{max}}{c} = \frac{1.5 \times 10^{6}}{3.0 \times 10^{8}} T = 5.0 \times 10^{-3} T$

$k = \frac{2\pi}{\lambda} = \frac{2\pi}{6.28 \times 10^{-6}} = 1.0 \times 10^{6}\ m^{-1}$

$\omega = kc = 1.0 \times 10^{6} \times 3.0 \times 10^{8}\ s^{-1} = 3.0 \times 10^{14}\ s^{-1}$

$\therefore \vec{B}(x,t) = 5.0 \times 10^{-3} \cos(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)\, \hat{j}$

(b). $\vec{E}$ travels in $+z$ direction

$\vec{E}(x,t) = \hat{k}\, E_{max} \cos(kx + \omega t)$

$= 1.5 \times 10^{6} \cos(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)\, \hat{k}$

(c). $I = \frac{1}{2} \epsilon_0 c E_{max}^{2} = \frac{1}{2} \times 8.85 \times 10^{-12} \times 3.0 \times 10^{8} \times (1.5 \times 10^{6})^{2} = 3.0 \times 10^{9}\ \frac{W}{m^2}$

(d). $u = \epsilon_0 E^{2} = \epsilon_0 \cdot (1.5 \times 10^{6})^{2} \times \cos^{2}(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)$

$= 8.85 \times 10^{-12} \times (1.5 \times 10^{6})^{2} \times \cos^{2}(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)$

$= 19.9 \cos^{2}(1.0 \times 10^{6} x + 3.0 \times 10^{14} t)$

2.4 2 / 2

✓ **+ 1 pts** Correct expression for $$U$$.

✓ **+ 1 pts** Correct final expression.

+ 0 pts Not Attempted

Problem 3 (10 pts)

Please make sure to write down ***intermediate steps*** of your calculations, for partial credits.

The output of an ac generator has a frequency $f = 200$ Hz and an amplitude of 0.100 V. This ac generator is connected to a L-R-C series circuit with $R = 4.00\ \Omega, L = 3.00 \times 10^{-3}$ H, *and* $C = 8.00 \times 10^{-4}$ F. Please answer the following questions.

(a) (3 pts) What are the capacitive reactance, the inductive reactance and the impedance?

(b) (2 pts) What is the current amplitude?

(c) (3 pts) What is the phase difference between the current and the voltage of the generator?

(d) (2 pts) What is the average power out of the generator?

(a). $\omega = 2\pi f = 400\pi\ \text{rad}\cdot\text{s}^{-1}$

$X_C = \frac{1}{\omega C} = \frac{1}{400\pi \times 8.00\times10^{-4}}\ \Omega = 0.995\ \Omega$

$X_L = \omega L = 400\pi \times 3.00\times10^{-3}\ \Omega = 3.77\ \Omega$

$Z = \sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2} = \sqrt{4.00^2 + (3.77 - 0.995)^2} = 4.87\ \Omega$

(b). $I = \frac{V}{Z} = \frac{0.100}{4.87} = 0.0205\ \text{A}$

(c). $\because \tan\phi = \frac{\omega L - \frac{1}{\omega C}}{R}$

$\therefore \phi = \tan^{-1}\left(\frac{\omega L - \frac{1}{\omega C}}{R}\right) = \tan^{-1}\left(\frac{3.77 - 0.995}{4.00}\right) = 34.8°$

(d). $P_{av} = \frac{1}{2} VI\cos\phi$

$= \frac{1}{2} \times 0.100 \times 0.0205 \times \cos(34.8°)$

$= 8.42\times10^{-4}\ \text{W}$

3.1 3 / 3

✓ **- 0 pts** **Correct**

- 1 pts Wrong X_C

- 1 pts Wrong X_L

- 1 pts Wrong Z

- 0.5 pts Numerical error for X_C

- 0.5 pts Numerical error for X_L

- 0.5 pts Numerical error for Z

- 3 pts Blank

Problem 3 (10 pts)

Please make sure to write down ***intermediate steps*** of your calculations, for partial credits.

The output of an ac generator has a frequency $f = 200$ Hz and an amplitude of 0.100 V. This ac generator is connected to a L-R-C series circuit with $R = 4.00\ \Omega, L = 3.00 \times 10^{-3}$ H, *and* $C = 8.00 \times 10^{-4}$ F. Please answer the following questions.

(a) (3 pts) What are the capacitive reactance, the inductive reactance and the impedance?

(b) (2 pts) What is the current amplitude?

(c) (3 pts) What is the phase difference between the current and the voltage of the generator?

(d) (2 pts) What is the average power out of the generator?

(a). $\omega = 2\pi f = 400\pi\ \text{rad}\cdot\text{s}^{-1}$

$X_C = \frac{1}{\omega C} = \frac{1}{400\pi \times 8.00\times10^{-4}}\ \Omega = 0.995\ \Omega$

$X_L = \omega L = 400\pi \times 3.00\times10^{-3}\ \Omega = 3.77\ \Omega$

$Z = \sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2} = \sqrt{4.00^2 + (3.77 - 0.995)^2} = 4.87\ \Omega$

(b). $I = \frac{V}{Z} = \frac{0.100}{4.87} = 0.0205\ \text{A}$

(c). $\because \tan\phi = \frac{\omega L - \frac{1}{\omega C}}{R}$

$\therefore \phi = \tan^{-1}\left(\frac{\omega L - \frac{1}{\omega C}}{R}\right) = \tan^{-1}\left(\frac{3.77 - 0.995}{4.00}\right) = 34.8°$

(d). $P_{av} = \frac{1}{2} VI\cos\phi$

$= \frac{1}{2} \times 0.100 \times 0.0205 \times \cos(34.8°)$

$= 8.42\times10^{-4}\ \text{W}$

3.2 2 / 2

✓ **- 0 pts** **Correct**

- 1 pts Incorrect formula

- 0.5 pts Numerical error

- 2 pts Blank

- 1 pts No numerical result

Problem 3 (10 pts)

Please make sure to write down ***intermediate steps*** of your calculations, for partial credits.

The output of an ac generator has a frequency $f = 200$ Hz and an amplitude of 0.100 V. This ac generator is connected to a L-R-C series circuit with $R = 4.00\ \Omega, L = 3.00 \times 10^{-3}$ H, *and* $C = 8.00 \times 10^{-4}$ F. Please answer the following questions.

(a) (3 pts) What are the capacitive reactance, the inductive reactance and the impedance?

(b) (2 pts) What is the current amplitude?

(c) (3 pts) What is the phase difference between the current and the voltage of the generator?

(d) (2 pts) What is the average power out of the generator?

(a). $\omega = 2\pi f = 400\pi\ \text{rad}\cdot\text{s}^{-1}$

$X_C = \frac{1}{\omega C} = \frac{1}{400\pi \times 8.00\times10^{-4}}\ \Omega = 0.995\ \Omega$

$X_L = \omega L = 400\pi \times 3.00\times10^{-3}\ \Omega = 3.77\ \Omega$

$Z = \sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2} = \sqrt{4.00^2 + (3.77 - 0.995)^2} = 4.87\ \Omega$

(b). $I = \frac{V}{Z} = \frac{0.100}{4.87} = 0.0205\ \text{A}$

(c). $\because \tan\phi = \frac{\omega L - \frac{1}{\omega C}}{R}$

$\therefore \phi = \tan^{-1}\left(\frac{\omega L - \frac{1}{\omega C}}{R}\right) = \tan^{-1}\left(\frac{3.77 - 0.995}{4.00}\right) = 34.8°$

(d). $P_{av} = \frac{1}{2} VI\cos\phi$

$= \frac{1}{2} \times 0.100 \times 0.0205 \times \cos(34.8°)$

$= 8.42\times10^{-4}\ \text{W}$

3.3 3 / 3

✓ **- 0 pts** **Correct**

- 2 pts Incorrect formula

- 0.5 pts Numerical error

- 2.5 pts Incorrect argument.

- 3 pts Blank

Problem 3 (10 pts)

Please make sure to write down ***intermediate steps*** of your calculations, for partial credits.

The output of an ac generator has a frequency $f = 200$ Hz and an amplitude of 0.100 V. This ac generator is connected to a L-R-C series circuit with $R = 4.00\ \Omega, L = 3.00 \times 10^{-3}$ H, *and* $C = 8.00 \times 10^{-4}$ F. Please answer the following questions.

(a) (3 pts) What are the capacitive reactance, the inductive reactance and the impedance?

(b) (2 pts) What is the current amplitude?

(c) (3 pts) What is the phase difference between the current and the voltage of the generator?

(d) (2 pts) What is the average power out of the generator?

(a). $\omega = 2\pi f = 400\pi\ \text{rad}\cdot\text{s}^{-1}$

$X_C = \frac{1}{\omega C} = \frac{1}{400\pi \times 8.00\times10^{-4}}\ \Omega = 0.995\ \Omega$

$X_L = \omega L = 400\pi \times 3.00\times10^{-3}\ \Omega = 3.77\ \Omega$

$Z = \sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2} = \sqrt{4.00^2 + (3.77 - 0.995)^2} = 4.87\ \Omega$

(b). $I = \frac{V}{Z} = \frac{0.100}{4.87} = 0.0205\ \text{A}$

(c). $\because \tan\phi = \frac{\omega L - \frac{1}{\omega C}}{R}$

$\therefore \phi = \tan^{-1}\left(\frac{\omega L - \frac{1}{\omega C}}{R}\right) = \tan^{-1}\left(\frac{3.77 - 0.995}{4.00}\right) = 34.8°$

(d). $P_{av} = \frac{1}{2} VI\cos\phi$

$= \frac{1}{2} \times 0.100 \times 0.0205 \times \cos(34.8°)$

$= 8.42\times10^{-4}\ \text{W}$

3.4 2 / 2

✓ **- 0 pts** **Correct**

- 1 pts Incorrect formula

- 1 pts Numerical error

- 0.5 pts Numerical error

- 1.5 pts Incorrect argument

- 2 pts Blank