ECE110 - Quiz #3

Only non-programmable calculators are allowed.
Duration: 30 Minutes

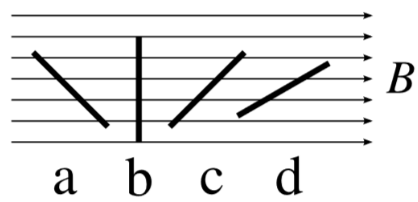
First Name: ______________________ *Last Name:* _______________________________

*Student #:*________________________ *Tutorial Room:* ___________________________

Q1 [3 Marks] Circle the correct answer.

i. The Figure shows a magnetic field (B) and 4 loops of equal areas. Which loop has the smallest magnetic flux?

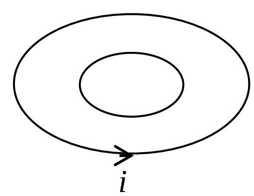
a) a
b) b
c) c
d) d



Answer is d.

ii. In the Figure shown, if the current (***i***) in the outer loop is counter-clockwise and decreasing, then the current in the inner loop is clockwise.

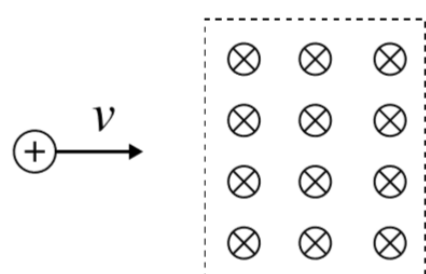
a) True
b) False



Answer is b (False).

iii. In the Figure shown, as the positive charge enters the region where the magnetic field exists then the charge will be:

a) deflected downwards.
b) travel straight without any deflection.
c) deflected upwards.
d) deflected out of the page.



Answer is c.

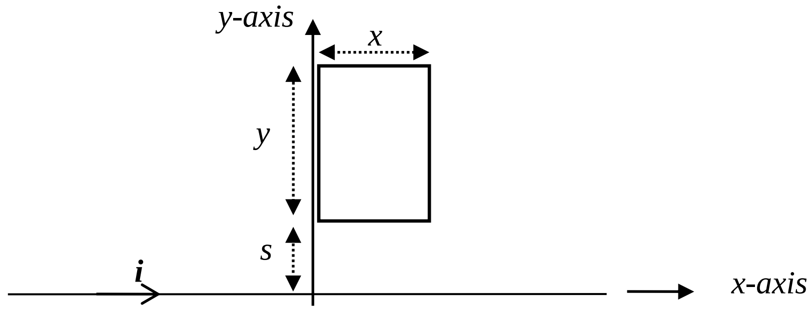
Q2 [7 Marks] Consider a very long straight wire carrying current ***i*** in the direction of x-axis as shown in the Figure below. At time ***t=0*** the current in this wire is increased from ***i=1A*** to ***i=21A*** in ***20 µsec***.

A rectangular loop of wire of width ***x=1m*** and length ***y=2m*** is located at distance ***s=1m*** from the current carrying wire.

a) Derive a relation for the magnetic flux in terms of ***i***, ***x***, ***y***, and ***s***.

b) Determine the magnitude of the induced ***emf*** in the loop of wire while current changing.

c) Indicate the direction of induced current in the loop of wire. Justify.



Solution:

Part a)

$\Phi_B = \oint \vec{B}\cdot d\vec{A} = \iint B\,dA$ since B due to i

By R.H.R is out of the page and $d\vec{A}$ is out of the page

$\Rightarrow \vec{B}\cdot d\vec{A} = B\,dA\cos\theta = B\,dA$

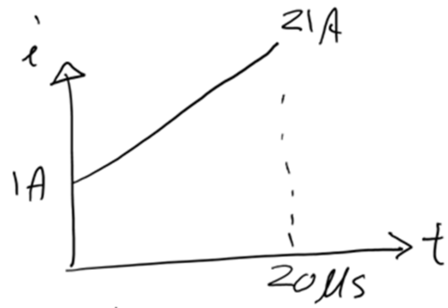
For long straight wire $B = \dfrac{\mu_0 i}{2\pi R}$

$$\Phi_B = \int_s^{y+s}\int_0^x \frac{\mu_0 i}{2\pi y'}\,dy'\,dx' = \frac{\mu_0 i}{2\pi}\int_s^{y+s}\frac{dy'}{y'}\int_0^x dx'$$

$$\Phi_B = \frac{\mu_0 i}{2\pi}\ln y'\Big|_s^{y+s}(x) = \frac{\mu_0 i x}{2\pi}\left(\ln(y+s) - \ln s\right)$$

$$\boxed{\Phi_B = \frac{\mu_0 i}{2\pi}\,x\ln\frac{y+s}{s}}$$

Part b)



$$i = \frac{21-1}{20\times10^{-6}}t + 1$$

$$i = 10^6 t + 1 \quad (A) \text{ where } t \text{ in seconds}$$

$$\Phi_B = \frac{\cancel{4}^{2}\cancel{\pi}\times10^{-7}}{\cancel{2\pi}}(10^6 t+1)(1)\left(\ln\left(\frac{3}{1}\right)\right) = 2.197\times10^{-7}(10^6 t+1) \quad (Wb)$$

$$\mathcal{E} = -N\frac{d\Phi_B}{dt} \Rightarrow \mathcal{E} = \frac{d}{dt}\left((2.197\times10^{-7})(10^6 t+1)\right)$$

$$\mathcal{E} = (2.197\times10^{-7})(10^6) = 0.2197 \quad (V)$$

$$\mathcal{E} \simeq 220 \quad (mV)$$

Part c)

By R.H.R B due to current i is out of the page and increasing

B_{ind} is into the page

$\Rightarrow$ By R.H.R and B_{ind} can determine $\boxed{i_{ind} \text{ is C.W}}$