Exam 2

Name: SOLUTION

PID:

Lab section: (circle one)

W 10:30 am	W 4:30 pm	Th 7:30 am
Th 10:30 am	Th 1:30 pm	M 1:30 pm
F 10:30 am	F 1:30 pm	

$$\vec{F} = q\vec{v} \times \vec{B}$$

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

$$\mu_0 = 4\pi \times 10^{-7} Tm / A$$

$$dB = \frac{\mu_0 I}{4\pi} \frac{dS \times \hat{r}}{r^2}$$

1

2

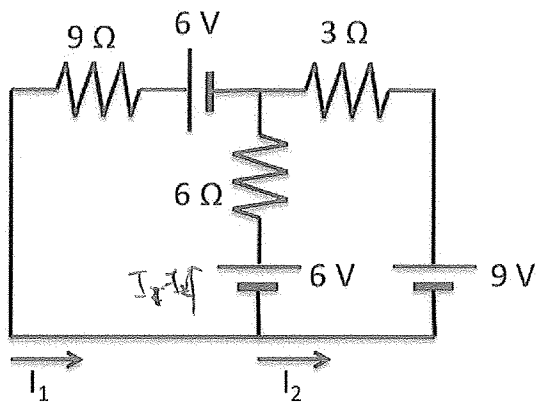
3

4

5

Total:

Problem 1: Calculate I_1 and I_2 for the circuit shown below [20 points: setting up the algebra correctly will get you 15 points, so show your work]



$$6 - 6(I_1 - I_2) + 6 - 9I_1 = 0$$

$$12 - 15I_1 + 6I_2 = 0$$

$$\boxed{15I_1 - 6I_2 = 12} \quad \cdots (1)$$

$$9 - 3I_2 + 6(I_1 - I_2) - 6 = 0$$

$$3 + 6I_1 - 9I_2 = 0$$

$$\boxed{-6I_1 + 9I_2 = 3} \quad \cdots (2)$$

$$\boxed{\begin{aligned} I_1 &= 1.272\,A \\ I_2 &= 1.181\,A \end{aligned}}$$

OR

(1) $\times$ 3/2 : $\frac{45}{2} I_1 - 9I_2 = 18$

(2) $-6I_1 + 9I_2 = 3$

$$\frac{33}{2} I_1 = 21$$

$$\boxed{I_1 = \frac{14}{11}\,A}$$

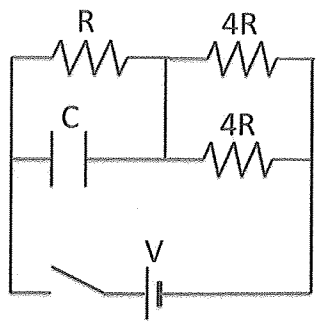
PLUG INTO (2)

$$-\frac{84}{11} + 9I_2 = 3$$

$$9I_2 = \frac{84+33}{11} = \frac{117}{11}$$

$$\boxed{I_2 = \frac{13}{11}\,A}$$

Problem 2 At t = 0 sec, the switch is closed. The capacitor is fully discharged prior to closing the switch.



(a) Calculate current sourced by the battery at t=0 sec. [10 points]

$R_{TOTAL} = 2R$

$$I = \frac{V}{2R}$$

(b) Calculate the charge on the capacitor at t = infinity. [10 points]

AT ∞

$R_{TOTAL} = 3R$

$$I_{TOTAL} = \frac{V}{3R}$$

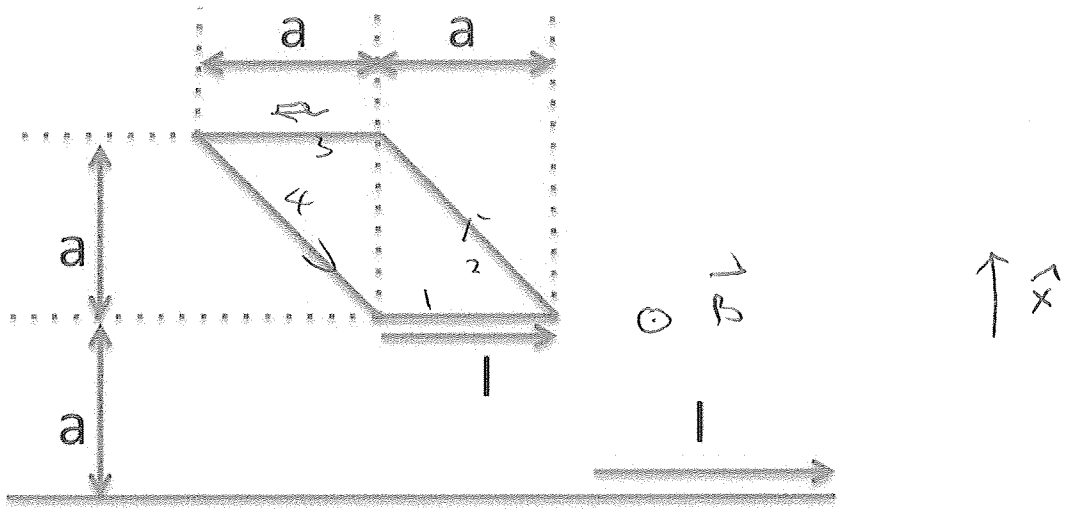
VOLTAGE OVER RESISTOR R IS $\frac{V}{3}$

$Q = C(\Delta V)$

$$Q = C\frac{V}{3}$$

SIGN DIC.

Problem 3 There is two wires: an infinitely long wire carrying current I and a parallelogram carrying current I as shown in the figure. Calculate the force (direction and magnitude) exerted on the parallelogram. [20 points]



SEGMENTS 2 AND 4 CANCEL

$$\vec{F}_1 = I\ell B \quad (-\hat{x})$$

$$= Ia\frac{\mu_0 I}{2\pi a} = \frac{\mu_0 I^2}{2\pi}(-\hat{x})$$

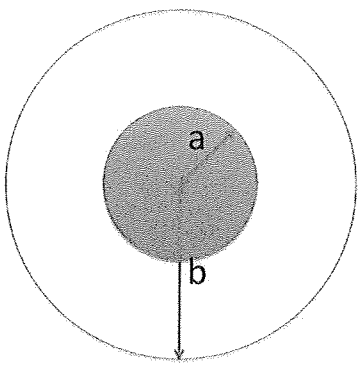
$$\vec{F}_3 = I\ell B = Ia\frac{\mu_0 I}{4\pi a} = \frac{\mu_0 I^2}{4\pi}\hat{x}$$

$\frac{\mu_0 I^2}{4\pi}$

POINTING TOWARDS THE OTHER WIRE

SIGN WRONG (-4)

Problem 4: There is an infinitely long coaxial cable as shown below. The inside conductor has radius a and has current I ***coming out of the paper***. The current is uniformly distributed in the inside conductor. The outside conductor is infinitely thin and has current I ***coming out of the paper***. [note that both inside and outside conductors are carrying current in the same direction.



(a) Calculate the magnitude of magnetic field when r>b [6 points]

$$\frac{\mu_0 2I}{2\pi r} = \boxed{\frac{\mu_0 I}{\pi r}}$$

(b) Calculate the magnitude of magnetic field when b>r>a [6 points]

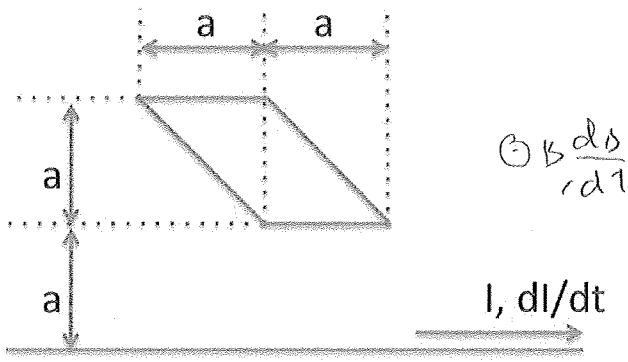
$$\boxed{\frac{\mu_0 I}{2\pi r}}$$

(c) Calculate the magnitude of magnetic field when r<a [8 points]

$$\frac{I}{\pi a^2}\pi r^2 = I_{THRU} = \frac{I r^2}{a^2}$$

$$B = \frac{\mu_0 I r^2}{2\pi a^2 r} = \boxed{\frac{\mu_0 I r}{2\pi a^2}}$$

Problem 5 There are an infinitely long wire carrying a *changing* current I. (dI/dt: the rate of change, i.e. the current going to right is increasing). (a) Find the direction of the induced current in the parallelogram loop [5 points]



$\ominus B \frac{dB}{dt}$

CLOCKWISE

(b) Calculate the magnitude of the induced electromotive force in the parallelogram. [15 points]

$$\Phi_B = \int_a^{2a} a \frac{\mu_0 I}{2\pi r} dr = \frac{\mu_0 I a}{2\pi} \ln 2$$

$$\frac{d\Phi_B}{dt} = \frac{\mu_0 a}{2\pi} \ln 2 \frac{dI}{dt}$$

$$|\mathcal{E}| = \frac{\mu_0 a}{2\pi} \ln 2 \frac{dI}{dt}$$

- ; MINUS OK