Joel Trussell **ECE303_Adams**
Assignment ECE303_HW_Set_1 due 09/04/2019 at 03:00pm EDT

---

1. **(1 point)** local/ECE303/Ulaby_7Ed_Ch1/ECE303_Ulaby_Ed7_1.9.pg

Give the expressions for $y(x,t)$ for a sinusoidal wave traveling along a string in the negative x-direction, given that $y_{max} = 40$ cm, $\lambda = 40$ cm, $f = 5$ Hz, and x is measured in meters and assigned a positive sign: The form of the solution is $y(x,t) = A\cos(2\pi ft + \beta x + \phi)$ with x in meters, and your answers are validated to ± 0.01 absolute:

(a) $y(x,0) = 0$ at $x = 0$ cm

There are two phases, ϕ_1 and ϕ_2 that will work for this case. The phases should in the interval $[-\pi, \pi]$. Give the two phases, where $\phi_1 > \phi_2$:

$\phi_1 =$ _____ and $\phi_2 =$ _____ radians help (numbers)

$y(x,t) =$ _____ (cm) for phase 1 help (formulas)

$y(x,t) =$ _____ (cm) for phase 2 help (formulas)

(b) $y(x,0) = 0$ at $x = 4.5$ cm

There are two phases, ϕ_1 and ϕ_2 that will work for this case. The phases should in the interval $[-\pi, \pi]$. Give the two phases, where $\phi_1 > \phi_2$:

$\phi_1 =$ _____ and $\phi_2 =$ _____ radians help (numbers)

$y(x,t) =$ _____ (cm) for phase 1 help (formulas)

$y(x,t) =$ _____ (cm) for phase 2 help (formulas)

---

2. **(1 point)** local/ECE303/Ulaby_7Ed_Ch1/ECE303_Ulaby_Ed7_1.13.pg

The voltage of an electromagnetic wave traveling on a transmmission line is given by $v(z,t) = 9e^{-\alpha z}\sin(2\pi \cdot 2.5 \times 10^9 t - 2\pi \cdot 13z)$ (V), where z is the distance in meters from the generator.

(a) Find the frequency, wavelength and phase velocity of the wave.

$f =$ _____ GHz help (numbers)

$\lambda =$ _____ cm help (numbers)

$u_p =$ _____ $\cdot 10^3 km/s$ help (numbers)

(b) At $z = 2.4m$, the amplitude of the wave was measured to be $1.8V$. Find α.

Your answer for part (b) will be validated to ± 0.01 absolute.

$\alpha =$ _____ Np/m help (numbers)

---

3. **(1 point)** local/ECE303/Ulaby_7Ed_Ch1/ECE303_Ulaby_Ed7_1.16.pg

Evaluate each of the following complex numbers and express the result in rectangular form, your answers will be validated to ± 0.01 absolute.

(a) $z_1 = 18e^{j\cdot\pi/3}$= _____ + j _____ help (numbers)

(b) $z_2 = \sqrt{6}\cdot e^{j\cdot\pi\cdot 2/9}$= _____ + j _____ help (numbers)

(c) $z_3 = 5\cdot e^{j\cdot\pi/(-1)}$= _____ + j _____ help (numbers)

(d) $z_4 = j^7$= _____ + j _____ help (numbers)

(e) $z_5 = j^{-6}$= _____ + j _____ help (numbers)

(f) $z_6 = (1-j)^5$= _____ + j _____ help (numbers)

(g) $z_7 = (1-j)^{1/4}$= _____ help (numbers)

Note: There are multiple solutions for (g), please enter your answers in comma separated list. Your answers may be listed in any order.

---

4. **(1 point)** local/ECE303/Ulaby_7Ed_Ch1/ECE303_Ulaby_Ed7_1.26.pg

Evaluate each of the following complex numbers and express the result in phasor form.

The answers to the first three questions should be expressed in imaginary exponential form with respect to variable x and/or t. In these three questions, your answers will be validated to ± 0.01 absolute.

(a) $v(t) = 22cos(\omega t + \frac{\pi}{3})\ V$

$\tilde{V} =$ _____ V help (formulas)

(b) $v(t) = 2sin(\omega t + \frac{\pi}{5})\ V$

$\tilde{V} =$ _____ V help (formulas)

(c) $i(x,t) = 5e^{-2x}sin(\omega t + \frac{\pi}{9})\ A$

$\tilde{I} =$ _____ A help (formulas)

In the following two questions, the phase angles should be expressed in degrees. In these two questions, your answers will be validated to $\pm 1\%$.

(d) $i(t) = -4cos(\omega t + \frac{3\pi}{4})\ A$

$\tilde{I} =$ _____ $\angle$ _____ $^\circ A$ help (numbers)

(e) $i(t) = 6sin(\omega t + \frac{\pi}{3}) - 1cos(\omega t - \frac{\pi}{6})\ A$

$\tilde{I} =$ _____ $\angle$ _____ $^\circ A$ help (numbers)

---

5. **(1 point)** local/ECE303/Ulaby_7Ed_Ch1/ECE303_Ulaby_Ed7_1.28.pg

A series RLC circuit is connected to a generator with a voltage with $v_s(t) = V_0 cos(\omega t + \pi/3)$ Volts.

a) Write the voltage loop equation in terms of the current $i(t)$, using the symbolic values R, L, C, $v_s(t)$.

$v_s(t) =$ _____ $\frac{di(t)}{dt}$ + _____ $\int i(t)dt$ + _____ $i(t)$ help (formulas)

b) Write the corresponding phasor-domain equation. In addition to the variables specified in Part a), use upper case I for the phasor current $\tilde{I}$ and w for the frequency ω.

$\tilde{V}_s =$ _____ help (formulas)

c) Solve the equation to obtain an expression for the phasor current $\tilde{I}$.

$\tilde{I} =$ _____ help (formulas)

Generated by ©WeBWorK, http://webwork.maa.org, Mathematical Association of America

Joel Trussell **ECE303_Adams**
Assignment ECE303_HW_Set_10 due 12/06/2018 at 11:59pm EST

---

1. **(1 point)** local/ECE303/Ulaby_7Ed_Ch7/ECE303_Ulaby_Ed7_7.2.pg

Write general expression for the electric field of a $f = 1$GHz sinusoidal plane wave traveling in the +y-direction in a lossless nonmagnetic medium with relative permittivity $\varepsilon_r = 9$. The electric field is polarized along the x-direction, its peak value is $E_p = 7\mathrm{V/m}$, and its intensity is $E_0 = 4\mathrm{V/m}$ at $t_0 = 0$ and $y_0 = 4$cm.

$\mathbf{E}(y,t)$ = _____ $(\mathrm{V/m})$ help (formulas)

Note: Your answer should be in the form of "ax+by+cz", where "x", "y" and "z" represent $\hat{\mathbf{x}}, \hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively and "a", "b" and "c" are vector coefficients determined by you. You may use "t" (t) and **"yy"** (y) inside the cos or sin terms. For the angle, radians should be used.

---

2. **(1 point)** local/ECE303/Ulaby_7Ed_Ch7/ECE303_Ulaby_Ed7_7.4.pg

The electric field of a plane wave propagating in a nonmagnetic material is given by

$$\mathbf{E} = [\hat{\mathbf{y}} 4\sin(10000000\pi t - 0.1\pi x) + \hat{\mathbf{z}} 3\cos(10000000\pi t - 0.1\pi x)] \quad (\mathrm{V/m})$$

Determine
(a) The wavelength λ = _____ (m) help (numbers)
(b) The relative permittivity ε_r = _____ help (numbers)
(c) The magnetic field (suppose $\eta_0 = 120\pi\ \Omega$)
$\mathbf{H}(x,t)$ = _____ $(\mathrm{A/m})$ help (formulas)

Note: Your answer should be in the form of "ax+by+cz", where "x", "y" and "z" represent $\hat{\mathbf{x}}, \hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively and "a", "b" and "c" are vector coefficients determined by you. You may use "t" (t) and **"xx"** (x) inside the cos or sin terms.

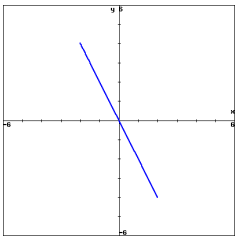
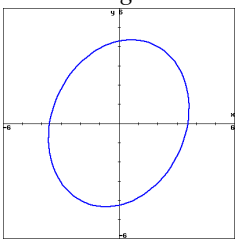
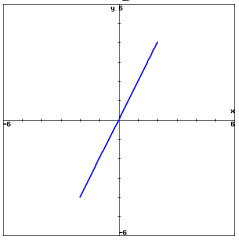
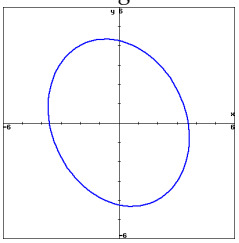
---

3. **(1 point)** local/ECE303/Ulaby_7Ed_Ch7/ECE303_Ulaby_Ed7_7.10.pg

For a wave characterized by the electric field $\mathbf{E}(z,t) = \hat{\mathbf{x}} a_x cos(\omega t - kz) + \hat{\mathbf{y}} a_y cos(\omega t - kz + \delta)$.
Given $a_x = 2V/m, a_y = 4V/m$ and $\delta = 0$.
The polarization state is

- ?
- Linear
- Right hand circular
- Left hand circular
- Right hand elliptical
- Left hand elliptical
- none of the above

.
Select the graph that represents the locus of $\mathbf{E}(0,t)$:

- A. 
(click on image to enlarge)
- B. 
(click on image to enlarge)
- C. 
(click on image to enlarge)
- D. 
(click on image to enlarge)
- E. None of the above

---

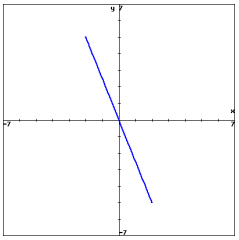
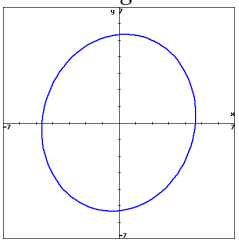
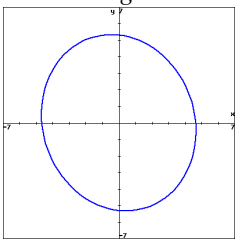
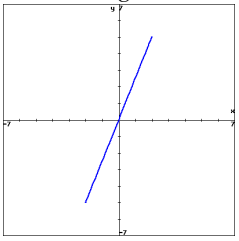
4. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch7/ECE303_Ulaby_Ed7_7.10d.pg`

For a wave characterized by the electric field $\mathbf{E}(z,t) = \hat{\mathbf{x}}a_x cos(\omega t - kz) + \hat{\mathbf{y}}a_y cos(\omega t - kz + \delta)$.
Given $a_x = 2V/m, a_y = 5V/m$ and $\delta = -140°$.
The polarization state is

- ?
- Linear
- Right hand circular
- Left hand circular
- Right hand elliptical
- Left hand elliptical
- none of the above

.

Select the graph that represents the locus of $\mathbf{E}(0,t)$:

- A. 
  (click on image to enlarge)
- B. 
  (click on image to enlarge)
- C. 
  (click on image to enlarge)
- D. 
  (click on image to enlarge)
- E. None of the above

---

5. (1 point) `local/ECE303/Ulaby_7Ed_Ch7/ECE303_Ulaby_Ed7_7.17.pg`

For each of the following combinations of parameters, determine if the material is a low-loss dielectric, a quasi-conductor, or a good conductor, and then calculate $\alpha, \beta, \lambda, u_p$ and η_c.

Note: Use "a+bj" to represent complex number if necessary. Use $\varepsilon_0 = \frac{1}{36\pi} \times 10^{-9}$ (F/m) for calculation.

(a) Glass with $\mu_r = 1, \varepsilon_r = 5$, and $\sigma = 3 \times 10^{-12}$ S/m at $f = 11$GHz

$\sigma/\omega\varepsilon$ = _____ $\times 10^{-12}$ help (numbers)

Type:

- ?
- good conductor
- quasi-conductor
- low-loss dielectric

α = _____ Np/m help (numbers)

β = _____ rad/m help (numbers)

λ = _____ cm help (numbers)

u_p = _____ m/s help (numbers)

η_c = _____ Ω help (numbers)

(b) Animal tissue with $\mu_r = 1, \varepsilon_r = 10$, and $\sigma = 0.5$ S/m at $f = 140$MHz

$\sigma/\omega\varepsilon$ = _____ help (numbers)

Type:

- ?
- good conductor
- quasi-conductor
- low-loss dielectric

α = _____ Np/m help (numbers)

β = _____ rad/m help (numbers)

λ = _____ cm help (numbers)

u_p = _____ m/s help (numbers)

η_c = _____ Ω help (numbers)

(c) Wood with $\mu_r = 1, \varepsilon_r = 2$, and $\sigma = 0.0003$ S/m at $f = 2$KHz

$\sigma/\omega\varepsilon$ = _____ help (numbers)

Type:

- ?
- good conductor
- quasi-conductor
- low-loss dielectric

α = _____ Np/m help (numbers)

β = _____ rad/m help (numbers)

λ = _____ km help (numbers)

u_p = _____ m/s help (numbers)

η_c = _____ Ω help (numbers)

---

6. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch7/ECE303_Ulaby_Ed7_7.22.pg`

Ignoring reflection at the air-water boundary, if the amplitude of a $f = 1$GHz incident wave in air is $V_0 = 16\text{V/m}$ at the water surface, determine the depth that make the electric field down to $V_{min} = 2\,\mu\text{V/m}$. Water has $\mu_r = 1$ and at 1GHz, $\varepsilon_r = 70$ and $\sigma = 1.5$ S/m.

d = _____ cm help (numbers)

Note: Use $\varepsilon_0 = \frac{1}{36\pi} \times 10^{-9}$ (F/m).

---

7. **(1 point)** local/ECE303/Ulaby_7Ed_Ch7/ECE303_Ulaby_Ed7_7.33.pg

The magnetic field of a plane wave traveling in air is given by

$$\mathbf{H} = \hat{\mathbf{x}} 60 \sin(2 \times 10^7 \pi t - ky) \quad (\text{mA/m})$$

Determine the average power density carried by the wave.

Note: Your answers are validated to ± 0.01 absolute for the numbers.

$\mathbf{S}_{av}$ = _____ (W/m^2) help (vectors)

Note: Your answer should be in the form of "ax+by+cz", where "x", "y" and "z" represent $\hat{\mathbf{x}}, \hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively and "a", "b" and "c" are vector coefficients determined by you.

---

8. **(1 point)** local/ECE303/Ulaby_7Ed_Ch7/ECE303_Ulaby_Ed7_7.38.pg

At microwave frequencies, the power density considered safe for human exposure is $S_{av} = 2\ (\text{mW/cm}^2)$. A radar radiates a wave with an electric field amplitude E that decays with distance as

$$E(R) = (3600/R) \quad (\text{V/m}),$$

where R is the distance in meters.

Determine the radius of the unsafe region.

R = _____ (m) help (numbers)

---

9. **(1 point)** local/ECE303/Ulaby_7Ed_Ch8/ECE303_Ulaby_Ed7_8.4.pg

A 220-MHz, left-hand circularly polarized plane wave with an electric field modulus of 5.2 V/m is normally incident in air upon a dielectric medium with $\varepsilon_r = 4.5$ and occupies the region defined by $z \geq 0$. Note: Your answers are validated to ± 0.01. You may use 'z' and 't' in your answers for formulae.

(a) Write an expression for the electric field phasor of the incident wave, given that the field is a positive maximum at $z = 0$ and $t = 0$:

$\tilde{\mathbf{E}}^i$=_____ $\cdot(\hat{\mathbf{x}} + j\hat{\mathbf{y}})(V/m)$. help (formulas)

(b) Calculate the reflection and transmission coefficient:

Γ=_____ help (numbers)

τ=_____ help (numbers)

(c) Write an expression for the electric field phasor of the total field in the region $z \leq 0$:

$\tilde{\mathbf{E}}_1$=_____ $\cdot(\hat{\mathbf{x}} + j\hat{\mathbf{y}})(V/m)$. help (formulas)

(d) Determine the percentages of the incident average power reflected by the boundary and transmitted into the second medium.

Generated by ©WeBWorK, http://webwork.maa.org, Mathematical Association of America

---

1. **(1 point)** local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.1.pg

A transmission line of length l connects a load to a sinusoidal voltage source with an oscillation frequency f.
Assuming the velocity of the wave propagation on the line is $c = 3 \times 10^8 m/s$, for which of the following situations is it reasonable to ignore the presence of the transmission line in the solution of the circuit:

Choose the correct situation from the dropdown menu.
(a) $l = 7.66667m, f = 30000Hz$
- ?
- negligible
- non-negligible
- borderline
- none of above

(b) $l = 75000m, f = 40Hz$
- ?
- negligible
- non-negligible
- borderline
- none of above

(c) $l = 0.465m, f = 4 \times 10^8 Hz$
- ?
- negligible
- non-negligible
- borderline
- none of above

(d) $l = 1 \times 10^{-5} m, f = 2 \times 10^9 Hz$
- ?
- negligible
- non-negligible
- borderline
- none of above

---

2. **(1 point)** local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.2a.pg

A two-wire copper transmission line is embedded in a dielectric material with $\varepsilon_r = 3.6$ and $\sigma = 2 \times 10^{-6} S/m$.
Its wires are separated by $5cm$ and their diameters are $2.5mm$ each.
Calculate the line parameters, R', L', G' and C' at $2GHz$.
$R' =$ _____ Ω/m help (numbers)
$L' =$ _____ $\mu H/m$ help (numbers)
$G' =$ _____ $\mu S/m$ help (numbers)

$C' =$ _____ pF/m help (numbers)

---

3. **(1 point)** local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.4.pg

A $1.1GHz$ parallel-plate transmission line consists of $1.5cm$ wide copper strips, separated by a $0.12cm$ thick layer of polystyrene.
Appendix B gives $\mu_c = \mu_0 = 4\pi \times 10^{-7}(H/m)$ and $\sigma_c = 5.8 \times 10^7(S/m)$ for copper, and $\varepsilon_r = 2.6$ for polystyrene. Use Table 2-1 to determine the line parameters of the transmission line.
Assume $\mu = \mu_0$ and $\sigma \approx 0$ for polystyrene.

(a)Calculate the line parameters, R', L', G' and C' at $1.1GHz$.

$R' =$ _____ Ω/m help (numbers)
$L' =$ _____ $\mu H/m$ help (numbers)
$G' =$ _____ $\mu S/m$ help (numbers)
$C' =$ _____ pF/m help (numbers)

(b)Using the values obtained above and the equations in Table 2-2 from the textbook , find the following parameters:

$\alpha =$ _____ Np/m help (numbers)
$\beta =$ _____ m/s help (numbers)
$u_p =$ _____ S/m help (numbers)
$Z_0 =$ _____ Ω help (numbers)

---

4. **(1 point)** local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.6.pg

A coaxial line with inner and outer conductor diameters of $0.55cm$ and $1.35cm$, respectively, is filled with an insulating material with $\varepsilon_r = 4.1$ and $\sigma = 0.0011S/m$.
The conductors are made of copper ($\sigma_c = 5.8 \times 10^7 S/m$). Assume $\mu = \mu_c = \mu_0$.

(a) Calculate the line parameters, R', L', G' and C' at $2.1GHz$.

Pay attention to the units requested for each parameter.

$R' =$ _____ Ω/m help (numbers)
$L' =$ _____ nH/m help (numbers)
$G' =$ _____ mS/m help (numbers)
$C' =$ _____ pF/m help (numbers)

(b) Using the values obtained above and Table 2-2, find the following parameters:

$\alpha =$ _____ Np/m help (numbers)
$\beta =$ _____ m/s help (numbers)
$u_p =$ _____ S/m help (numbers)
$Z_0 =$ _____ Ω help (numbers)

---

5. **(1 point)** local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.9.pg

A lossless microstrip line uses $1.5mm$ wide conducting strip over a $1.5cm$ thick substrate with $\varepsilon_r = 2.1$. Using the equations in the text, determine the line parameters, ε_{eff}, Z_0 and β at $7.4GHz$. compare your results with those obtained by using CD Module 2.3.

$\varepsilon_{eff} =$ _____ help (numbers)
$Z_0 =$ _____ Ω help (numbers)
$\beta =$ _____ rad/m help (numbers)

The wavelength on the transmission line $\lambda =$ _____ *mm* help (numbers)

---

6. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.18.pg`

A special polyethylene with $\varepsilon_r = 2.1$ is used as the insulating material in a lossless coaxial line with characteristic impedance of 35Ω. The radius of the inner conductor is $1.1mm$. Find the following:

outer radius of the conductor is: _____ *mm* help (numbers)

$u_p =$ _____ m/s help (numbers)

Generated by ©WeBWorK, http://webwork.maa.org, Mathematical Association of America

Joel Trussell **ECE303_Adams**
Assignment ECE303_HW_Set_3 due 09/27/2018 at 11:59pm EDT

---

1. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.19.pg`

A 46 Ω lossless transmission line is terminated in a load with impedance $Z_L = (30 - 50j)$ Ω. The wavelength is $\lambda = 9$cm. Find the following:

(a) The reflection coefficient at the load: _____ ∠ _____ ° help (numbers)
(b) the standing wave ratio on the line: _____ help (numbers)
(c) the position of the voltage maximum nearest the load: _____ *cm* help (numbers)
(d) the position of the current maximum nearest the load: _____ *cm* help (numbers)

Note: Your answers are validated to ±0.01 absolute.

---

2. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.20.pg`

A $Z_0 = 330$ Ω lossless air transmission line is connected to a complex load composed of a resistor in series with an indcutor, as shown in the figure below. The resistor is $R = 620$ Ω and the inductor is $L = 0.025$ mH.

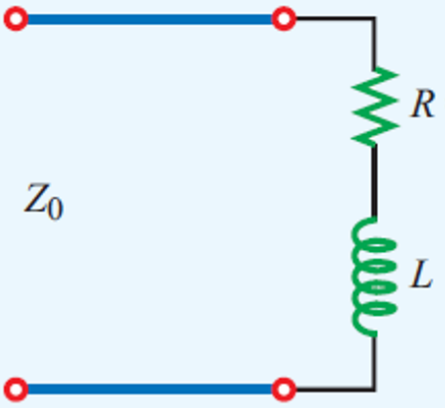


Figure P2.20 Circuit for Problem 2.20.

At frequency, $f = 7$ MHz. Find the following:

(a) The reflection coefficient, Γ = _____ ∠ _____ ° help (numbers)
(b) the standing wave ratio on the line, *S*: _____ help (numbers)
(c) the position of the voltage maximum nearest the load: _____ *m* help (numbers)
(d) the position of the current maximum nearest the load: _____ *m* help (numbers)

Note: Your answers are validated to ±0.01 absolute.

---

3. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.22.pg`

Using a slotted line, the following results were obtained: distance of first minimum from the load $d_{min(0)} = 4cm$; distance of second minimum from the load $d_{min(1)} = 13cm$; voltage standingwave ratio $S = 1.5$.

If the line is lossless and $Z_0 = 46\Omega$, find the load impedance:

$Z_L =$ _____ Ω help (numbers)

Note: You can use either a+bj or A*exp(jB) (the angle B should be in radians) to represent the complex number.

---

4. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.24.pg`

A $Z_0 = 46\Omega$ lossless line terminated in a purely resistive load has a voltage standing-wave ratio of $S = 4$.

Find all possible values of Z_L.
Note: Please enter your answers in comma separated list. Your answers may be listed in any order.

$Z_L =$ _____ Ω help (numbers)

Note: You can use either a+bj or A*exp(jB) (the angle B should be in radians) to represent the complex number if necessary.

---

5. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.27.pg`

At an operating frequency of $f = 100MHz$, a lossless $Z_0 = 60\Omega$ air-spaced transmission line $l = 1m$ in length is terminated with an impedance $Z_L = 10 + j70\Omega$.
Find the input impedance:

$Z_{in} =$ _____ Ω help (numbers)

Note: You can use either a+bj or A*exp(jB) (the angle B should be in radians) to represent the complex number.

---

6. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.28.pg`

A lossless transmission line of electrical length $l = 0.45\lambda$ (λ represents the wavelength of the microwave) is terminated in a load impedance as shown in below figure.

Given $Z_0 = 125\Omega$ and $Z_L = (80 + j35)\Omega$, find Γ, S, and Z_{in}.

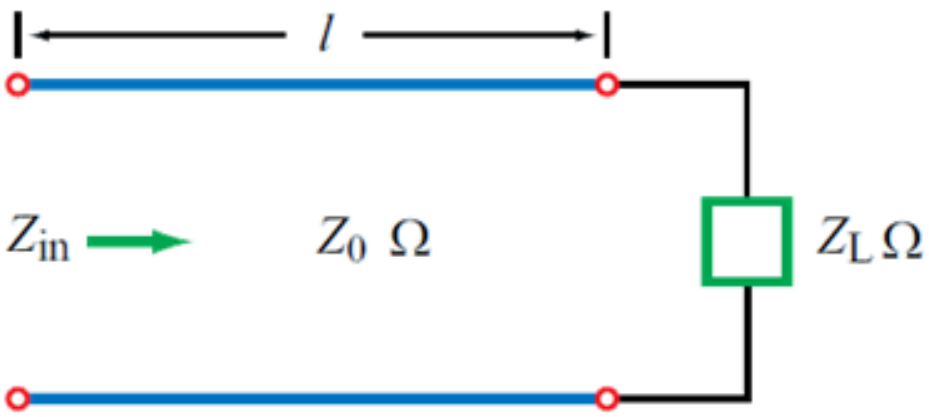


Figure P2.28 Circuit for Problem 2.28.

(a) $\Gamma =$ _____ help (numbers)

(b) $S =$ _____ help (numbers)

(c) $Z_{in} =$ _____ Ω help (numbers)

Note: Your answers will be validated to ± 0.01 absolute. You can use either a+bj or A*exp(jB) (the angle B should be in radians) to represent the complex number.

Generated by ©WeBWorK, http://webwork.maa.org, Mathematical Association of America

---

1. **(2 points)** `local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.33.pg`

Two half-wave dipole antennas, each with an impedance of $Z_L = 85\Omega$, are connected in parallel through a pair of transmissionlines, and the combination is connected to a feed transmission line, as shown in Fig. P2.33. Given: $l_0 = 0.3\lambda$, $l_1 = 0.5\lambda$ (λ represents the wavelength of the microwave).
All lines are lossless with impedance $Z_0 = 30\Omega$.

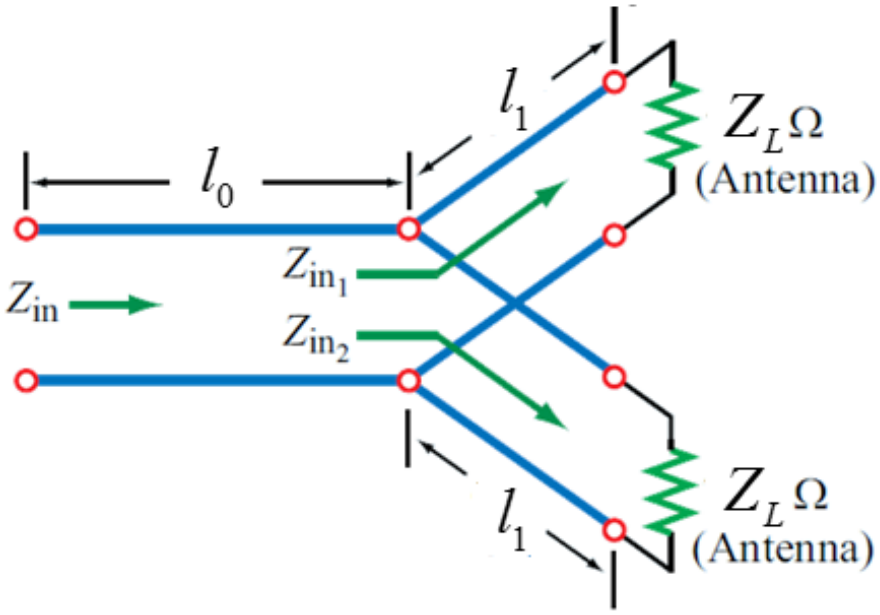


Figure P2.33 Circuit for Problem 2.33.

(a) Calculate Z_{in1} , the input impedance of the antenna terminated line, at the parallel juncture.
$Z_{in1} =$ _____ Ω help (numbers)

(b) Combine Z_{in1} and Z_{in2} in parallel to obtain Z'_L, the effective load impedance of the feedline.
$Z'_L =$ _____ Ω help (numbers)

(c) Calculate Z_{in} of the feedline.
$Z_{in} =$ _____ Ω help (numbers)

Notes: You can use either a+bj or A*exp(jB) (the angle B should be in radians) to represent the complex number.

---

2. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.35.pg`
For the lossless transmission line circuit shown in Fig. P2.35, determine the equivalent series lumped-element circuit at $f = 200MHz$ at the input to the line. The line has a characteristic impedance of $Z_0 = 30\Omega$, the insulating layer has $\varepsilon_r = 2.24$. Further in the diagram below, $Z_L = 85\Omega$ and $l = 35.7205cm$.

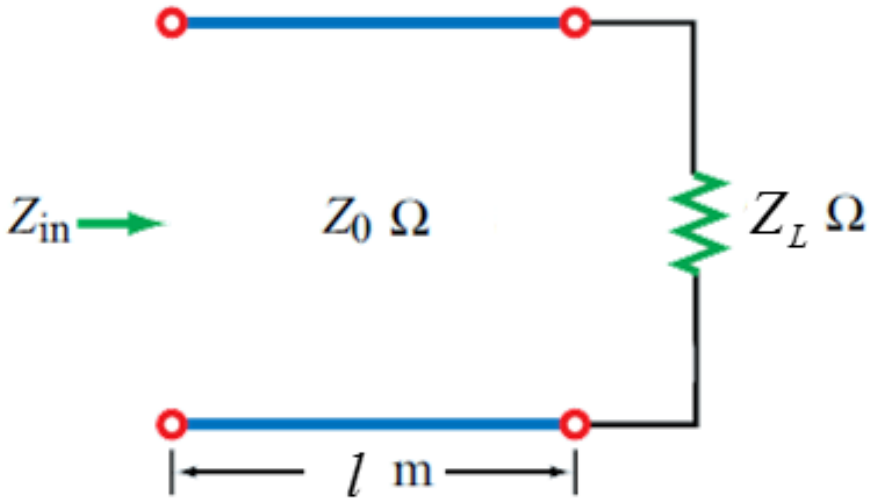


Figure P2.35 Circuit for Problem 2.35.

Note: The system can be thought of as an equivalent *RL* (lumped) circuit and $c = 3 \times 10^8 m/s$.

(a) Determine the input impedance Z_{in}.
$Z_{in} =$ _____ Ω help (numbers)
(b) Let Z_{in} is equivalent to a series RL circuit, then determine the the inductance L.
$L =$ _____ nH help (numbers)

Note: You can use either a+bj or A*exp(jB) (the angle B should be in radians) to represent the complex number.

---

3. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.36.pg`

At an operating frequency of $f = 350MHz$, it is desired to use a section of a lossless $Z_0 = 65\Omega$ transmission line terminated in a short circuit to construct an equivalent load with reactance$X = 30\Omega$. If the phase velocity of the line is $u_p = 0.7c$ $(c = 3 \times 10^8 m/s)$, determine the shortest possible line length l_{min} that would exhibit the desired reactance at its input.

$l_{min} =$ _____ cm help (numbers)

---

4. **(3 points)** `local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.42.pg`

A generator with $\tilde{V}_g = 400V$ and $Z_g = 80\Omega$ is connected to a load $Z_L = 105\Omega$ through a $Z_0 = 30\Omega$ lossless line of length $l = 0.45\lambda$ (λ represents the wavelength of the microwave).

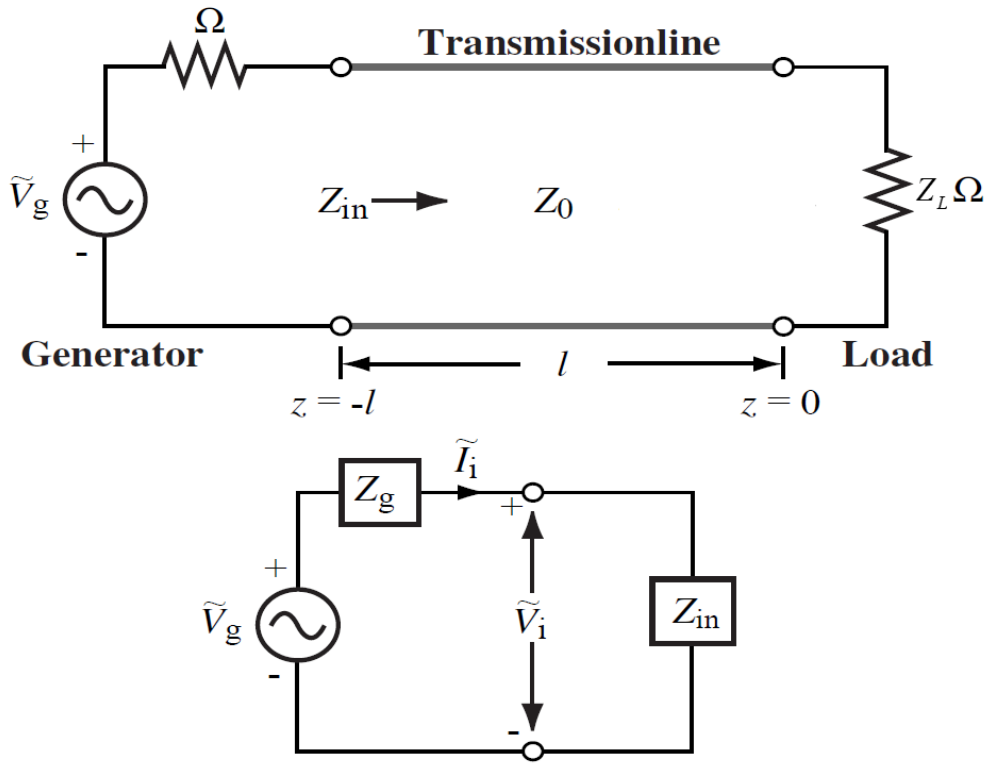


Figure P2.42 Circuit for Problem 2.42.

Note: Your answers are validated to ±0.01 absolute. You can use either a+bj or A*exp(jB) (the angle B should be in radians) to represent the complex number.

(a) Compute Z_{in}, the input impedance of the line at the generator end.

$Z_{in1} =$ _____ Ω help (numbers)

(b) Compute $\tilde{I}_i$ and $\tilde{V}_i$.

$\tilde{I}_i =$ _____ A help (numbers)

$\tilde{V}_i =$ _____ V help (numbers)

(c) Compute the time-average power delivered to the line, $P_{in} = 0.5Re(\tilde{V}_i\tilde{I}_i^*)$.

$P_{in} =$ _____ W help (numbers)

(d) Compute $\tilde{V}_L^*$, $\tilde{I}_L^*$ and the time-average power delivered to the load, $P_L = 0.5Re(\tilde{V}_L\tilde{I}_L^*)$.

$\tilde{I}_L =$ _____ A help (numbers)

$\tilde{V}_L =$ _____ V help (numbers)

$P_L =$ _____ W help (numbers)

Be prepared to relate P_{in} to P_L. Is P_L

- ?
- less than
- greater than
- equal to

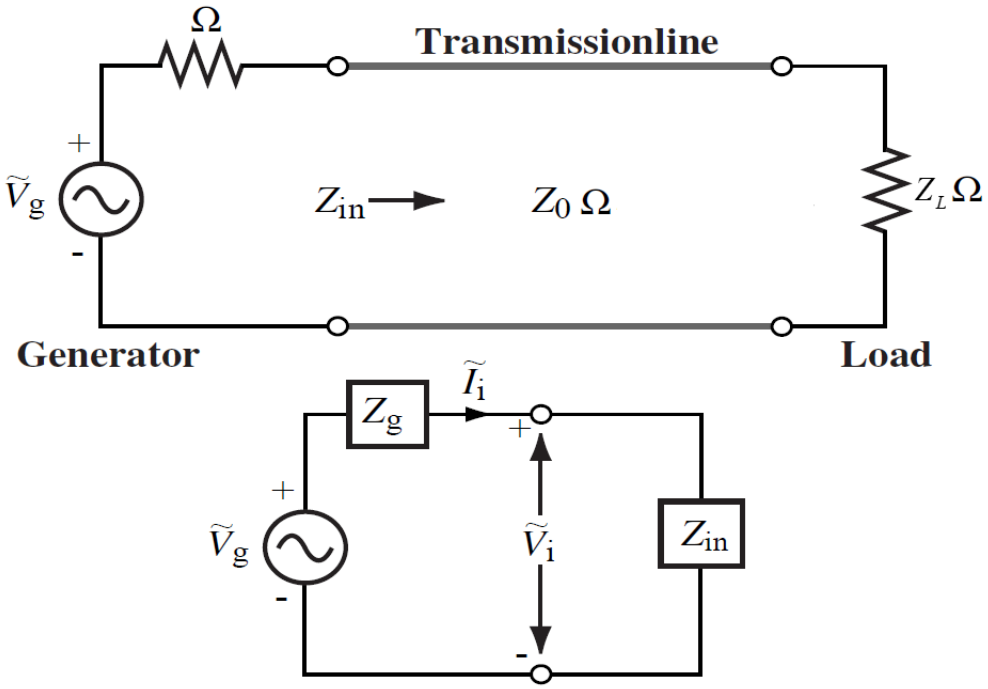
P_{in}?
Be able to explain why you would expect that result.

(e) Compute the time-average power delivered by the generator, P_g, and the time-average power P_{Zg} dissipated in Z_g.
$P_g =$ _____ W help (numbers)
$P_{Zg} =$ _____ W help (numbers)
For the conservation of power in this system, is P_g
- ?
- less than
- greater than
- equal to

$(P_{Z_g} + P_{in})$?

---

5. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch2/ECE303_Ulaby_Ed7_2.46.pg`
An antenna with a load impedance $Z_L = (75 + j40)\Omega$ is connected to a transmitter through a $Z_0 = 50\Omega$ lossless transmission line.



Under the matched conditions (50Ω load) that the transmitter can deliver $P_L = 25W$ to the load and $Z_g = Z_0$, determine power P_{av} delivered to the antenna.

$P_{av} =$ _____ W help (numbers)

Generated by ©WeBWorK, http://webwork.maa.org, Mathematical Association of America

Joel Trussell **ECE303_Adams**
Assignment ECE303_HW_Set_5 due 10/17/2018 at 11:59pm EDT

---

1. **(1 point)** local/ECE303/Ulaby_7Ed_Ch3/ECE303_Ulaby_Ed7_3.5.pg

Given $\mathbf{A} = -\hat{\mathbf{x}} + 5\hat{\mathbf{y}} - 2\hat{\mathbf{z}}$, $\mathbf{B} = -2\hat{\mathbf{x}} - 2\hat{\mathbf{y}} - 2\hat{\mathbf{z}}$, $\mathbf{C} = \hat{\mathbf{x}} + 2\hat{\mathbf{y}} - 4\hat{\mathbf{z}}$.
Evaluate each of the following vector manipulations following the right hand convention.
NOTE: You may use "x","y" and "z" to represent $\hat{\mathbf{x}}, \hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively in your answer. Your answers will be validated to ± 0.01 absolute.

a)
$|\mathbf{A}|$=_____ help (numbers)
$\hat{\mathbf{a}}$=_____ (The unit vector in $\mathbf{A}$ direction) help (vectors)

b)
The component of $\mathbf{B}$ in $\mathbf{C}$ is _____ help (numbers)

c)
θ_{AC}=___ $^\circ$ help (numbers)

d)
$\mathbf{A} \times \mathbf{C}$=_____ help (vectors)

e)
$\mathbf{A} \cdot (\mathbf{B} \times \mathbf{C})$=_____ help (numbers)

f)
$\mathbf{A} \times (\mathbf{B} \times \mathbf{C})$=_____ help (vectors)

g)
$\hat{\mathbf{x}} \times \mathbf{B}$=_____ help (vectors)

h)
$(\mathbf{A} \times \hat{\mathbf{y}}) \cdot \hat{\mathbf{z}}$=_____ help (numbers)

---

2. **(1 point)** local/ECE303/Ulaby_7Ed_Ch3/ECE303_Ulaby_Ed7_3.22.pg

Convert the coordinates of the following points from Cartesian to cylindrical and spherical coordinates: $P_1 = \langle -5,4,0 \rangle$, $P_2 = \langle 0,0,-4 \rangle$, $P_3 = \langle 0,2,2 \rangle$, $P_4 = \langle -4,4,-4 \rangle$.

Note: The coordinates are enclosed in $\langle\rangle$ in Webwork. Any angular values in the cylindrical and spherical coordinates should be expressed in radians.
Your answers will be validated to ± 0.01 absolute.

In cylindrical coordinates $\langle r, \theta, z \rangle$,
P_1 =_____ help (vectors)
P_2 =_____ help (vectors)
P_3 =_____ help (vectors)
P_4 =_____ help (vectors)

In spherical coordinates $\langle R, \theta, \phi \rangle$,
P_1 =_____ help (vectors)
P_2 =_____ help (vectors)
P_3 =_____ help (vectors)
P_4 =_____ help (vectors)

3. **(1 point)** local/ECE303/Ulaby_7Ed_Ch3/ECE303_Ulaby_Ed7_3.25.pg

Use the appropriate expression for the differential surface area ds to determine the area of each of the following surfaces (denoted as A):
(a) $2 \leq r \leq 5$; $0.5\pi \leq \phi \leq 1\pi$; $z = 0$.
A=_____ help (numbers)
(b) $R = 2$; $0 \leq \theta \leq \pi/3$; $0 \leq \phi \leq \pi/3$.
A=_____ help (numbers)
(c) $0 \leq R \leq 4$; $\theta = \pi/4$; $0 \leq \phi \leq 2\pi$.
A=_____ help (numbers)

---

4. **(1 point)** local/ECE303/Ulaby_7Ed_Ch3/ECE303_Ulaby_Ed7_3.27.pg

A section of a sphere is described by $0 \leq R \leq 4$ (in meters) ; $0 \leq \theta \leq \pi/4$; $\pi/6 \leq \phi \leq \pi/2$.
(a) the area of the surface normal to the $\hat{R}$-direction is _____ m^2 help (numbers)
(b) the total volume enclosed by the defined region is _____ m^3 help (numbers)

---

5. **(1 point)** local/ECE303/Ulaby_7Ed_Ch3/ECE303_Ulaby_Ed7_3.31.pg

Find the distance between the following pairs of points:
(a) $P_1 = (-5,-3,-3)$ and $P_2 = (-2,4,-3)$ in Cartesian coordinates.
The distance is =_____ m help (numbers)
(b) $P_3 = (4,\pi/2,3)$ and $P_4 = (4,\pi/2,-4)$ in Cylindrical coordinates.
The distance is =_____ m help (numbers)
(c) $P_5 = (-5,0.6\pi,0\pi)$ and $P_6 = (4,0.2\pi,0.6\pi)$ in Spherical coordinates.
The distance is =_____ m help (numbers)
Note: distances in meters. Your answer is validated to two decimal places.

---

6. **(1 point)** local/ECE303/Ulaby_7Ed_Ch3/ECE303_Ulaby_Ed7_3.36.pg

Find the gradient of the following scalar functions. In your answers, use t to represent θ, p to represent ϕ and note that r and R are not equivalent.
(a) $\nabla(z^3 cos\phi/(1+r^2))$= _____ $\hat{\mathbf{r}}$+_____ $\hat{\phi}$+ _____ $\hat{\mathbf{z}}$.
(b) $\nabla(e^{-3\cdot R} sin(\theta) + 2\cdot\phi)$= _____ $\hat{\mathbf{R}}$+_____ $\hat{\theta}$+ _____ $\hat{\phi}$.

---

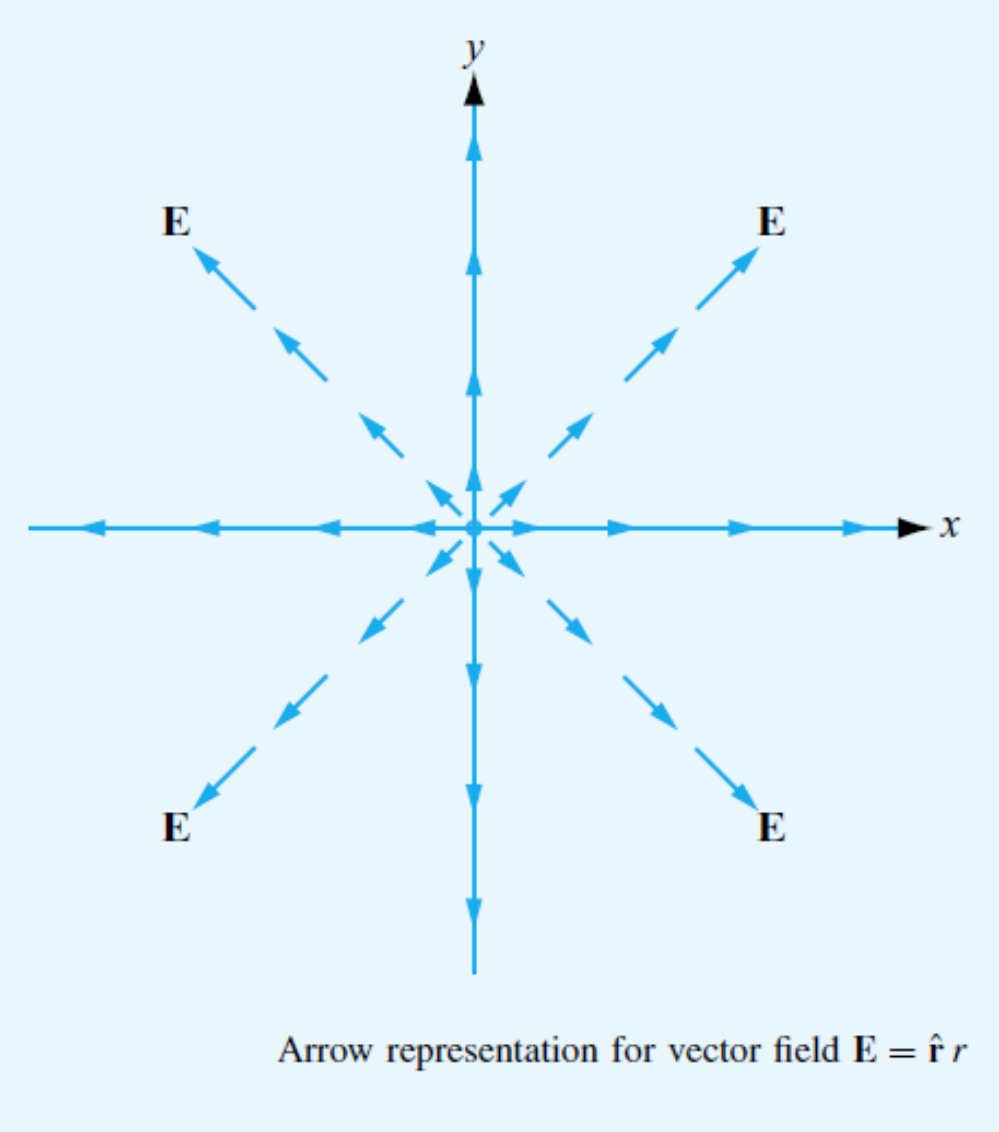
7. **(1 point)** local/ECE303/Ulaby_7Ed_Ch3/ECE303_Ulaby_Ed7_3.36b.pg

Let $A(x,y,z) = \hat{\mathbf{x}} sin(ax) + \hat{\mathbf{y}} ye^{-bx} + \hat{\mathbf{z}} cyz$ (a,b,c are random parameters). The variables allowed in your answers are a,b,c,x,y,z.
a) $\nabla \cdot \mathbf{A}$= _____ help (formulas)
b) $\nabla \times \mathbf{A}$=_____ $\hat{\mathbf{x}}$+_____ $\hat{\mathbf{y}}$+ _____ $\hat{\mathbf{z}}$
c) $\nabla \cdot (\nabla \times \mathbf{A})$=_____

---

8. **(1 point)** local/ECE303/Ulaby_7Ed_Ch3/ECE303_Ulaby_Ed7_3.20b.pg

The following figure demonstrates the spatial variation of vector field $E = \hat{\mathbf{r}}r$.



Arrow representation for vector field $\mathbf{E} = \hat{\mathbf{r}}\, r$

Following the same convention, determine values of the vector field (the vector values of the arrows in vector field plot) for $\hat{\mathbf{y}}x$ at the following four points:

At $\langle 4,4\rangle$, the vector field value is _____ help (vectors)

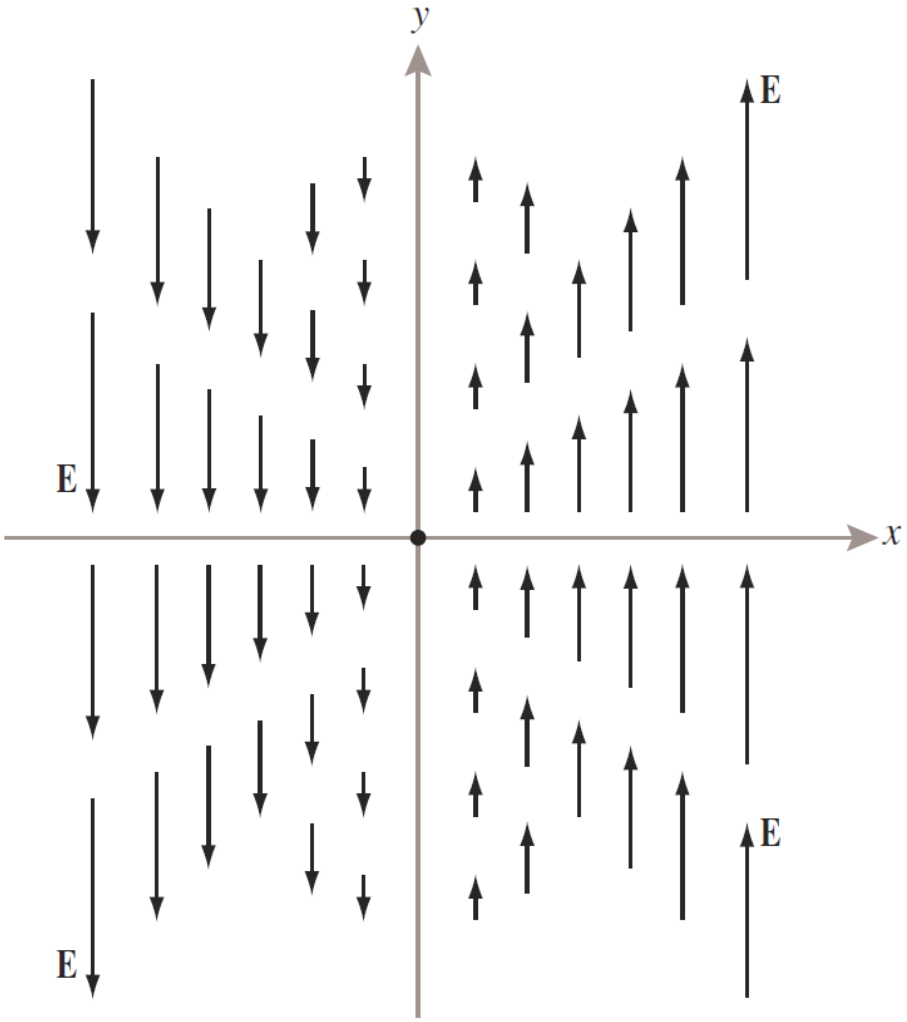
At $\langle -10,4\rangle$, the vector field value is _____ help (vectors)

At $\langle -10,-1\rangle$, the vector field value is _____ help (vectors)

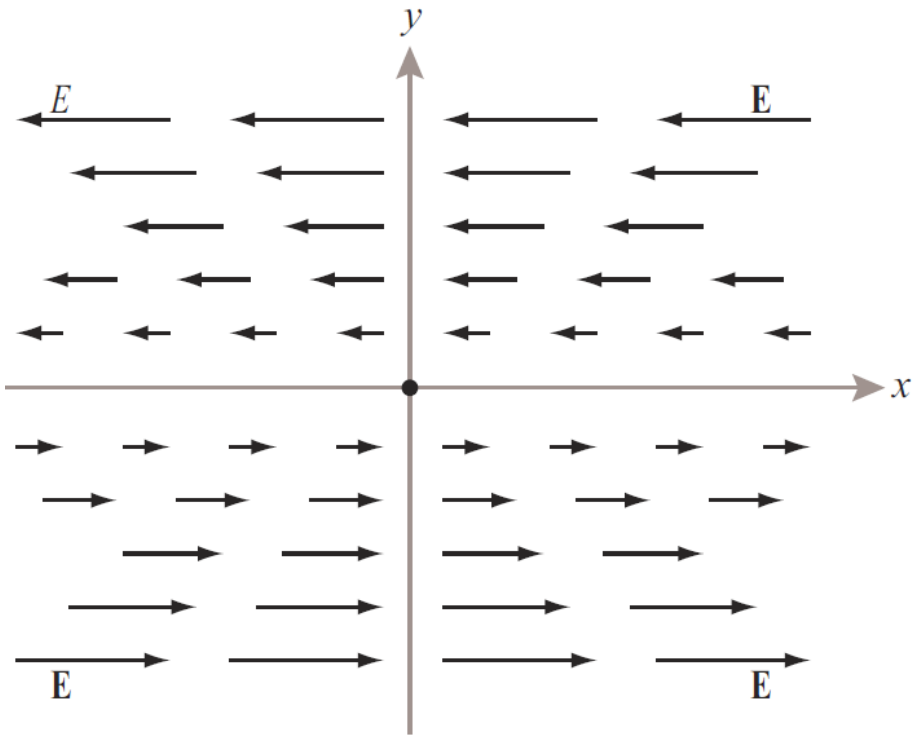
At $\langle 1,-7\rangle$, the vector field value is _____ help (vectors)

Note: Your answers should be in the form of $\langle x,y\rangle$.

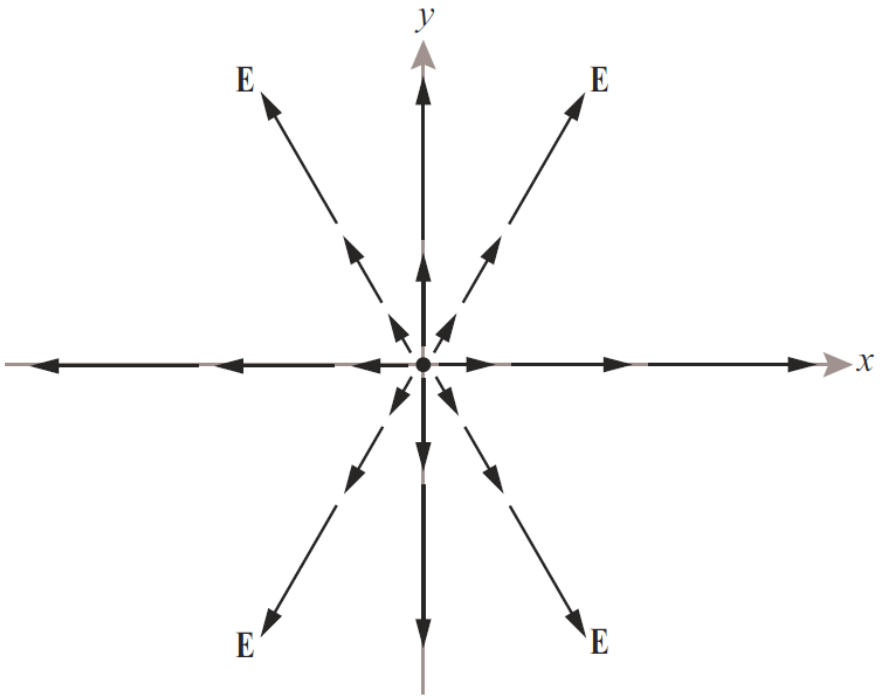
Select the graph that represents the vector field of $\hat{\mathbf{y}}x$:



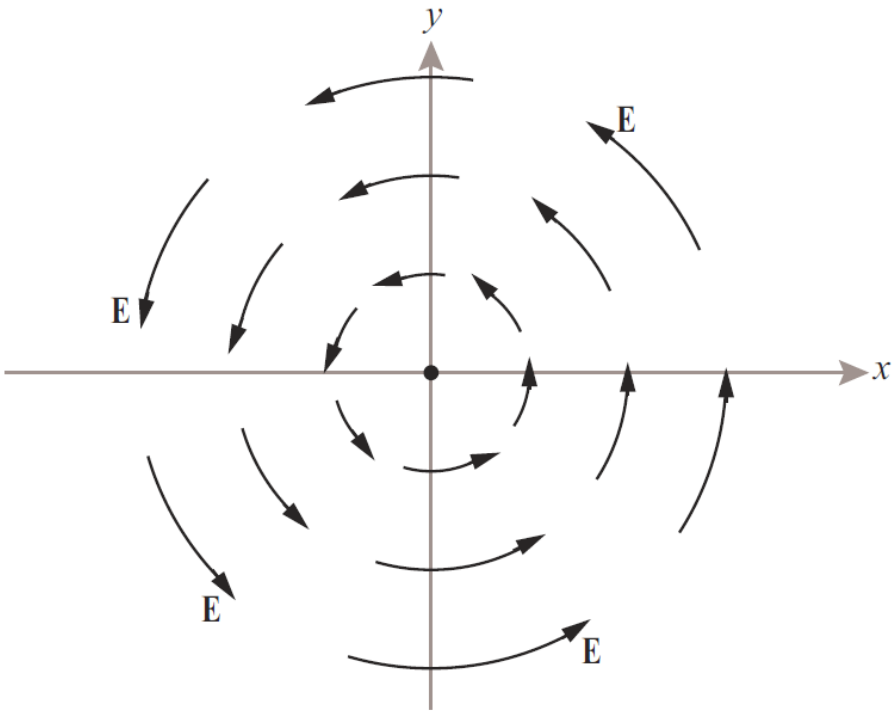
- A.
(click on image to enlarge)



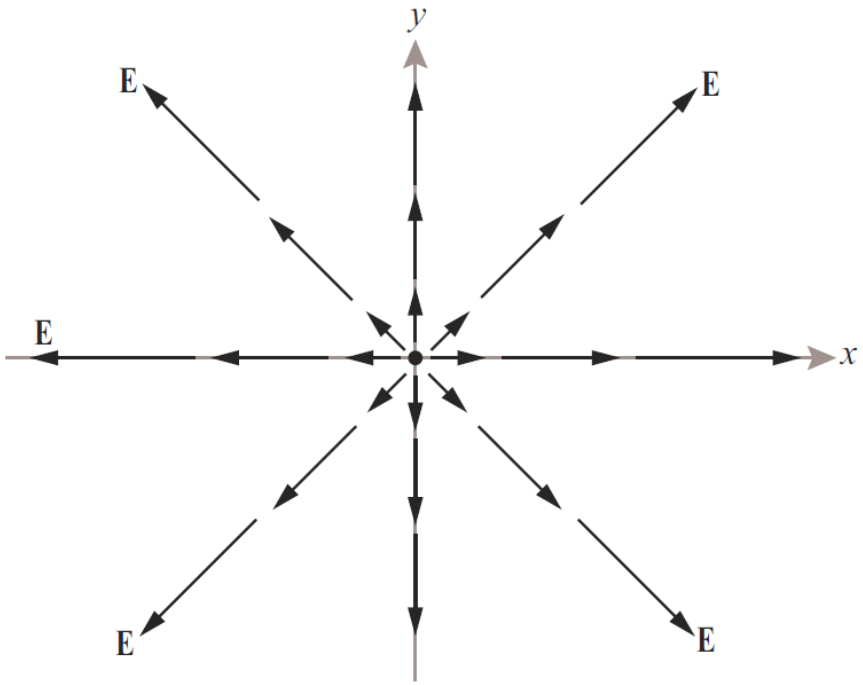
- B.
(click on image to enlarge)



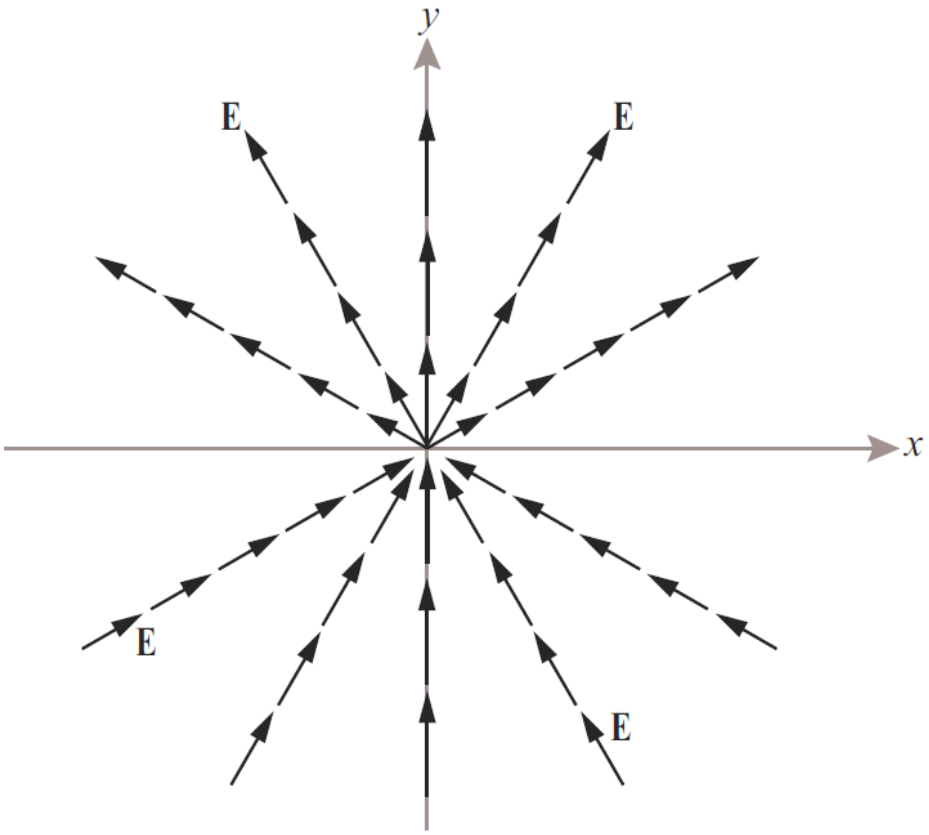
- C.
(click on image to enlarge)



- D.
(click on image to enlarge)



- E.
(click on image to enlarge)

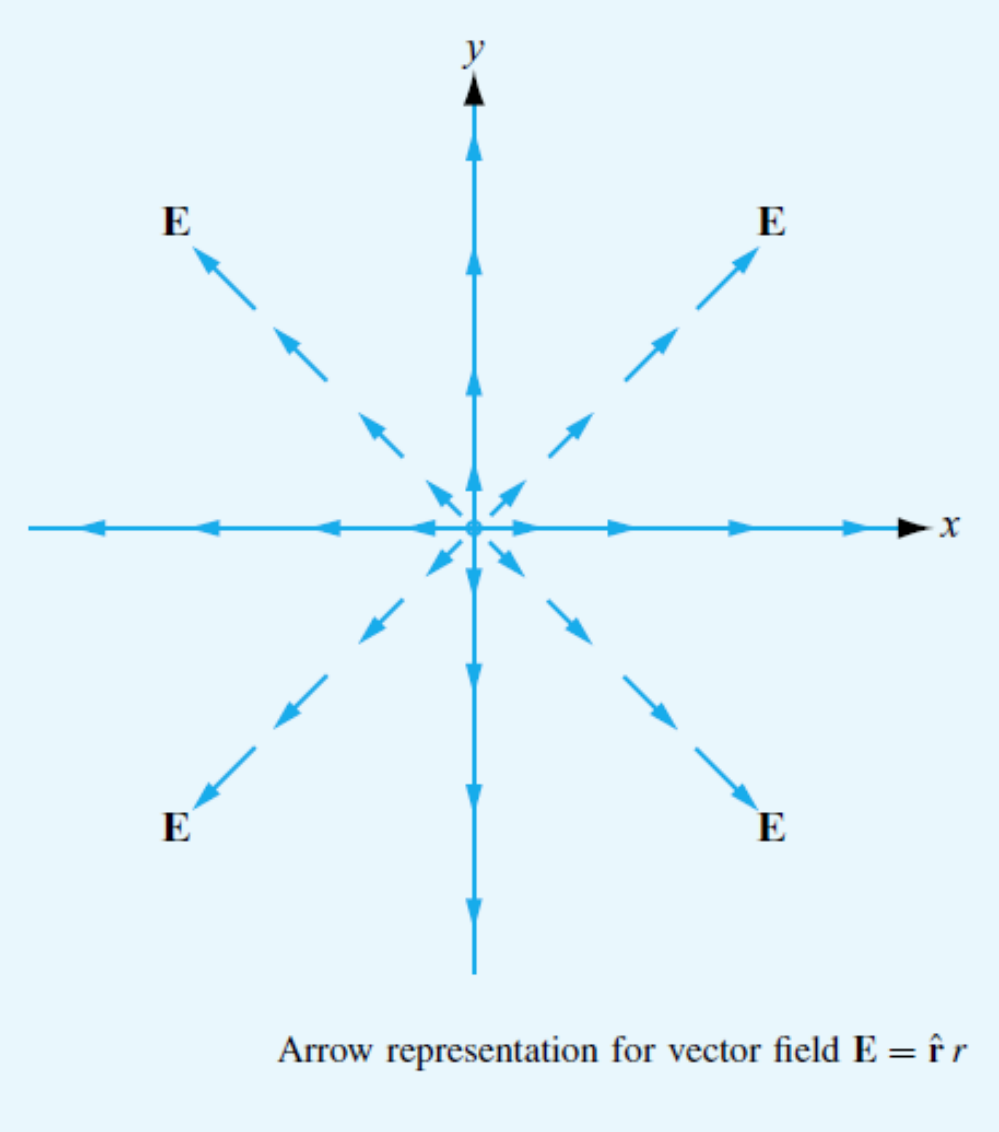


- F.
  (click on image to enlarge)
- G. None of the above

---

9. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch3/ECE303_Ulaby_Ed7_3.20d.pg`

The following figure demonstrates the spatial variation of vector field $E = \hat{\mathbf{r}}r$.



Arrow representation for vector field $\mathbf{E} = \hat{\mathbf{r}}\, r$

Following the same convention, determine values of the vector field (the vector values of the arrows in vector field plot) for $\hat{x}x + 2\hat{y}y$ at the following four points:

At $\langle 3,5\rangle$, the vector field value is _____ help (vectors)

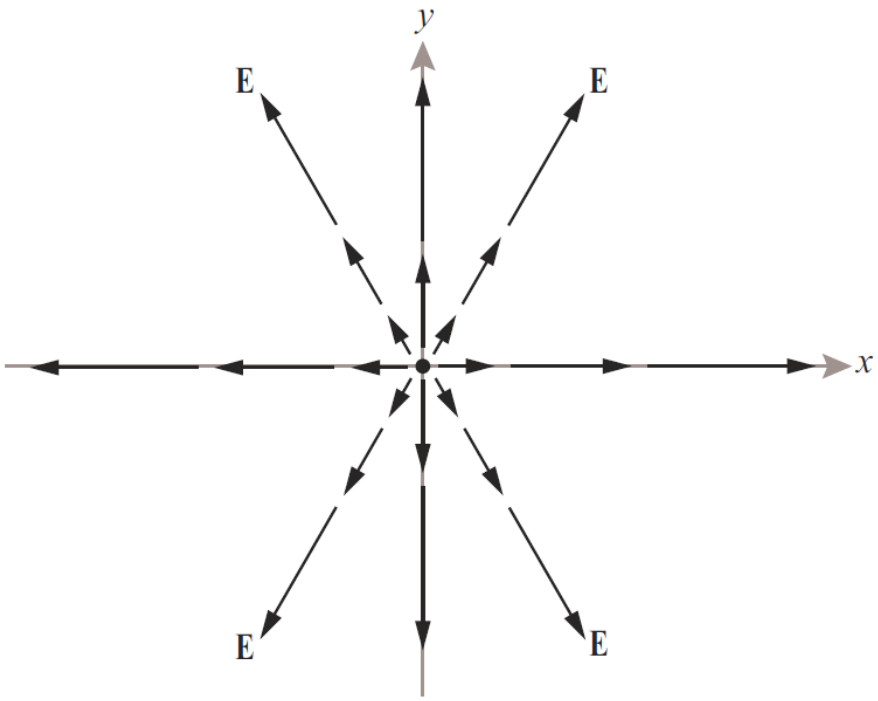
At $\langle -4,8\rangle$, the vector field value is _____ help (vectors)

At $\langle -7,-1\rangle$, the vector field value is _____ help (vectors)

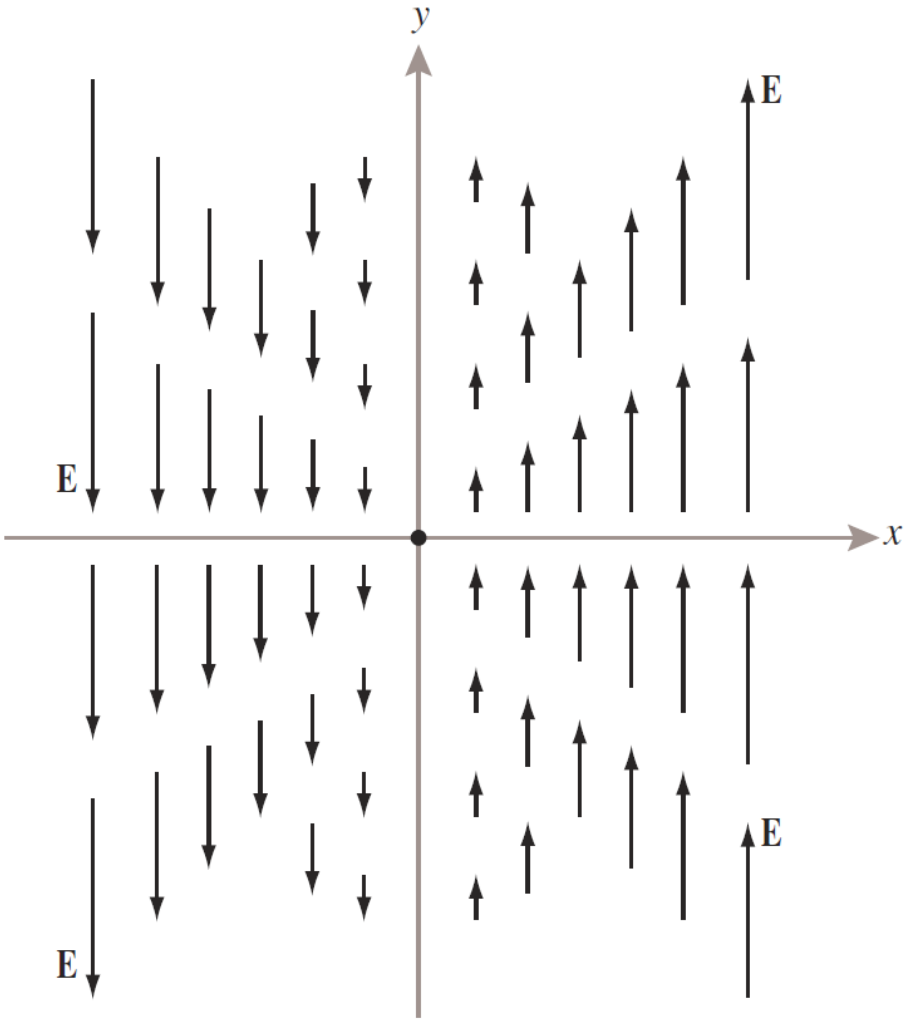
At $\langle 6,-9\rangle$, the vector field value is _____ help (vectors)

Note: Your answers should be enclosed in $\langle x,y\rangle$.

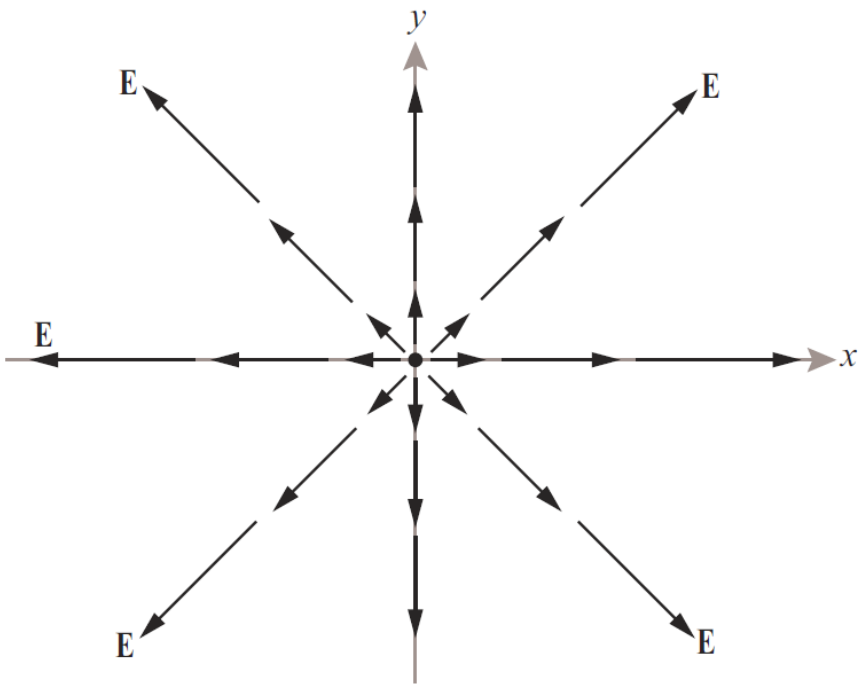
Select the graph that represents the vector field of $\hat{x}x + 2\hat{y}y$:



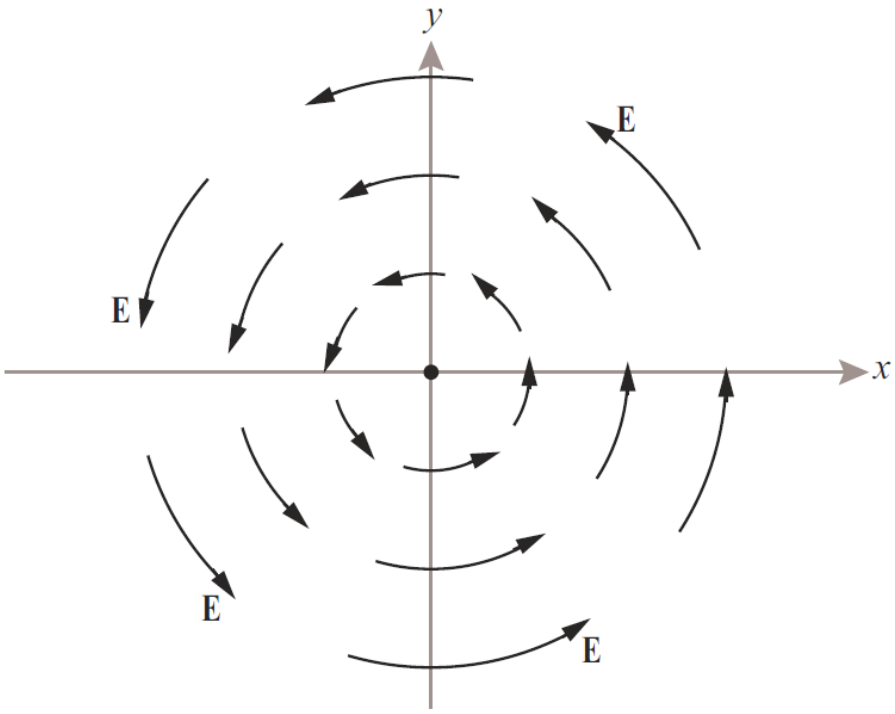
- A.
  (click on image to enlarge)



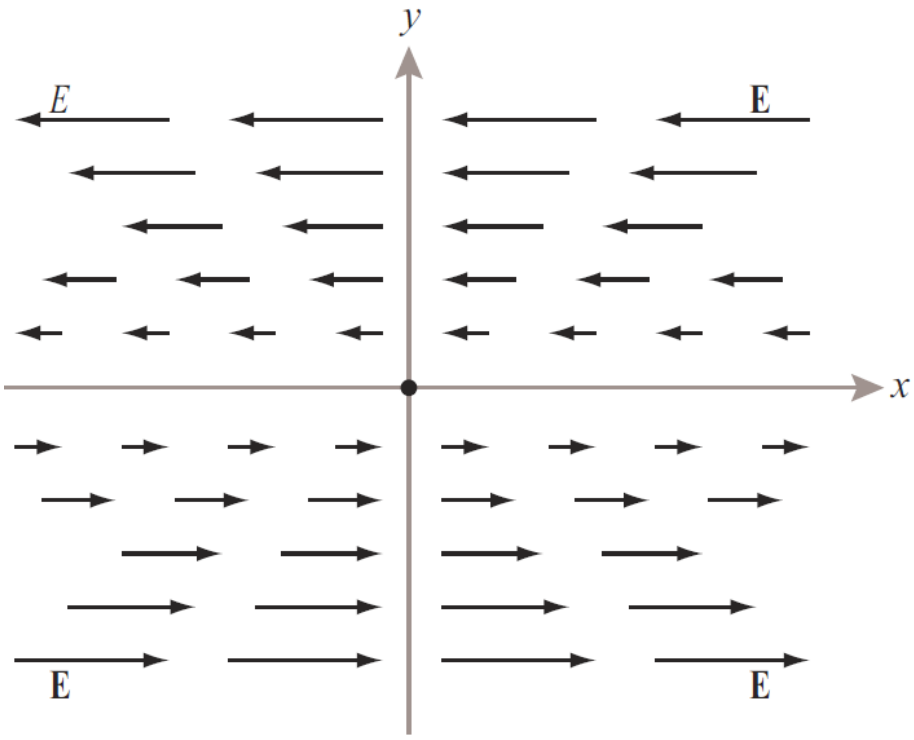
- B.
  (click on image to enlarge)



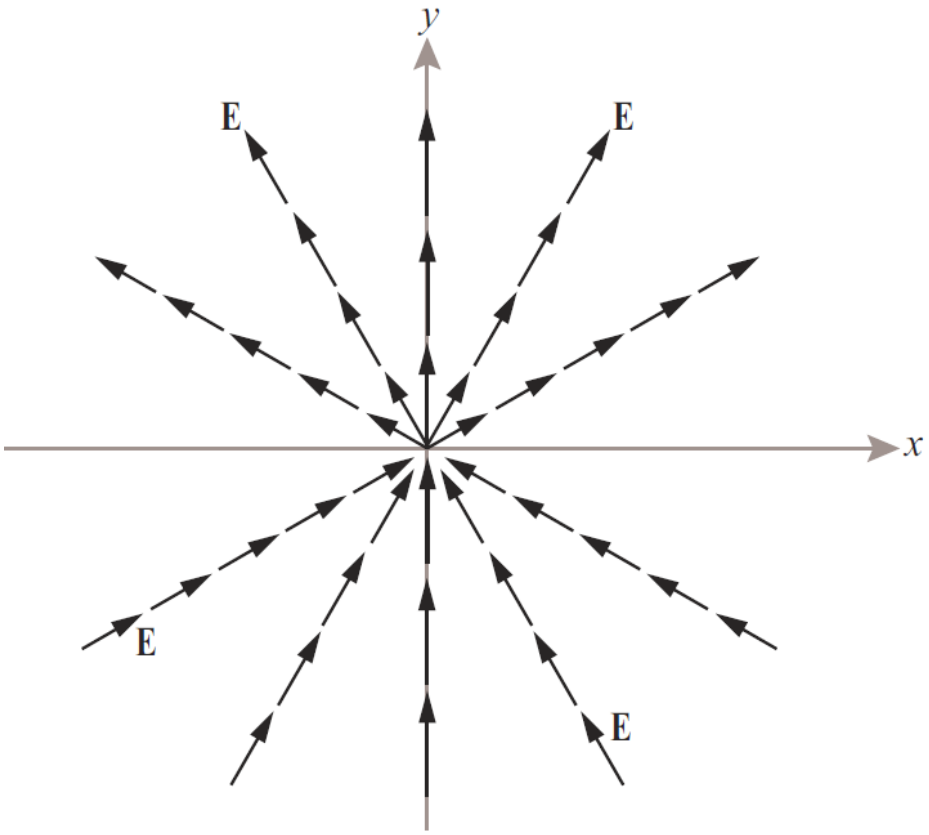
- C.
(click on image to enlarge)



- D.
(click on image to enlarge)



- E.
  (click on image to enlarge)

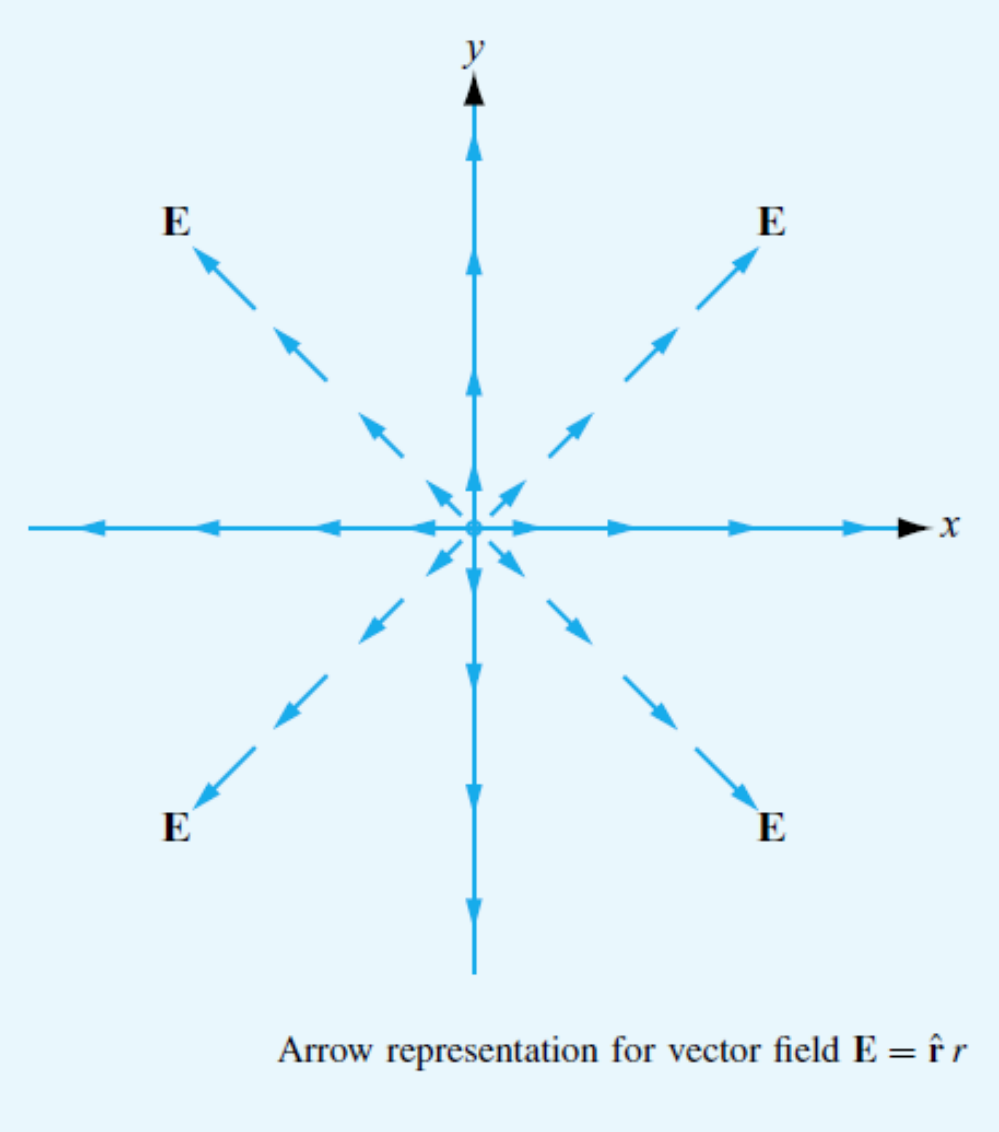


- F.
  (click on image to enlarge)
- G. None of the above

---

10. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch3/ECE303_Ulaby_Ed7_3.20f.pg`

The following figure demonstrates the spatial variation of vector field $E = \hat{\mathbf{r}}r$.



Arrow representation for vector field $\mathbf{E} = \hat{\mathbf{r}}\, r$

Following the same convention, determine values of the vector field (the vector values of the arrows in vector field plot) for $\hat{\mathbf{r}}sin\phi$ at the following four points (Note: your answers will be validated to ± 0.01 absolute):

At $\langle 3,4\rangle$, the vector field value is _____ help (vectors)

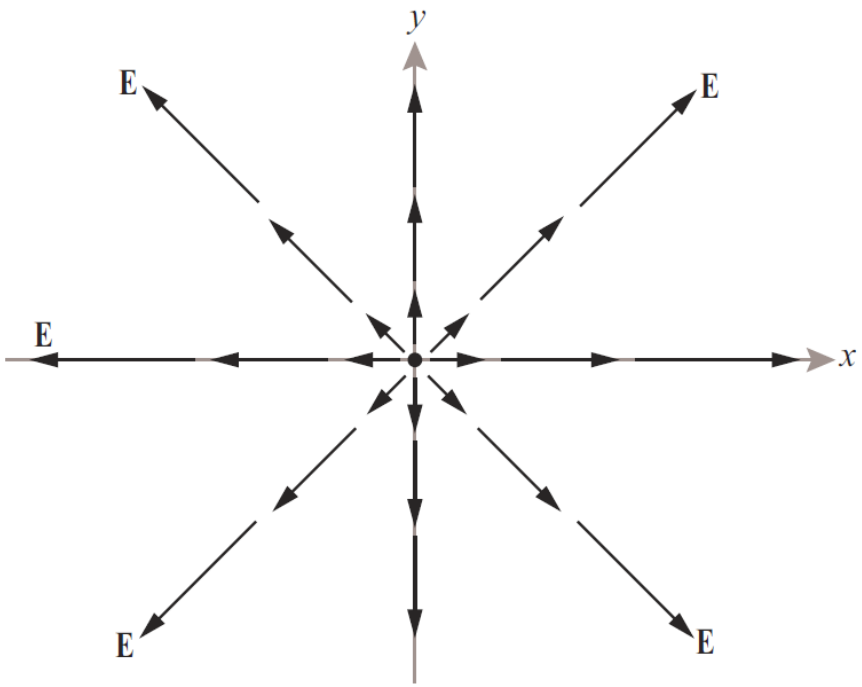
At $\langle -1,5\rangle$, the vector field value is _____ help (vectors)

At $\langle -9,-3\rangle$, the vector field value is _____ help (vectors)

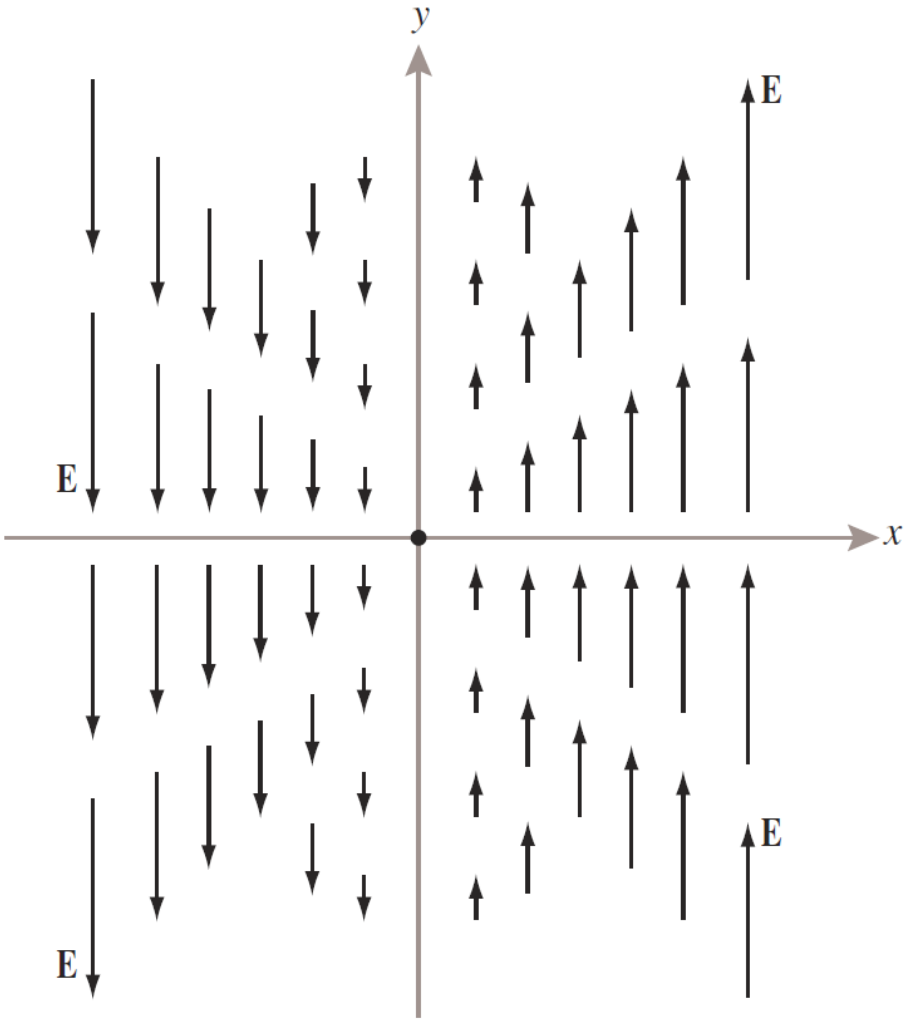
At $\langle 1,-1\rangle$, the vector field value is _____ help (vectors)

Note: Your answers should be enclosed in $\langle x,y\rangle$.

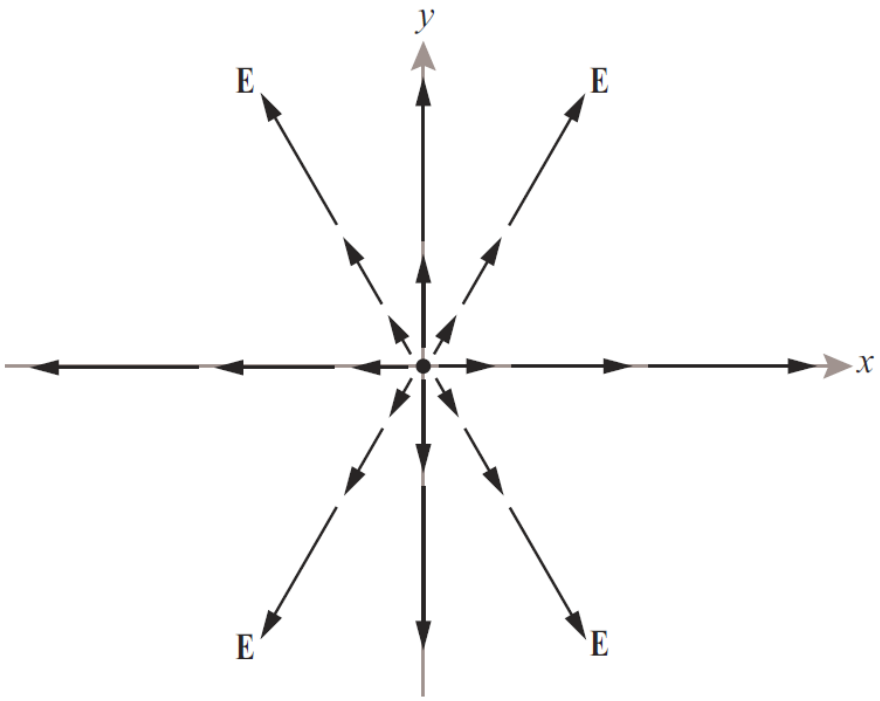
Select the graph that represents the vector field of $\hat{\mathbf{r}}sin\phi$:



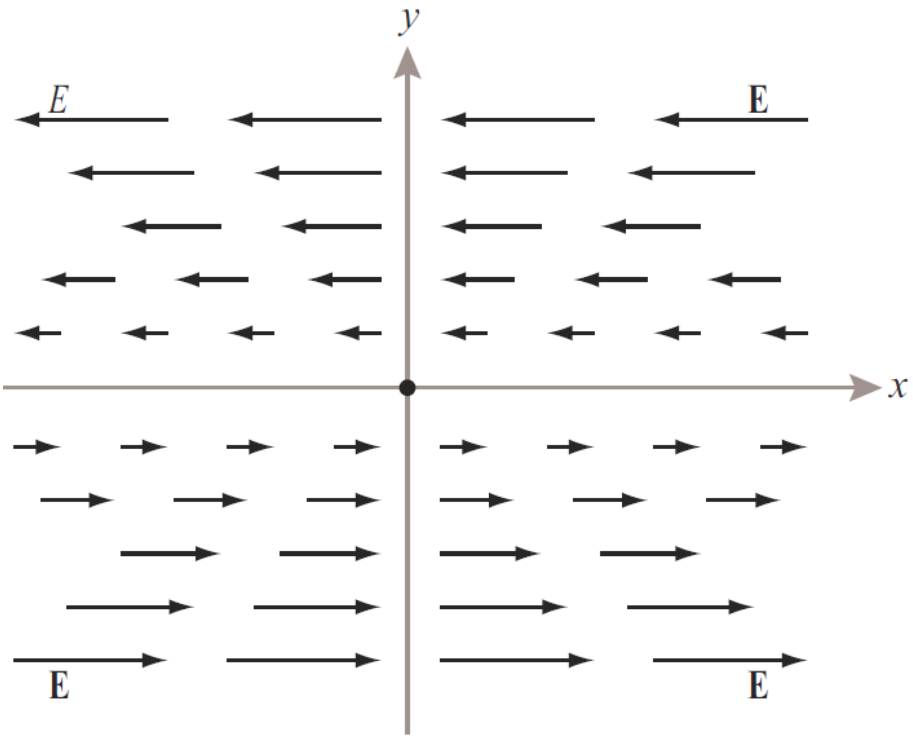
- A.
  (click on image to enlarge)



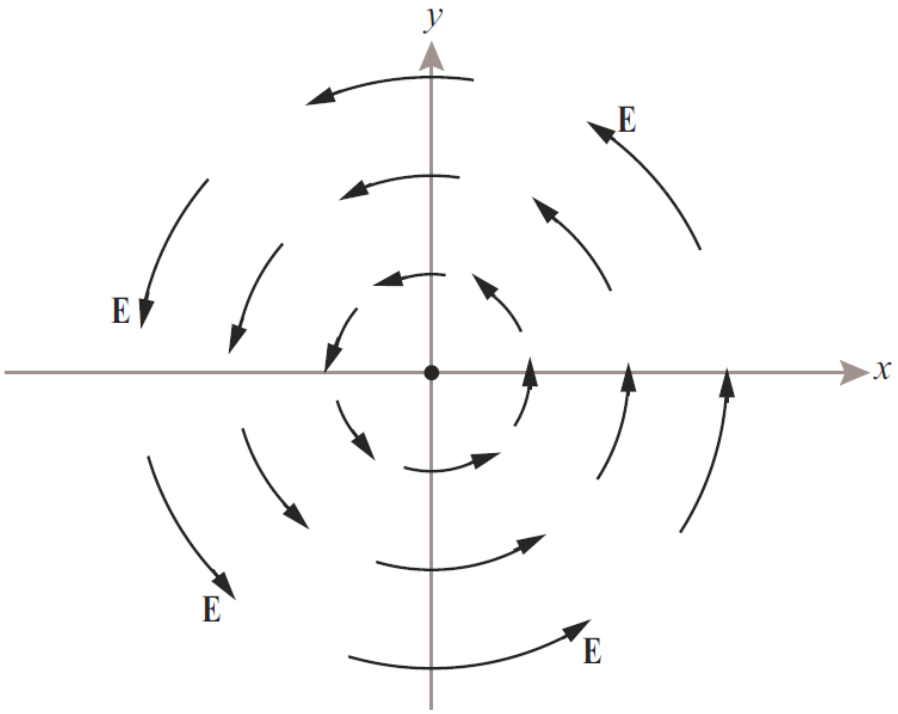
- B.
(click on image to enlarge)



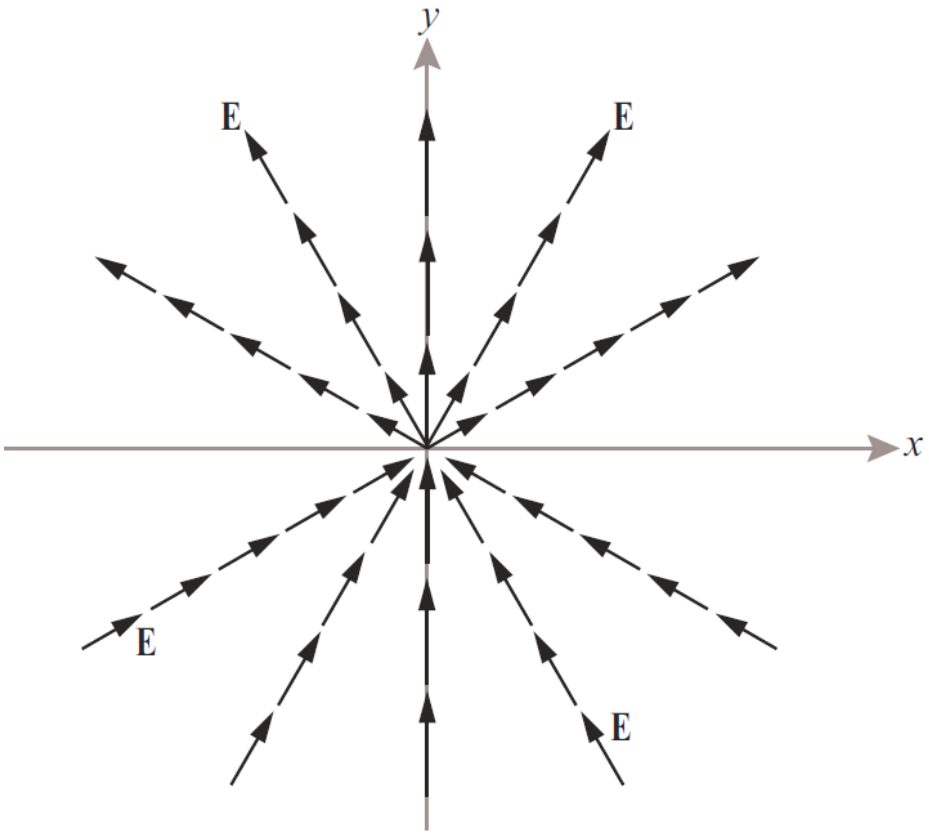
- C.
(click on image to enlarge)



- D.
(click on image to enlarge)



- E.
  (click on image to enlarge)



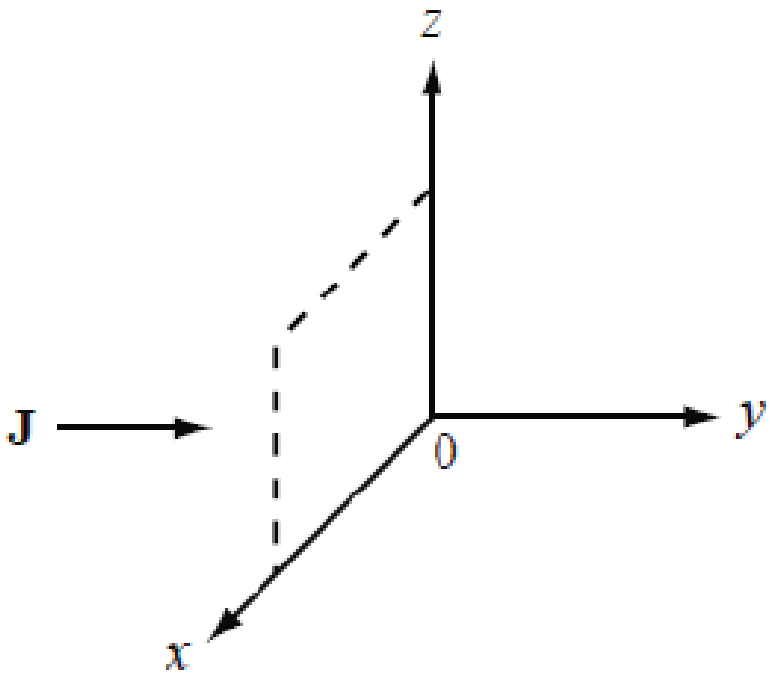
- F.
  (click on image to enlarge)
- G. None of the above

Generated by ©WeBWorK, http://webwork.maa.org, Mathematical Association of America

Joel Trussell **ECE303_Adams**
Assignment ECE303_HW_Set_6 due 10/24/2018 at 11:59pm EDT

---

1. **(1 point)** local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.6.pg



If $\mathbf{J} = \hat{\mathbf{y}} 4xz\,(A/m^2)$, find the current I flowing through a square with corners at $\langle 0,0,0\rangle$,$\langle 2,0,0\rangle$, $\langle 2,0,1\rangle$, and $\langle 0,0,1\rangle$.

I=_____ A help (numbers)

---

2. **(1 point)** local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.14.pg

A line of charge with uniform density $\rho_l = 8(\mu C/m)$ exists in air along the z axis between $z = 0$ and $z = 7(cm)$. Find $\mathbf{E}$ at $\langle 0, 11(cm), 0\rangle$.

NOTE: Your answer should be in the form of "ax+by+cz", where "x", "y" and "z" represent $\hat{\mathbf{x}}, \hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively and "a", "b" and "c" are vector coefficients determined by you. Use $\varepsilon_0 = \frac{10^{-9}}{36\pi}$. Make sure the unit is consistent.

E=_____ (kV/m) help (vectors)

---

3. **(1 point)** local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.15.pg

Electric charge is distributed along an arc located in the x-y plane and defined by $r = 4(cm)$ and $0 \leq \phi \leq \pi/4$. If $\rho_l = 4(\mu C/m)$, find E at the origin.

NOTE:Your answer should be in the form of "ax+by+cz", where "x", "y" and "z" represent $\hat{\mathbf{x}}, \hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively and "a", "b" and "c" are vector coefficients determined by you. Use $\varepsilon_0 = \frac{10^{-9}}{36\pi}$. Make sure the unit is consistent.

At $z = 0$, **E**=_____ (kV/m) help (vectors)

4. **(1 point)** local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.22.pg
Given the electric flux density $\mathbf{D} = \hat{\mathbf{x}}(\mathbf{2x}+\mathbf{5y})+\hat{\mathbf{y}}(\mathbf{1.5x}-\mathbf{2.5y})(\mathbf{C/m^2})$, determine
a) ρ_v=_____ (C/m^3) help (numbers)

b) Determine the total charge enclosed in a cube with a side length of $2(m)$, located in the first octant with three of its sides coincident with the x-,y-, and z-axes and one of its corners at the origin, Q=_____ (C). You may use either the flux density or the charge density to calculate this value. help (numbers)

---

5. **(1 point)** local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.24.pg

Charge Q_1 is uniformly distributed over a thin spherical shell of radius a, and charge Q_2 is uniformly distributed over a second spherical shell of radius b , with $b > a$. Apply Gauss's law to find $\mathbf{E}$ in the regions $R < a$, $a < R < b$, and $R > b$. Note: you may use "Q1", "Q2", "R", "a", "b", "pi" (π) and "eps" (ε).
a) For $R < a$, $\mathbf{E}$=_____ $\hat{\mathbf{R}}$ (V/m) help (formulas)

b) For $a < R < b$, $\mathbf{E}$=_____ $\hat{\mathbf{R}}$ (V/m) help (formulas)

c) For $R > b$, $\mathbf{E}$=_____ $\hat{\mathbf{R}}$ (V/m) help (formulas)

---

6. **(1 point)** local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.31.pg

The circular disk of radius a shown in Figure P4.31 has uniform charge density ρ_s across its surface.

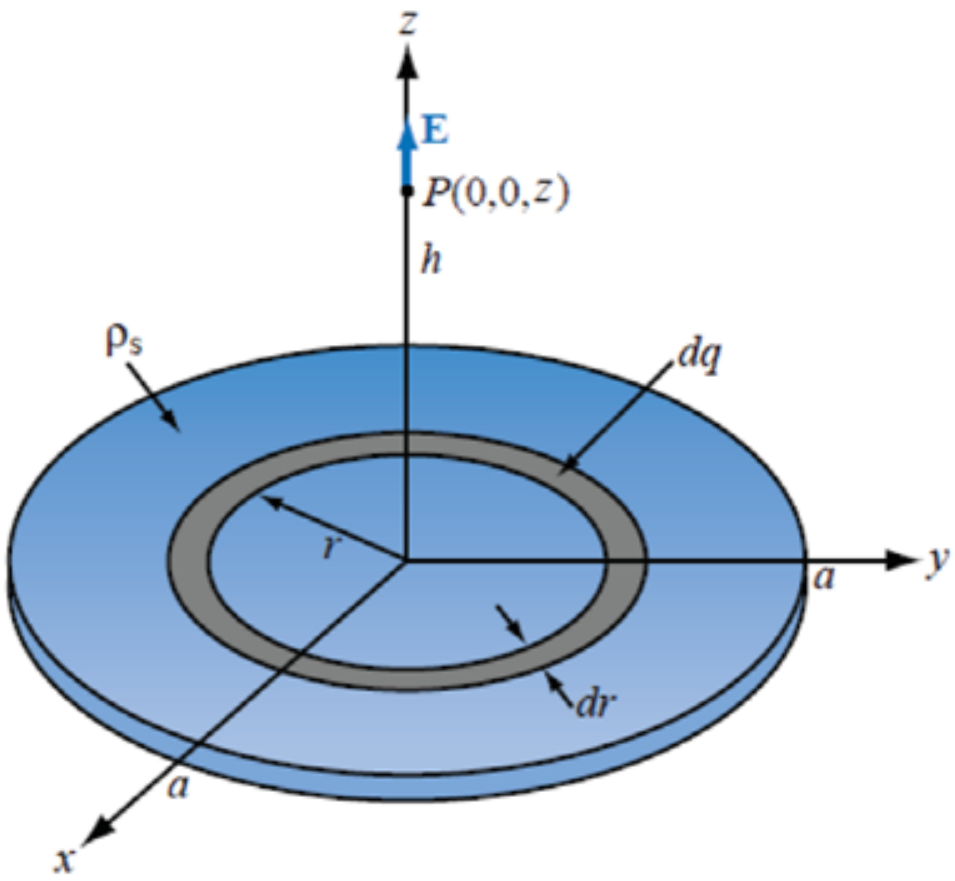


Figure P4.31 Circular disk of charge.

(a) Obtain an expression for the electric potential V at a point $P = (0,0,z)$ on the z-axis.
V = _____ help (formulas)
Notes: You may use "rhos"(ρ_s), "eps0"(ε_0), "a"(a), "zs"(z) in your answers.

(b) Use your result to find **E** and then evaluate it for point P in the diagram above.
E = _____ help (formulas)
NOTE: Your answer should be in the form of "ax+by+cz", where "x", "y" and "z" represent $\hat{\mathbf{x}}, \hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively and "a", "b" and "c" are vector coefficients determined by you. You should also use "rhos"(ρ_s), "eps0"(ε_0), "a"(a), "zs"(z) in your answers when required.

Does this expression of **E** comply with the Eq.(4.24) in the textbook?
Answer: [?/Yes/No]

---

7. (1 point) `local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.34.pg`

Find the electric potential V at a location a distance b from the origin in the x-y plane due to a line charge with charge density ρ_l and of length l. The line charge is coincident with the z-axis and extends from

$z = -l/2$ to $z = l/2$.

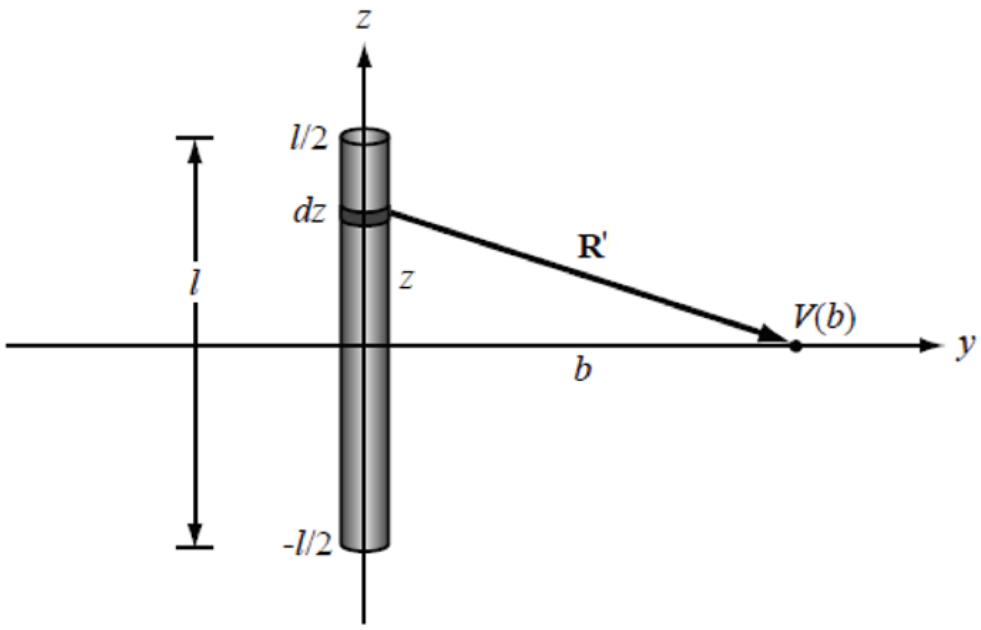


Figure P4.34 Line of charge of length ℓ.

$V(b)$ = _____ help (formulas)

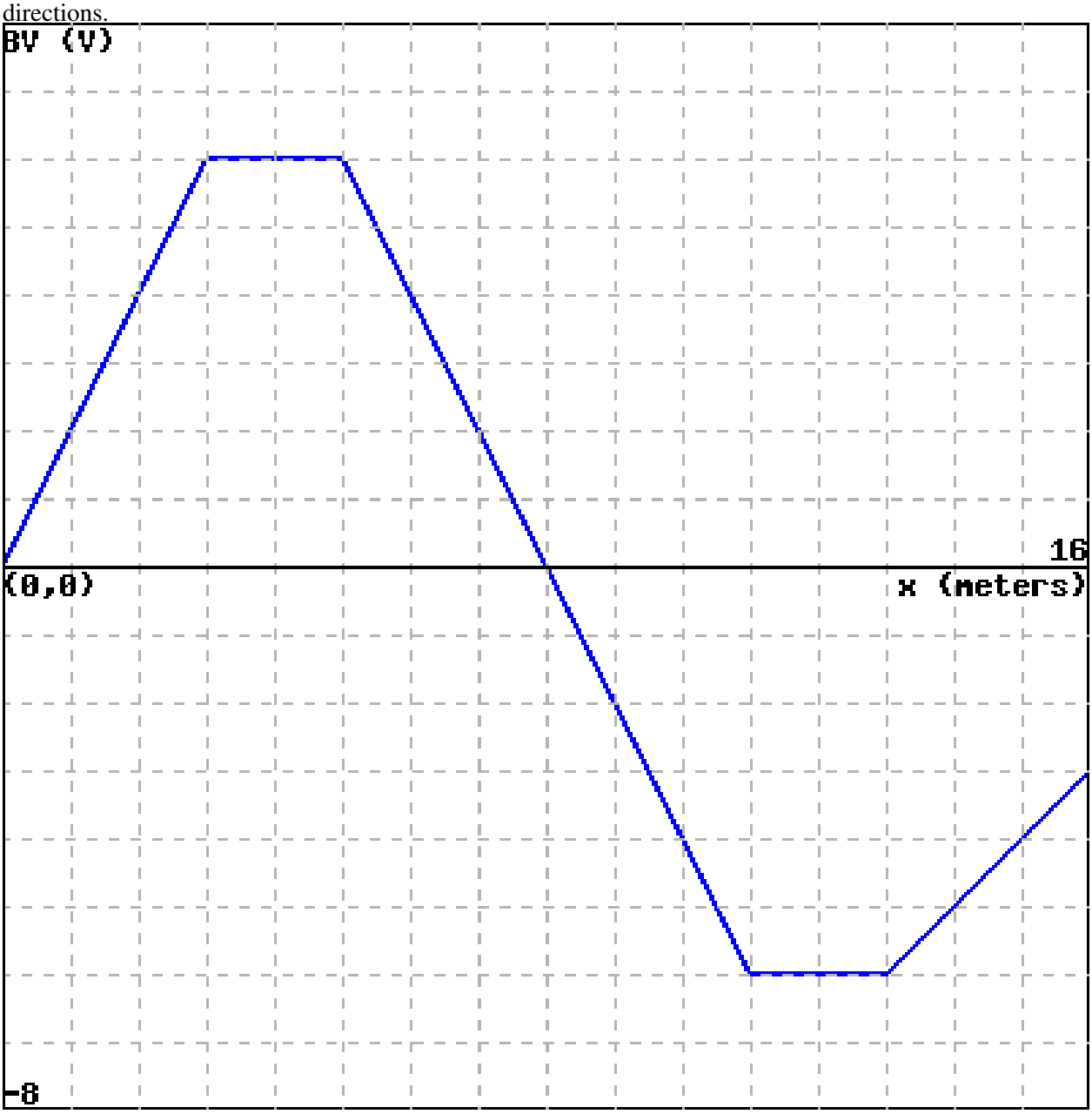
Notes: You may use "rhol"(ρ_l), "eps"(ε), "l" (l), "b" (b) in your answers.

Generated by ©WeBWorK, http://webwork.maa.org, Mathematical Association of America

---

1. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.36.pg`

Part a) The distribution of the electric potential V is shown below. Determine the corresponding distribution of E as a function of x. Note: The grid lines (dashed lines) are exactly 1 unit apart in both x and y directions.



Determine the expression for $E(x)$.

For $0 < x < 3meter$, $E(x)$ = _____ (V) help (formulas)

For $3 < x < 5meters$, $E(x)$ = _____ (V) help (formulas)

For $5 < x < 11meters$, $E(x)$ = _____ (V) help (formulas)

For $11 < x < 13 meters$, $E(x)$ = _____ (V) help (formulas)
For $13 < x < 16 meters$, $E(x)$ = _____ (V) help (formulas)
Hint: the answers may be functions of x or constant values.

Part b). If the distribution of electric potential $V(x) = 13 sin(2\pi x/10)(V)$. Then the distribution of E
$E(x)$= _____ (V) help (formulas)

Part c). If the distribution of electric potential $V(x) = -15 sin(2\pi x/10)(V)$. Then the distribution of E
$E(x)$= _____ (V) help (formulas)

---

2. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.38.pg`

Given the electric field

$$\mathbf{E} = \hat{\mathbf{R}} \frac{22}{R^2} (V/m)$$

find the electric potential of point A with respect to point B, where A is at $Z_A = 1(m)$ and B at $Z_B = -3(m)$, both on the z-axis.

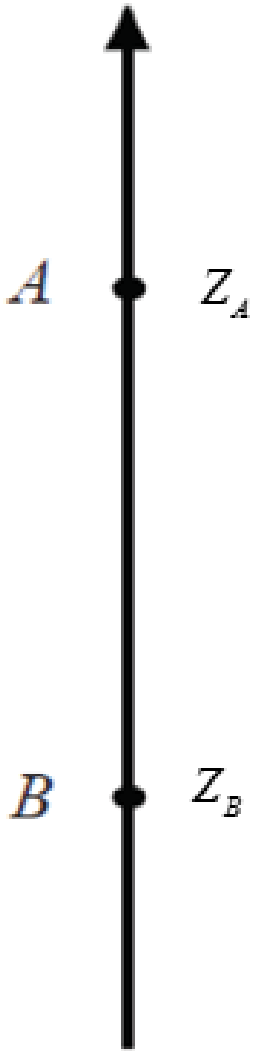


Figure P4.38 Potential between B and A.

$V_{AB} =$ _____ (V) help (numbers)

---

3. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.50.pg`

If $\mathbf{E} = \hat{\mathbf{R}}105(V/m)$ at the surface of a conducting sphere centered at the origin with $r = 6.5(cm)$, what is the total charge Q on the sphere$'$s surface?

$Q =$ _____ $\cdot\varepsilon_0(C)$ help (numbers)
Notes: ε_0 **represents the electrical permittivity of free space.**

---

4. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.51.pg`

Figure P4.51 shows three planar dielectric slabs of equal thickness but with different dielectric constants. If E_0 in air makes an angle of $\theta_0 = 40^o$ with respect to the Z axis, find the angle of E in each of the other layers.
Labeling the upper air layer as layer 0, the parameters for other layers are $\varepsilon_1 = 3\varepsilon_0$, $\varepsilon_2 = 5.1\varepsilon_0$, $\varepsilon_3 = 6.6\varepsilon_0$. In the lower air layer, $\varepsilon_4 = \varepsilon_0$.

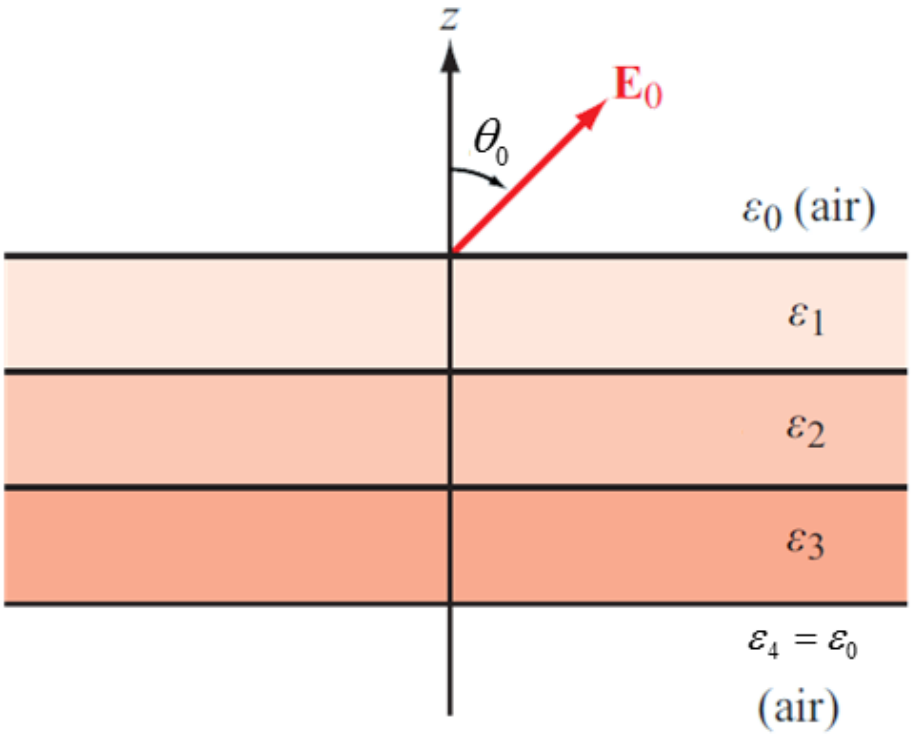


Figure P4.51 Dielectric slabs in Problem 4.51.

$\theta_1 =$ _____ ^{o} help (numbers)
$\theta_2 =$ _____ ^{o} help (numbers)
$\theta_3 =$ _____ ^{o} help (numbers)
$\theta_4 =$ _____ ^{o} help (numbers)

---

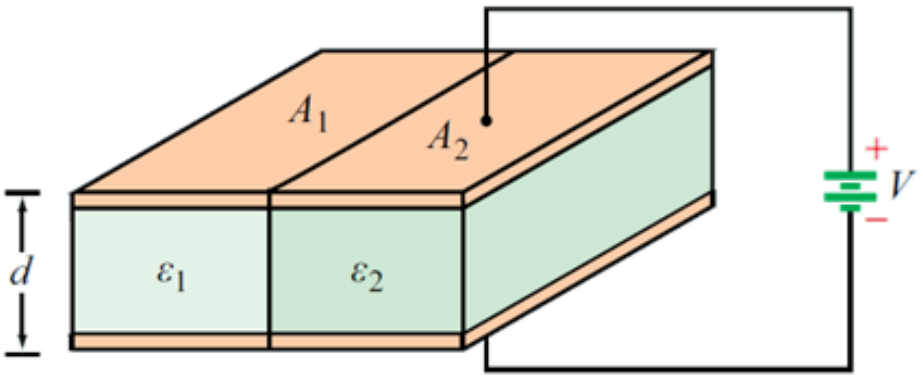
5. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.56.pg`

Figure P4.56(a) depicts a capacitor consisting of two parallel, conducting plates separated by a distance d. The space between the plates contains two adjacent dielectrics, one with permittivity ε_1 and surface area A_1 and another with ε_2 and A_2.

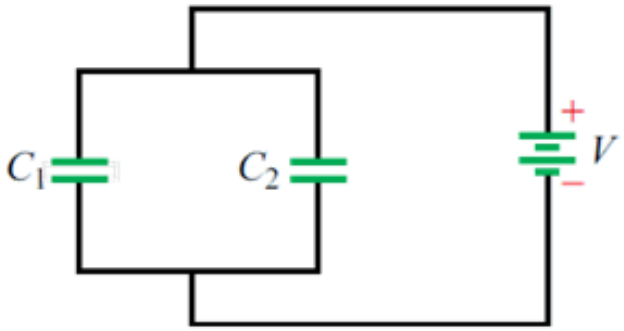
The objective of this problem is to show that the capacitance C of the configuration shown in Fig. P4.56(a) is equivalent to two capacitances in parallel, as illustrated in Fig. P4.56(b), with

$$C = C_1 + C_2$$

where $C_1 = \frac{\varepsilon_1 A_1}{d}$, $C_2 = \frac{\varepsilon_2 A_2}{d}$.



(a)



(b)

Figure P4.56 (a) Capacitor with parallel dielectric section, and (b) equivalent circuit.

To this end, proceed as follows:
Notes: You may use "V"(V), "d"(d), "eps1" (ε_1), , "eps2" (ε_2), "A1"(A_1), "A2"(A_2) in your answers.
(a) Find the electric fields E_1 and E_2 in the two dielectric layers.
E_1 = _____ help (formulas)
E_2 = _____ help (formulas)

(b) Calculate the energy stored in each section and use the result to calculate C_1 and C_2.
W_{e_1} = _____ help (formulas)
W_{e_2} = _____ help (formulas)

C_1 = _____ help (formulas)
C_2 = _____ help (formulas)

(c) Use the total energy stored in the capacitor to obtain an expression for C.
C = _____ help (formulas)

Is C [?/not equal to/equal to] $(C_1 + C_2)$?

---

6. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch4/ECE303_Ulaby_Ed7_4.36a.pg`

Follow the directions in the Flash below to sketch your answer. The applet is setup with a large tolerance considering the difficulties in sketching. You may use the "smooth" button to smoothen your sketch. For locations where there is a instantaneous change of y values (infinite gradient), simply sketch the line as vertical as you can.

object code
This problem requires that Flash be enabled on your device.

Generated by ©WeBWorK, http://webwork.maa.org, Mathematical Association of America

---

1. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch5/ECE303_Ulaby_Ed7_5.6.pg`

A $N = 20$ turns rectangular coil with sides $l = 35$cm and $w = 20$cm is placed in the y-z plane as shown in Fig. P5.6. When the loop is in the negative-y of the y-z plane, $\hat{\mathbf{n}}$ is equal to $\hat{\mathbf{x}}$.

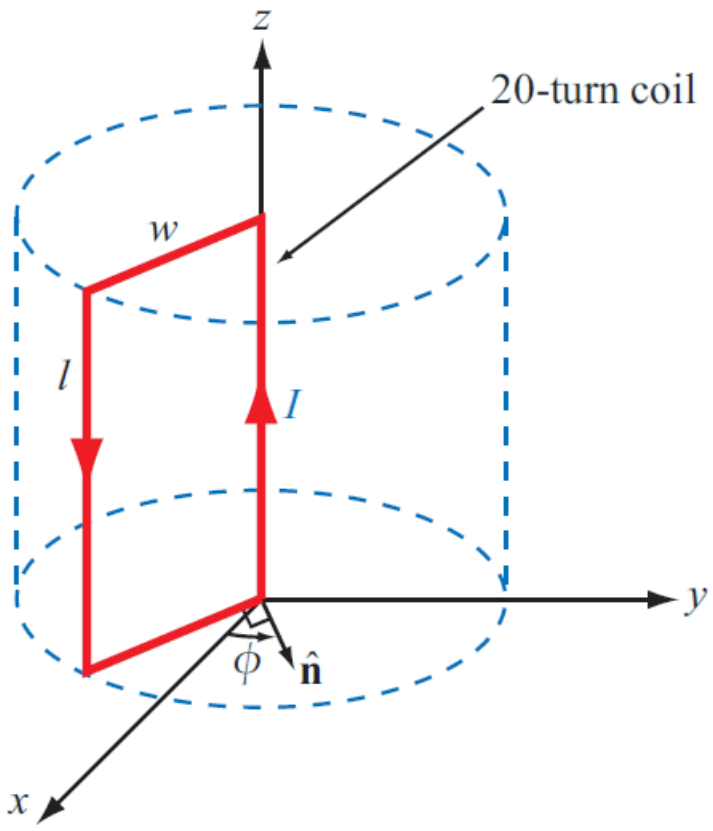


Figure P5.6 Rectangular loop of Problem 5.6.

Suppose the plane of the loop is moved to an angle ϕ, proceed as follows.

Note: Your answers are validated to ± 0.01 absolute.

(a) If the coil, which carries a current $I = 5$A, is in the presence of a magnetic flux density

$$\mathbf{B} = 2 \times 10^{-2}(\hat{\mathbf{x}} + \hat{\mathbf{y}}3) \quad \text{(T)}$$

and the angle $\phi = 45^o$, determine the torque acting on the coil.

T=_____ $(\mathrm{N}\cdot\mathrm{m})$ help (vectors)

Note: Your answer should be in the form of "ax+by+cz", where "x", "y" and "z" represent $\hat{\mathbf{x}},\hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively and "a", "b" and "c" are vector coefficients determined by you.

(b) At what angle ϕ (in degree) is the torque zero?

ϕ_0=_____ ^{o} help (numbers)

Note: There are multiple solutions for the angles here, please enter your answers in comma separated list. Give ALL angles in $[-\pi,\pi]$ that satisfy the conditions. Your answers may be listed in any order.

(c) At what angle ϕ (in degree) is the torque maximum? Determine the maximal torque $\mathbf{T_{max}}$.

ϕ_{max}=_____ ^{o} help (numbers)

$\mathbf{T_{max}}$=_____ $(\mathrm{N}\cdot\mathrm{m})$ help (vectors)

Note: There are multiple solutions for the angles here, please enter your answers in comma separated list. Give ALL angles in $[-\pi,\pi]$ that satisfy the conditions. Your answers may be listed in any order.

---

2. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch5/ECE303_Ulaby_Ed7_5.7.pg`

An $a \times b = 7\text{cm} \times 12\text{cm}$ rectangular loop of wire is situated in the x-y plane with the center of the loop at the origin and its long sides parallel to the x-axis. The loop has a current of $I = 60\text{A}$ flowing clockwise (when viewed from above).

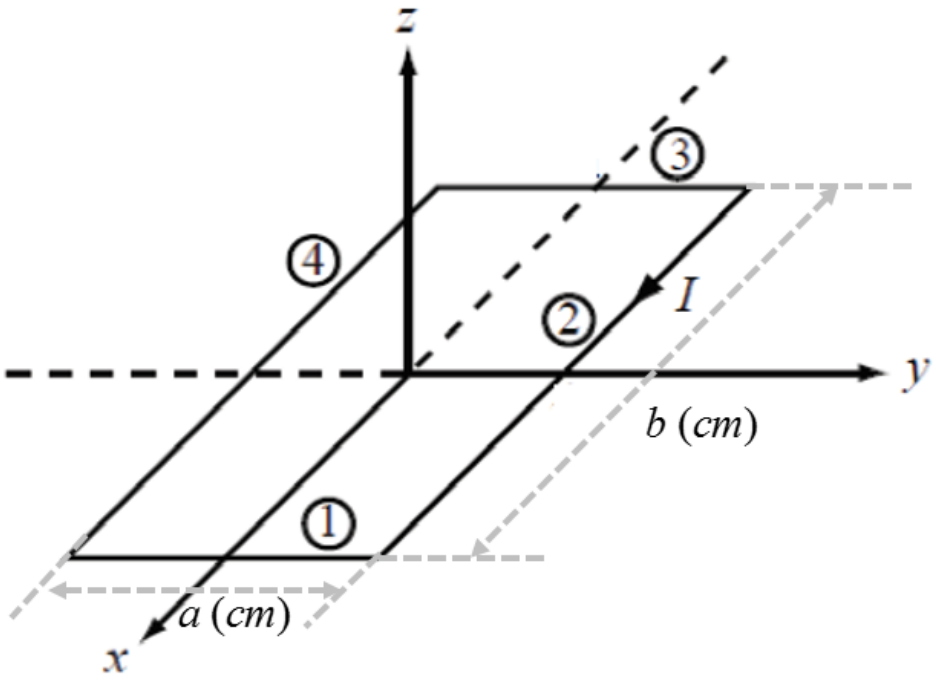


Figure P5.7 Problem 5.7.

Determine the magnetic field at the center of the loop.
Note: Your answers are validated to ± 0.01 absolute.

B=_____ (mT) help (vectors)

Note:Your answer should be in the form of "ax+by+cz", where "x", "y" and "z" represent $\hat{\mathbf{x}}, \hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively and "a", "b" and "c" are vector coefficients determined by you.

---

3. (1 point) `local/ECE303/Ulaby_7Ed_Ch5/ECE303_Ulaby_Ed7_5.12.pg`

Two infinitely long, parallel wires are carrying $I = 9.5$A currents in opposite directions.

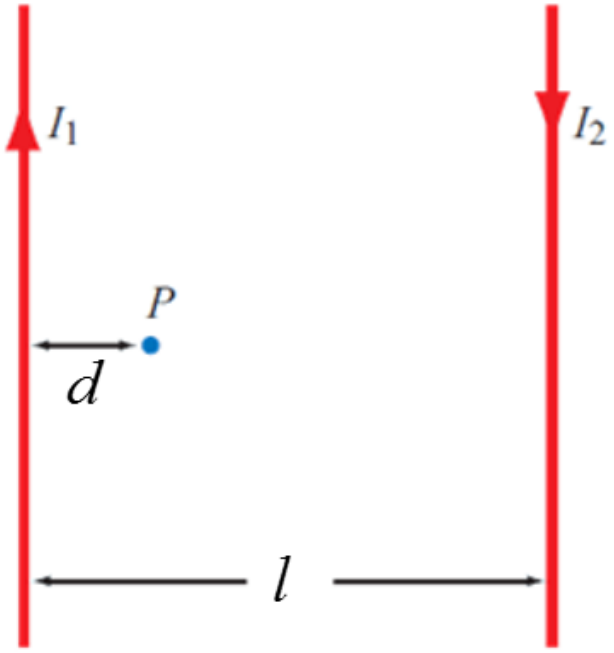


Figure P5.12 Arrangement for Problem 5.12.

Determine the magnetic flux density at point P in Fig. P5.12, with $d = 0.3$m and $l = 2$m.

B=_____ $\hat{\phi}$ (T) help (formulas)

Note: You may use "pi" (π) and "mu0" (μ_0) in your answer.

---

4. (1 point) `local/ECE303/Ulaby_7Ed_Ch5/ECE303_Ulaby_Ed7_5.16.pg`

The long, straight conductor shown in Fig. P5.16 lies in the plane of the rectangular loop at a distance $d = 0.1$m. The loop has dimensions $a = 0.1$m and $b = 0.25$m, and the currents are $I_1 = 15$A and $I_2 = 30$A.

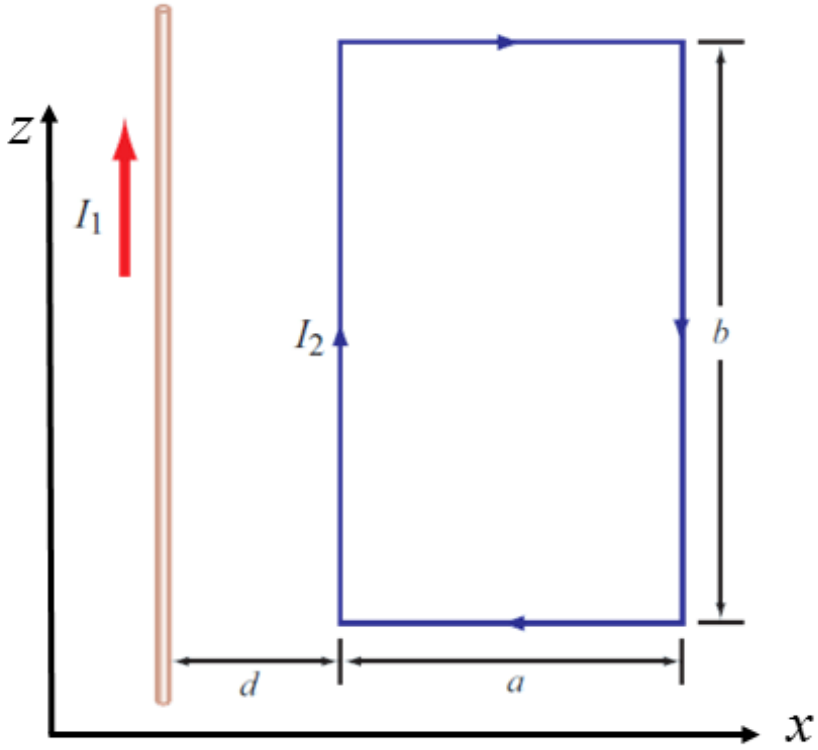


Figure P5.16 Current loop next to a conducting wire (Problem 5.16).

Determine the net magnetic force acting on the loop.

Note: Your answers are validated to ± 0.01 absolute.

$\vec{F}$=_____ (mN) help (vectors)

Note: Your answer should be in the form of "px+qy+rz", where "x", "y" and "z" represent $\hat{\mathbf{x}}, \hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively and "p", "q" and "r" are vector coefficients determined by you.

---

5. (1 point) `local/ECE303/Ulaby_7Ed_Ch5/ECE303_Ulaby_Ed7_5.22.pg`

A long cylindrical conductor whose axis is coincident with the z-axis has a radius $a = 0.05$m and carries a current characterized by a current density $\mathbf{J} = \hat{\mathbf{z}} J_0/r$, where $J_0 = 175(\text{A/mm})$ and r is the radial distance from the axis of cylinder.
Obtain the values for the magnetic field $\tilde{\mathbf{H}}$ for

(a) $r = 0.04$m
$\tilde{\mathbf{H}}_1$=_____ $\hat{\phi}$ (A/mm) help (numbers)

(b) $r = 0.09$m
$\tilde{\mathbf{H}}_2$=_____ $\hat{\phi}$ (A/mm) help (numbers)

6. **(1 point)** local/ECE303/Ulaby_7Ed_Ch5/ECE303_Ulaby_Ed7_5.33.pg

Given that a current sheet with surface current density $\mathbf{J_s} = \hat{\mathbf{x}}\ 5(\mathrm{A/m})$ exists at y = 0, the interface between two magnetic media, and $\mathbf{H_1} = \hat{\mathbf{z}}\ 12.2(\mathrm{A/m})$ in medium 1 (y ¿ 0), determine $\mathbf{H_2}$ in medium 2 (y ¡ 0).

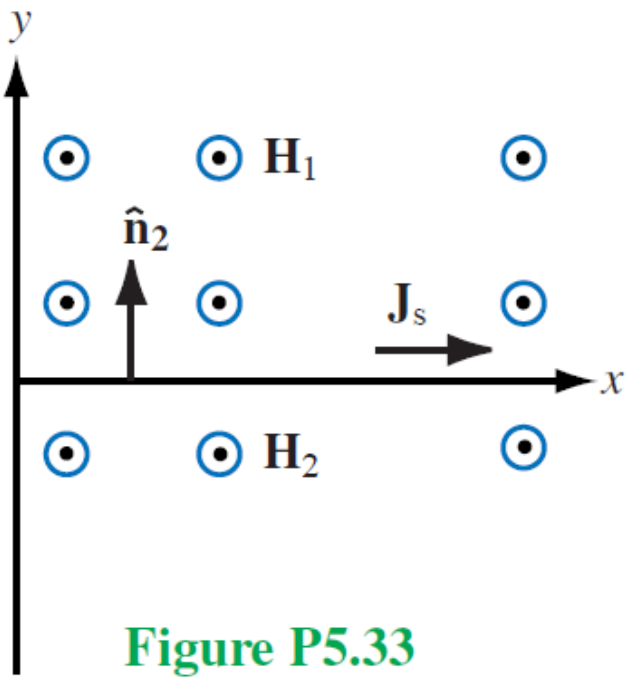


Figure P5.33

Adjacent magnetic media with $\mathbf{J_s}$ on boundary.

$\mathbf{H_2}$=_____ (A/m) help (vectors)

Note:Your answer should be in the form of "ax+by+cz", where "x", "y" and "z" represent $\hat{\mathbf{x}}, \hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively and "a", "b" and "c" are vector coefficients determined by you.

---

7. **(1 point)** local/ECE303/Ulaby_7Ed_Ch5/ECE303_Ulaby_Ed7_5.34.pg

In Fig. P5.34, the plane defined by x-y=1 separates medium 1 of permeability μ_1 from medium 2 of permeability μ_2. If no surface current exists on the boundary and

$$\mathbf{B}_1 = \hat{\mathbf{x}}1.2 + \hat{\mathbf{y}}3 \quad (\mathrm{T})$$

find $\mathbf{B}_2$ in terms of μ_1 and μ_2, and then evaluate your result for $\mu_1 = 3\mu_2$.
Hint: Start by deriving the equation for the unit vector normal to the given plane.

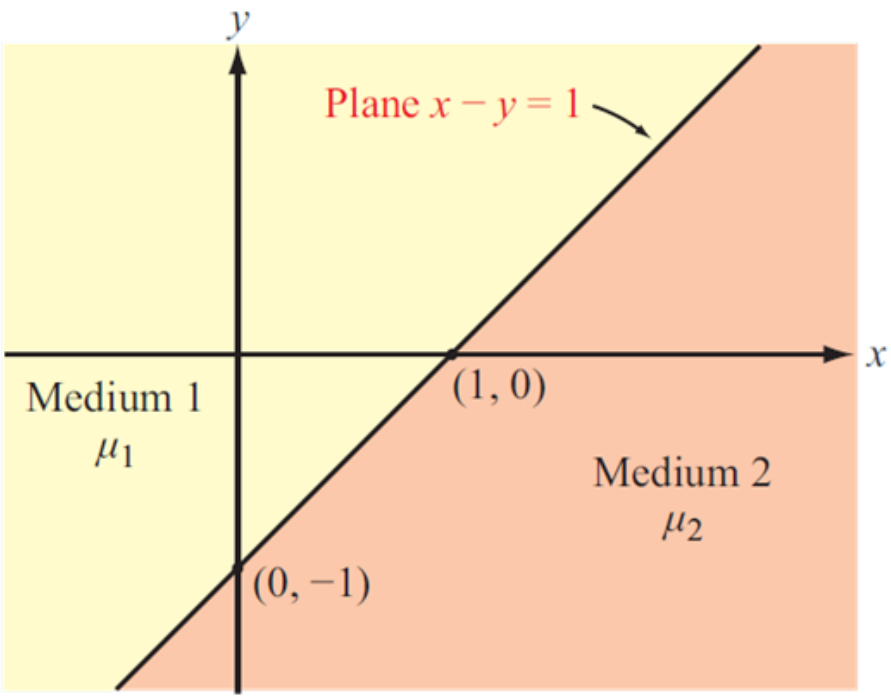


Figure P5.34 Magnetic media separated by the plane $x - y = 1$ (Problem 5.34).

$\mathbf{B}_2(\mu_1,\mu_2)$ =_____ (T) help (vectors)
$\mathbf{B}_2(\mu_1 = 3\mu_2)$ =_____ (T) help (vectors)

Note: Your answer should be in the form of "ax+by+cz", where "x", "y" and "z" represent $\hat{\mathbf{x}}, \hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively and "a", "b" and "c" are vector coefficients determined by you. You may use "mu1" (μ_1) and "mu2" (μ_2) in your answer.

---

8. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch5/ECE303_Ulaby_Ed7_5.37.pg`

Obtain an expression for the self-inductance per unit length (L_{pu}) for the parallel wire transmission line of Fig. 5.37 in terms of μ, where $\mu = 4\pi \times 10^{-7}$(H/m) is the permeability of the medium in which they reside. Before getting that expression, you are required to obtain the expression for magnetic fields ($\vec{B}_1$ and $\vec{B}_2$) and magnetic flux (Φ) first.

Parameter $a = 0.03$m is the radius of the wires and $d = 7$m is the axis-to-axis distance between the wires.

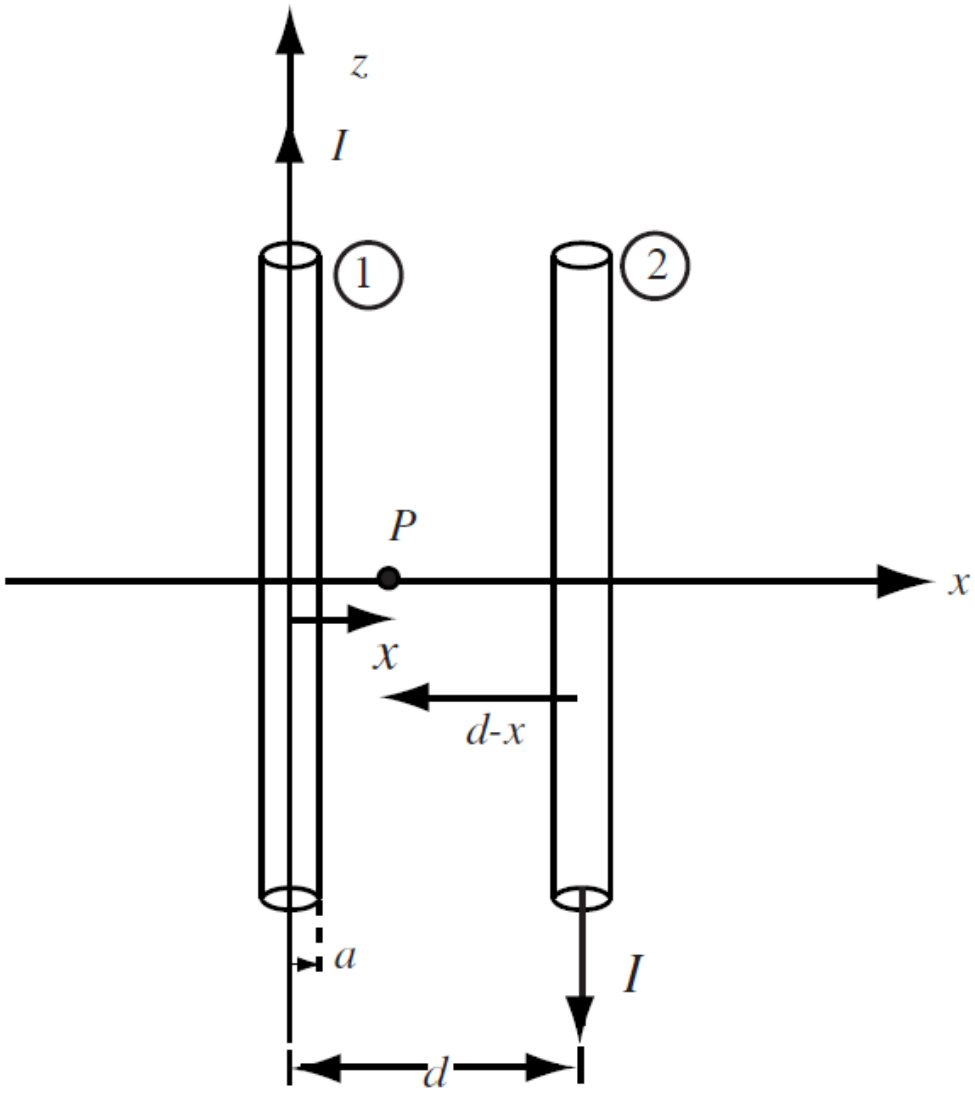


Figure P5.37 Parallel wire transmission line.

(a) Find an expression for magnetic fields $\vec{B}_1$ and $\vec{B}_2$ generated by each wire at point $P = (1.5, 0, z)$.

$\vec{B}_1$=_____ (nT) help (vectors)
$\vec{B}_2$=_____ (nT) help (vectors)

Note: Your answer should be in the form of "ax+by+cz", where "x", "y" and "z" represent $\hat{\mathbf{x}}, \hat{\mathbf{y}}$ and $\hat{\mathbf{z}}$ respectively and "a", "b" and "c" are vector coefficients determined by you. You may use "I" (I), and "l" (l) in your answer for (a) and (b). Be careful about the current "I" (I) and length "l" (l) since they are similar in this font.

(b) Find the magnetic flux crossing the surface area between the wires over a length l of the wire structure.

Φ=_____ $(\mathrm{nH}\cdot\mathrm{A})$ help (formulas)

(c) The inductance per unit length is:

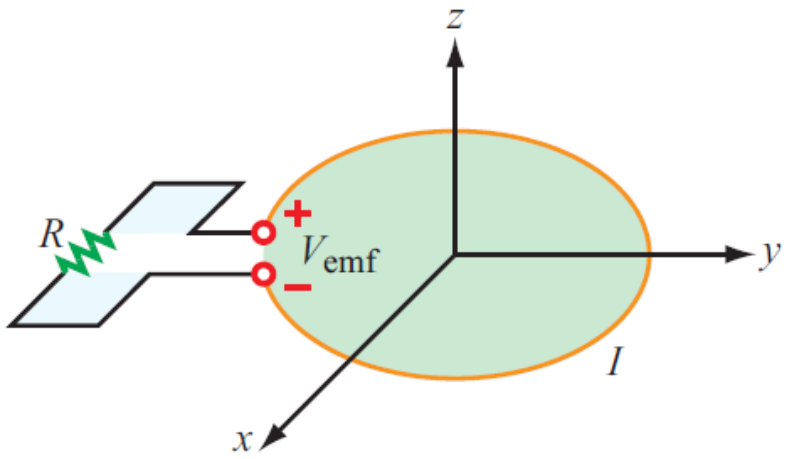
L_{pu} =_____ (nH/m) help (formulas)

Generated by ©WeBWorK, http://webwork.maa.org, Mathematical Association of America

Joel Trussell **ECE303_Adams**
Assignment ECE303_HW_Set_9 due 11/27/2018 at 11:59pm EST

---

1. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch6/ECE303_Ulaby_Ed7_6.2.pg`



The loop in the figure above is in the $x-y$ plane and $\mathbf{B} = \hat{\mathbf{z}} B_0 sin(\omega t)$ with B_0 positive. What is the direction of I ($+\hat{\phi}$ or $-\hat{\phi}$) at:
(a) $\omega t = 0\pi$, I is

-
- in the direction
- in the opposite direction
- in neither direction nor opposite direction
- possibly in the direction or opposite direction

of $\hat{\phi}$;
(b) $\omega t = 2\pi/6$, I is

-
- in the direction
- in the opposite direction
- in neither direction nor opposite direction
- possibly in the direction or opposite direction of

of $\hat{\phi}$;
(c) $\omega t = 3\pi/6$, I is

-
- in the direction
- in the opposite direction
- in neither direction nor opposite direction
- possibly in the direction or opposite direction of

of $\hat{\phi}$;
(d) $\omega t = 4\pi/6$, I is

-
- in the direction
- in the opposite direction
- in neither direction nor opposite direction
- possibly in the direction or opposite direction of

of $\hat{\phi}$.

---

2. **(1 point)** local/ECE303/Ulaby_7Ed_Ch6/ECE303_Ulaby_Ed7_6.3.pg

A coil consists of 110 turns of wire wrapped around a square frame of sides 0.25 m. The coil is centered at the origin with each of its sides parallel to the x- or y-axis. Find the induced emf across the open-circuited ends of the coil as a function of "t" if the magnetic field is given by

(a) $\hat{\mathbf{B}} = \hat{\mathbf{z}}28e^{-3t}(T)$

emf=_____ (V) help (formulas)

(b) $\hat{\mathbf{B}} = \hat{\mathbf{z}}28cos(x)cos(10^3t)(T)$

emf=_____ (kV) help (formulas)

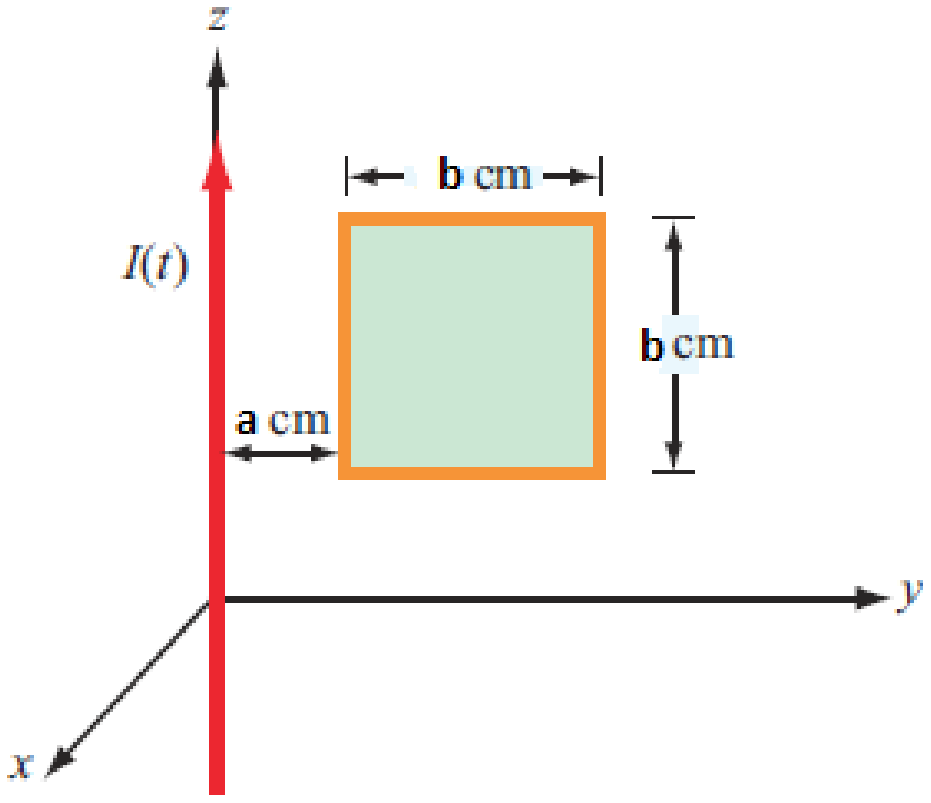
(c) $\hat{\mathbf{B}} = \hat{\mathbf{z}}28cos(x)sin(2y)cos(10^3t)(T)$

emf=_____ (V) help (formulas)

Note: Ensure your unit is consistent.

---

3. **(1 point)** local/ECE303/Ulaby_7Ed_Ch6/ECE303_Ulaby_Ed7_6.6.pg



The square loop shown above is coplanar with a long, straight wire carrying a current $I(t) = 21cos(2\pi \cdot$

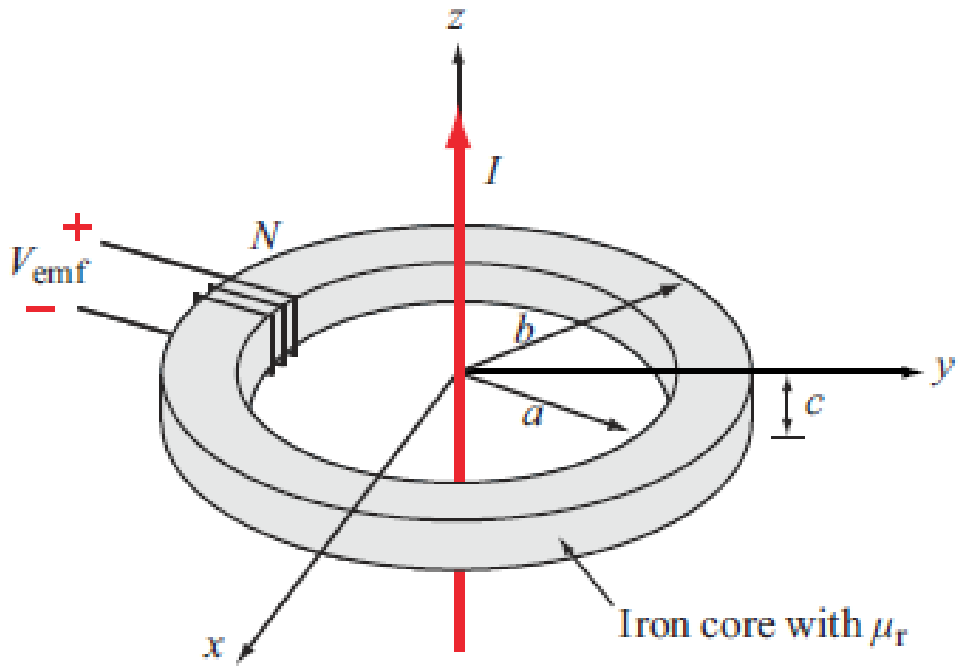
$10000t)(A)$, $a = 6(cm)$, and $b = 9(cm)$.
Note: Ensure your unit is consistent.

(a) The emf induced across a small gap created in the loop is _____ (mV) help (formulas)

(b) Determine the current that would flow through a $4.5-\Omega$ resistor connected across the gap, The loop has an internal resistance of $1.5-\Omega$.
$I(t)$=_____ (mA) help (formulas)
Note: Your current function should follow the convention that when looking into the $-\hat{\mathbf{x}}$ direction as shown in the diagram above, the current is positive when it is flowing counter clockwise which can also be described as following the right hand rule along the $\hat{\mathbf{x}}$ direction .

---

4. **(1 point)** `local/ECE303/Ulaby_7Ed_Ch6/ECE303_Ulaby_Ed7_6.8.pg`



The transformer shown in figure above consists of a long wire coincident with the z-axis carrying a current $I = I_0 cos(\omega t)$, coupling magnetic energy to a toroidal coil situated in the $x-y$ plane and centered at the origin. The toroidal core uses iron material with relative permeability $\mu_r = 4000$, around which 80 turns of a tightly wound coil serves to induce a voltage V_{emf}, as shown in the figure. Calculate V_{emf} for $f = 60Hz, a = 4cm, b = 6.5cm, c = 2cm$, and $I_0 = 52A$.
V_{emf}= _____ (V) help (formulas)

Generated by ©WeBWorK, http://webwork.maa.org, Mathematical Association of America