November 25, 2008
Physics 272 Exam 3:

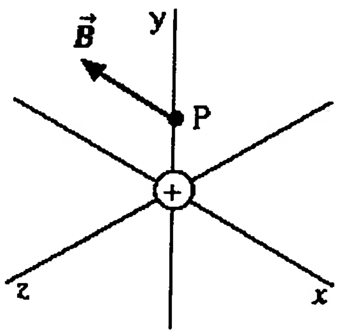
Name: Solution

The value of the electric constant $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$.
The value of the magnetic constant $\mu_0 = 4\pi \times 10^{-7}$ T m/A^2

Solve the five questions in the exam.

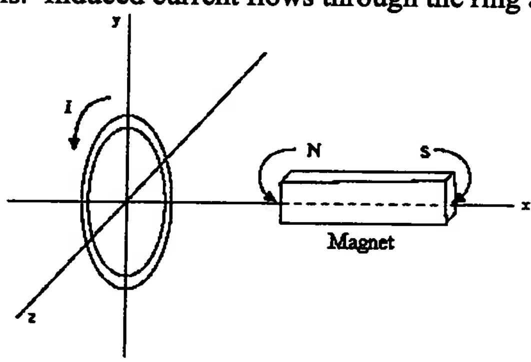
1.-

i. At the instant the ~~negatively~~ charged body is at the origin, the magnetic field at point P due to its motion is in the negative x direction. The charged body must be moving



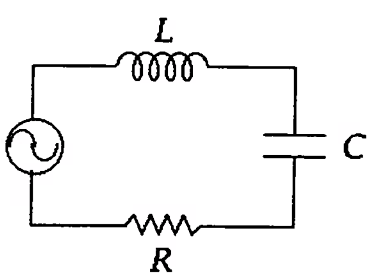
A) in the negative z direction.
B) in the positiv y direction.
C) in the positive x direction.
D) in the negative y direction.
E) in the positive z direction.

ii. A copper ring lies in the yz plane as shown. The magnet's long axis lies along the x axis. Induced current flows through the ring as indicated. The magnet



a) must be moving away from the ring.
b) must be moving toward the ring.
c) is not necessarily moving.
d) Must remain stationary to keep the current flowing.

iii. If you double the frequency in the circuit shown, the impedance of the capacitor (reactance of the capacitor)



A) increases by a factor of 2
B) does not change
C) decreases by a factor of 2
D) increases by a factor of 4
E) decreases by a factor of 4

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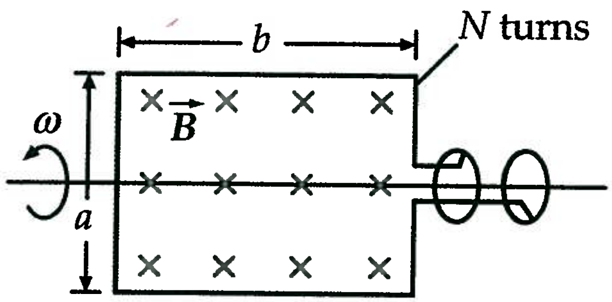
3.- The figure shows an ac generator. The generator consists of a rectangular loop of dimensions a and b with N turns connected to slip rings. The loop rotates with angular velocity ω in a uniform magnetic field B.

Find the potential difference between the two slip rings.



$$V = -\frac{d\Phi}{dt}$$

$$\Phi = ABN$$

$$A = ab \sin \omega t$$

$$\frac{d\Phi}{dt} = abN\omega \cos \omega t$$

$$V = -abBN\omega \cos \omega t$$

another possibility is

$$\Phi = abBN \cos \omega t$$

$$\frac{d\Phi}{dt} = -abBN\omega \sin \omega t$$

$$V = abBN\omega \sin \omega t$$

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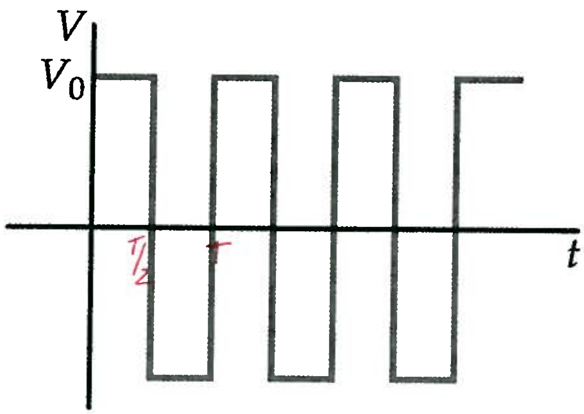
4.- The figure shows the voltage V versus time t for a "square-wave" with amplitude voltage V_0



a) What is the rms voltage of this waveform?

b) If this alternating waveform is rectified by eliminating the negative voltages so that only the positive voltages remain, what now is the rms voltage of the rectified waveform?

$V = V_0 \quad 0 < t < T/2$

$V = -V_0 \quad T/2 < t < T$

$$V_{rms} = \left[\frac{1}{T} \int_0^T V^2 dt \right]^{1/2}$$

a) V_0

b) $$\left[\frac{1}{T} \int_0^{T/2} V_0^2 dt \right]^{1/2} \qquad \frac{V_0^2}{T} \frac{T}{2} \Rightarrow \frac{V_0}{\sqrt{2}}$$

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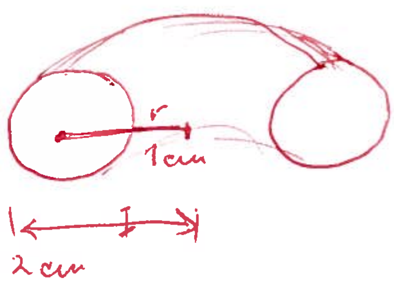
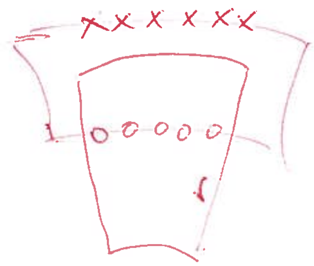
2) A tightly wound 1000-turn toroid has an inner radius of 1.00 cm and an outer radius of 2.00 cm, and carries a current of 1.5 A. the toroid is centered at the origin with the centers of the individual turns in the z=0 plane. In the z=0 plane:

a) Use Ampere's law to calculate the magnetic field at a distance r from the origin when r is inside the toroid and when r is outside the toroid (larger than the outer radius).

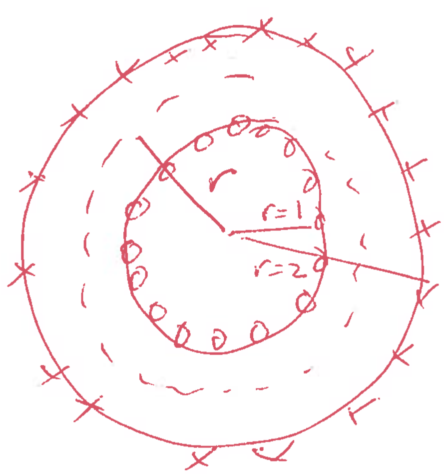
b) What is the magnetic field strength at a distance of 1.10 cm from the origin?





$$\oint_C B \cdot dl = \mu_0 I$$

View from above



$1 < r < 2$

$$2\pi r B = \mu_0 I \times 1000$$

a) $B = \dfrac{3 \times 10^{-4}}{r}$

$B = 0$ r outside.

b) $B = \dfrac{1000 \mu_0 I}{2\pi \times .011} = \dfrac{10^3 \times 4\pi \times 10^{-7} \times 1.5}{2\pi \times .011}$

$= 2.7 \times 10^{-2}$ T

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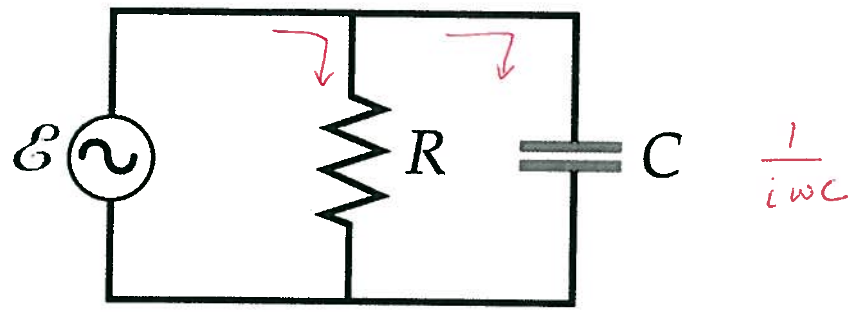
5.-



A resistor and a capacitor are connected in parallel across a sinusoidal emf $E=E_{max}\cos\omega t$ as shown in the figure.

a) Find the current in the resistor

b) Find the current in the capacitor.

1 a) $I = \frac{\mathcal{E}_{max}\cos\omega t}{R}$

3 b) $I = \frac{\mathcal{E}_{max}\cos\omega t}{\frac{1}{i\omega C}} = \frac{\mathcal{E}_{max}\cos(\omega t + 90^\circ)}{\frac{1}{\omega C}}$ ✓

$= -\mathcal{E}\omega C \sin\omega t$

for the capacitor:

$\frac{dV}{dt} = \frac{I}{C}$

$-\omega(\sin\omega t)\mathcal{E}_{max}C = I$

or

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

$\frac{dV}{dt} = \frac{dQ}{dt}\frac{1}{C}$

$\frac{dV}{dt} = \frac{I}{C}$

$-\omega\mathcal{E}_{max}\sin\omega t = \frac{I}{C}$

ϕ	$\cos(\phi + 90^\circ)$	$\sin\phi$
0	0	0
-90°	1	-1
90°	-1	1