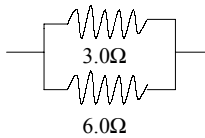
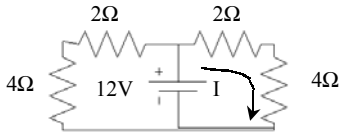


Practice Midterm 2 Solutions

- 1. What is the equivalent resistance between points A and B in the circuit below?



- 2. Current through resistor R_4 in the circuit below?



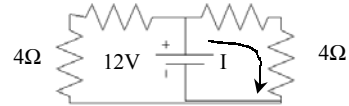
- 1.
$$\frac{1}{R_{||}} = \frac{1}{3\Omega} + \frac{1}{6\Omega} = \frac{3}{6\Omega}$$

$$R_{||} = 2\Omega$$

- 2. Loop Eqn. for right-hand loop:

$$\varepsilon - IR_3 - IR_4 = 0$$

$$I = \frac{\varepsilon}{R_3 + R_4} = \frac{12V}{6\Omega} = 2A$$



- 3. The capacitor shown has parallel plates, each of area 0.1 m^2 , separated by a distance of 10^{-3} m , with vacuum between the plates. A charge of $+8.85 \times 10^{-12} \text{ C}$ is on the left-hand plate and a charge of $-8.85 \times 10^{-12} \text{ C}$ is on the right-hand plate. The right-hand plate has electric potential 0. What is the potential of the left-hand plate?



- 4. A parallel plate capacitor with vacuum between the plates is charged by a battery and the battery is then removed. The capacitor has a stored energy of 5 J. A dielectric with $\kappa = 5$ is then put in to fill the space between the plates. What is the new stored energy?

- 3.

$$C = \frac{\varepsilon_0 A}{d}$$

$$Q = C\Delta V \Rightarrow \Delta V = \frac{Q}{C} = \frac{Q}{\varepsilon_0 A/d}$$

- 4. Charge is constant!

Dielectric increases capacitance: $C' = 5C$

Before dielectric: $U = 0.5Q^2/C = 5J$

After: $U' = 0.5Q^2/C' = 5J/5 = 1J$

- 5. A particle of charge -10^{-6} C has a velocity $\vec{v} = (100 \text{ m/s})(\hat{i} + \hat{j})$ in a region where the magnetic field \vec{B} is $2T \hat{k}$. What is the magnetic force on the particle?
- 6. The magnetic field produced by a line element $d\vec{l}$ at a position \vec{r} is found to be $0.1T \hat{i}$. Which one of the following combinations of $d\vec{l}$ and \vec{r} could produce this field?
- 7. A wire of radius 0.1 m carries a current of 2A. What is the circulation C of magnetic field around the wire?

- 5.

$$\vec{F} = q\vec{v} \times \vec{B} = (-10^{-6} \text{ C})(100 \text{ m/s})(\hat{i} + \hat{j}) \times (2T\hat{k})$$

$$= -2 \times 10^{-4} \text{ N}(-\hat{j} + \hat{i})$$

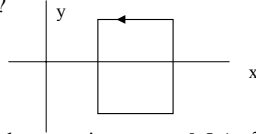
- 6.
$$d\vec{B} = \frac{\mu_0 I d\vec{l} \times \hat{r}}{r^2}$$

 Need... $d\vec{l} \times \hat{r} = \hat{i} \Rightarrow d\vec{l} = \hat{j}, \hat{r} = \hat{k}$

- 7. By Ampere's Law:

$$\mathcal{C} = \mu_0 I_{\text{through}} = \mu_0 (2A)$$

- 8. A 5A current flow square loop shown; each side of the loop is of length 0.2 m. What is the magnetic moment of the loop?



- 9. A current loop with magnetic moment 0.5 Am^2 is placed in a magnetic field of strength 3T . The normal to the loop makes a 60 degree angle with the field direction. What is the magnitude of the torque on the loop?
- 10. Magnetic field inside a solenoid in air is 0.1T . A material is placed in the solenoid and the magnetic field becomes 10T . The material is best described as

- 8
$$\vec{m} = IA\hat{k} = (5A)(0.2\text{m})^2\hat{k}$$

$$= 0.2\text{Am}^2\hat{k}$$

- 9.

$$|\vec{\tau}| = |\vec{m} \times \vec{B}| = mB \sin\theta$$

$$= (0.5\text{Am}^2)(3\text{T})(\sin 60^\circ)$$

$$= 1.3\text{Nm}$$

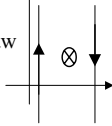
- 10. Ferromagnetic! .

- 1. Long straight parallel wires separated by 0.2 Current 5A \hat{j} in left-hand wire, $-5\text{A}\hat{j}$ right-hand wire.

- a) B halfway between the wires?
Fields from two wires add. Use Ampere's Law

$$2\pi r B_1 = \mu_0 I$$

$$B = 2B_1 = 2 \mu_0 I / [2\pi(0.1\text{m})] = 2 \times 10^{-5} \text{T in } -\hat{k} \text{ direc.}$$



- b) Magnetic force/unit length on the right-hand wire?
B at RH wire = $\mu_0 I / [2\pi(0.2\text{m})] = 5 \times 10^{-6} \text{T toward } -\hat{k}$

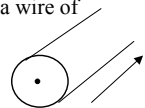
$$\vec{F} = I\vec{l} \times \vec{B}$$

$$F/l = IB(-\hat{j} \times -\hat{k}) = 2.5 \times 10^{-5} \text{Ni}$$

- c) Right-hand $I = +5\text{A}\hat{j}$. B halfway between the wires?
 $B=0$; fields from two wires cancel at center

- d) Mag. force on RH wire = $-2.5 \times 10^{-5} \text{Ni}$

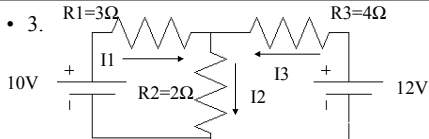
- 2. A current of 8A flows uniformly in a wire of radius 0.05 m as shown.



- a) Amperian curve you would use to find the magnetic field strength at radius 0.025 m .
Circle of radius 0.025 m
- b) Strength of the magnetic field at radius 0.025 m .
Ampere's Law:
$$2\pi(0.025\text{m})B = \mu_0 (J\pi(.025\text{m})^2)$$

$$J = 8\text{A}/(0.5\text{m})^2; B = 1.6 \times 10^{-7} \text{T}$$
- c) Magnetic field at $r = 0.025 \text{ m}$ in terms of \hat{r}, θ, \hat{k}

$$\vec{B} = -1.6 \times 10^{-7} T \hat{\theta}$$



- a) What is the current flowing in resistor R_2 ?

- $I_1 + I_2 = I_3$

- $10\text{V} - I_1(3\Omega) - I_2(2\Omega) = 0$; $12\text{V} - I_3(4\Omega) - I_2(2\Omega) = 0$
 $12\text{V} - (I_2 - I_1)(4\Omega) - I_2(2\Omega) = 0$
 $12\text{V} + (4\Omega)I_1 - (6\Omega)I_2 = 0$

$$\text{Take } 4/3 \text{ times 2nd eqn } 13.33\text{V} - (4\Omega)I_1 - (2.66\Omega)I_2 = 0$$

$$\text{Add to get } 25.33\text{V} = (8.66\Omega)I_2; I_2 = 2.9\text{A}$$

- b) Voltage drop across R_2 ? $(2.9\text{A})(2\Omega) = 5.8\text{V}$

- c) Power is dissipated in R_2 ? $P = (2.9\text{A})(5.8\text{V}) = 17\text{W}$

- 4. For the circuit shown

- a) Find the charge on capacitor C_2

- $Q_2 = Q_3 = Q_s$

$$1/C_s = (1/3 \text{mF}) + (1/5 \text{mF})$$

$$C_s = (15/8)\text{mF}$$

$$Q_2 = Q_s = C_s(10\text{V}) = 1.88 \times 10^{-2} \text{C}$$

- b) Charge on capacitor C_3 : $Q_3 = Q_2 = 1.88 \times 10^{-2} \text{C}$

- c) Find the potential difference across capacitor C_2 .

$$\Delta V_2 = Q_2/C_2 = (1.88 \times 10^{-2} \text{C}/3 \text{mF}) = 6.25\text{V}$$

