مراجعة ليلة الامتحان.. وبنك أسئلة شامل لأهم الأسئلة المتوقعة فى سؤال الاثباتات

تلخيص مثالى .. لن يخلو منه الامتحان

إعداد

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الليلة الثانية

(1) Show how to prove that the equivalent 3 resistors connected in series is given by

[$R_T = R_1 + R_2 + R_3$]

Proof

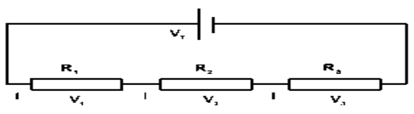
To obtain a large resistance from a small ones.

<u>To calculate the total resistance:</u>

$V = V_1 + V_2 + V_3$

$I R_T = I R_1 + I R_2 + I R_3$

(I is const.)



<u>From which</u>

$\boxed{R_T = R_1 + R_2 + R_3}$

(2) Show that the reciprocal of the equivalent 3 resistors connected in parallel is equal to the sum of the reciprocals

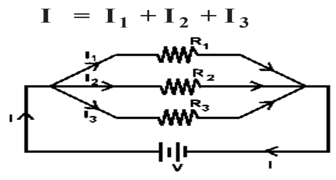
Proof

<u>Resistors in parallel:</u>

The aim of this type is to obtain a small resistance from a group of large one.

<u>To calculate the total resistance:</u>

$I = I_1 + I_2 + I_3$



$\frac{V}{R_T} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$

(V is const.)

<u>From which:</u>

$\boxed{\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$

(3) Prove that the force (F) acting on a current (I) carrying wire of length (ℓ) placed perp. To a magnetic field of flux density (B) is determined by the relation:

$F = B I \ell$

Proof

The force acting on a current carrying wire placed perp. To a magnetic field depends on:

1- The length of the wire (L):

The magnetic force is directly prop. to the length of the wire.

$F \propto L$

2- The magnetic flux density (B):

The magnetic force is directly prop. to the magnetic flux density.

$F \propto B$

3- The elec. current intensity (I):

The magnetic force is directly prop. to the current flowing through the wire.

$F \propto I$

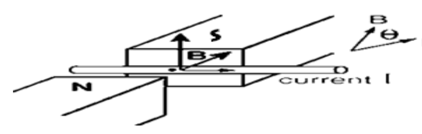
So we can conclude that:

$F \propto B I L$

$F = \text{const. } B I L$

When (B) is in web./m^2 (tesla), (I) is in ampere and (L) is it metre, the force will be in Newton, and the const. will be equal to unity, thus:

$F = B I L$



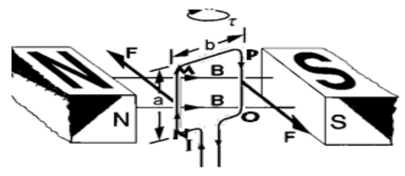
**When a current carrying wire makes an angle (θ) with the direction of the magnetic field.

<u>The force is given by:</u>

$F = B I L \sin\theta$

(4) Prove that the torque (τ) acting on on a rectangular current (I)–carrying loop of face area (A), number of turns (N) and placed parallel to a magnetic flux (B) is [$\tau = B I A N$]

Proof



The two sides (mn) and (op) of the loop are each of length (a) and perp. to the magnetic flux of density (B) Thus two equal and opposite forces are produced on the sides where:

$F = B I L$

$F = B I a$

Due to these two forces a resultant torque is produced which tends to rotate the coil and is given by:

$\tau = F \times b$

$\because F = B I a$

$\tau = B I a b$

$\because ab = A$

$\tau = B I A$

Assuming the loop of (N) turns

$\tau = B I A N$

$\tau = B I A N = B\,|\overrightarrow{m_d}|$

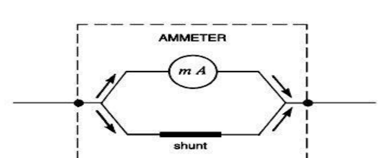
$|\overrightarrow{m_d}| = IAN$ is the magnetic dipole moment (Its unit A.m^2)

(5) Explain how the sensitive galvanometer is connected to be used as ammeter deduce the required relation.

Proof

The coil a galvanometer is connected in parallel with a very low resistance called a shunt resistance.

To calculate the value of shunt resistance (Rs):



$\because R_g$ and R_s are connected in parallel

$V_g = V_s$

$I_g R_g = I_s R_s$

$R_s = \frac{I_g R_g}{I_s}$

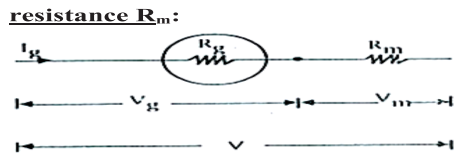
$\because I_s = I - I_g \qquad R_s = \frac{I_g R_g}{I - I_g}$

(6) Explain how the sensitive galvanometer is connected to be used as a voltmeter deduce the required relation.

Proof

A large multiplier resistance is connected in series with the coil of galv. to convert it to voltmeter.

<u>To calculate the value of multiplier resistance R_m:</u>



$V = V_g + V_m$

$V = I_g R_g + I_g R_m$

$V = I_g R_g = I_g R_m$

$R_m = \frac{V - I_g R_g}{I_g}$

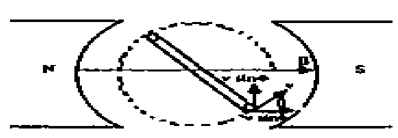
$\because V = I_g R_g$

$R_m = \frac{V - V_g}{I_g}$

(7) Deduce the relation by which one can evaluate the instantaneous emf induced in an AC generator

Proof

The calculation of the induced E.M.F. produced in the Dynamo. (The operation of the dynamo)



The E.M.F. generated in each segment of the loop must obey this relation.

e.m.f. $= -B L v \sin\theta$

$\because v = \omega r$

Where (ω) is the angular velocity

$\therefore$ e.m.f. $= -B L \omega r \sin\theta$

<u>The total E.M.F. of the two segments is given by this relation:</u>

e.m.f. $= -2 B L \omega r \sin\theta$

$\because A = 2 L r$

$\therefore$ e.m.f. $= -B A \omega \sin\theta$

<u>If the number of turns is (N)</u>

$\therefore$ e.m.f.$_{inst} = -N B A \omega \sin\theta$ (1)

where (emf) is the instantaneous E.M.F. which has max. value when $\theta = 90°$

(coil // flux lines) $\sin\theta = 1$

sub. In eq. (1)

e.m.f.$_{max} = -N B A \omega$

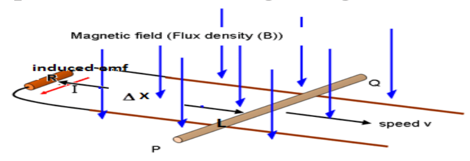
sub. In (1)

$\therefore$ e.m.f.$_{inst}$ = e.m.f.$_{max} \sin\theta$

(8) Deduce the relation by which one can evaluate the induced E.M.F. produced in a moving straight wire

Proof

<u>To calculate the induced E.M.F. produced in a moving straight wire:</u>



If a wire of length (L) moves with a const. velocity (v) perp. to a magnetic field is displaced to the right by a distance (Δx) at a time (Δt) since.

$\because$ e.m.f. $= -\frac{\Delta\Phi}{\Delta t}$

and $\Delta\Phi = B \Delta A$

$\therefore$ e.m.f. $= -\frac{B\Delta A}{\Delta t}$

since $\Delta A = L \Delta x$

$\therefore$ e.m.f. $= -\frac{BL\Delta x}{\Delta t}$

$\because \frac{\Delta x}{\Delta t} = v$

$\therefore$ e.m.f. $= -B L v$

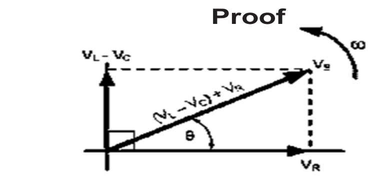
When the angle between the direction of velocity (v) and the direction of magnetic flux lines (B) is (θ)

e.m.f. $= -B L v \sin\theta$

(9) **Prove that** the total impedance of an A-C circuit possessing an inductive coil, a capacitor and a resistor connected in series is given by the relation

$Z = \sqrt{R^2 + (X_L - X_C)^2}$.

Proof



The resultant of voltage vectors is given by: $V = \sqrt{V_R^2 + (V_L - V_C)^2}$

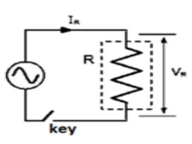
Dividing by I: $Z = \sqrt{R^2 + (X_L - X_C)^2}$

(10) In mathematical way, prove that, A.C. voltage and the A.C. current in a non-inductive resistor have the same phase angle on passing A.C. in a non-inductive ohmic resistor.

Proof

When close the circuit, the potential difference at both ends of the resistance

$V = V_{max} \sin \omega t$ (1)



Instantaneous current intensity is determined from the relationship:-

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

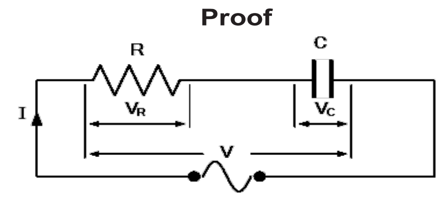
$I = \frac{V_{max}}{R} \sin \omega t$

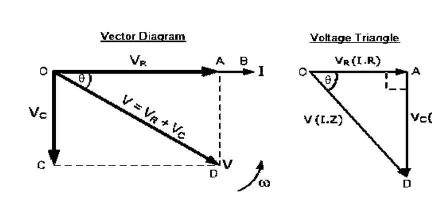
$I = I_{max} \sin \omega t$ ......(2)

Comparing equations (1), (2) find that both (I, V) in, non -induction resistance have the same phase.

(11) **Prove** the law total impedance of an A-C circuit possessing ohmic resistance and capacitors in series

Proof





The total voltage V can be determined by the relation:

$V = \sqrt{V_R^2 + V_C^2}$

$\tan\theta = \frac{-V_c}{V_R} = \frac{-X_c}{X_R}$

$\because V_R = IR$ and $V_C = I X_C$

$\therefore Z = \sqrt{R^2 + X_C^2}$

(12) Deduce the relation by which one can calculate the force by which the photon acts

Proof

When a beam of photons is incident on a certain surface and then reflect

- The change in its linear momentum $\Delta P \qquad P_L = 2\,mc$

- The force which each photon applies to the surface = the change in linear momentum per second. $F_{(\text{each photon})} = \frac{\Delta P_L}{\Delta t} = \frac{2mc}{\Delta t}$

- The force which a beam of photons applies to the surface $F = \frac{2mc\,N}{\Delta t}$

ϕ_L is the rate by which the photons incident on a the surface ($\phi_L = N/\Delta t$ photons/s).

$F = 2\,mc\,\phi_L$

$\boxed{F = 2\,mc\,\phi_L = 2\left(\frac{h\upsilon}{c}\right)\phi_L = \frac{2P_w}{c}}$

(13) Deduce the relation between photon wavelength and its linear momentum.

Proof

$\lambda = c / v \rightarrow (x\frac{h}{h})$

$\lambda = \frac{hc}{hv} = \frac{h}{hv/c}$

Linear momentum $P_L = mc = \frac{hv}{c}$

$p_L = \frac{hv}{c} \qquad \therefore \lambda = \frac{h}{P_L}$

(13) In a mathematical way to discuss the basic idea of the transistor action as an amplifier

Proof

$I_e = I_c + I_B$

$\alpha_e = I_c/I_e$ (it is the ratio between the collector current and the emitter current)

$I_c = \alpha_e I_e$

If the base current is a small electrical signal, its effect appears amplified in the collector current. The base current supply holes to the base to make up for the losses due to the recombination process.

$\beta_e = \frac{I_c}{I_B} = \frac{\alpha_e I_E}{(1-\alpha_e) I_E} = \frac{\alpha_e}{1-\alpha_e}$

(14) If a current passes through a coil, deduce an equation relating the induced emf in the coil and the rate of change of the current in the coil. From this, deduce a definition for the coefficient of self-induction and the Henry.

Proof

<u>The self-inductance:</u>

$\because$ e.m.f. $\propto \frac{\Delta\Phi}{\Delta t}$,

$\frac{\Delta\Phi}{\Delta t} \propto \frac{\Delta I}{\Delta t}$

$\therefore$ e.m.f. $\propto \frac{\Delta I}{\Delta t}$

$\therefore$ e.m.f. $= -L \frac{\Delta I}{\Delta t}$

Where (L) is a constant known as the self-inductance of the coil and the –ve sign due to Lenz's rule.

*The self-inductance of a coil (L):

It is equal to the induced E.M.F. produced in a coil by self-induction when the current in the coil changes at a rate of 1A/sec.

*******The unit of self-inductance (L) Henry (volt.sec./A)***

<u>The Henry:</u>

It is the self-inductance of a coil which produces an induced E.M.F. of 1volt in the coil when the current changed by 1A/sec.

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