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Total No. of Questions : 09

Total No. of Pages : 02

B.Tech. (Agriculture Engineering/Artificial Intelligence & Machine Learning/Artificial Intelligence (AI) and Data Science/Artificial Intelligence/Automation & Robotics/Automobile Engineering/Bio Technology/Civil Engineering/Computer Science & Engineering/Computer Science & Engineering (Artificial Intelligence & Machine Learning)/ Computer Science & Engineering (Cyber Security)/ Computer Science & Engineering (Data Science)/ Computer Science & Engineering (IOT)/ Data Science/Electrical & Electronics Engineering/Electrical Engineering/Electronics & Communication Engineering/Electronics & Electrical Engineering/Food Technology/Information Technology/Mechanical Engineering/CSE (Internet of Things and Cyber Security including Block Chain Technology)/B.Tech Computer Engg./CSE/ECE (PIT))

(Sem-1,2)

BASIC ELECTRICAL ENGINEERING

Subject Code : BTEE-101-18

M.Code : 75339

Date of Examination : 15-07-22

Time : 3 Hrs.

Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

1. SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.
2. SECTION - B & C. have FOUR questions each.
3. Attempt any FIVE questions from SECTION B & C carrying EIGHT marks each.
4. Select atleast TWO questions from SECTION - B & C

SECTION-A

Answer the following questions in brief :

1. a) Define apparent power and reactive power of an AC circuit.

   b) What is the effect of frequency on capacitive reactance?

   c) A resistance of 15Ω is connected in series with an inductance of 0.02H. This combination is connected across 200V, 50hz supply. Calculate (i) current flowing in the circuit, (ii) power factor.

   d) Differentiate between star and delta connections.

   e) What is series resonance?

f) What material are used in these parts of a DC motor (i) commutator segments (ii) brushes?

g) Define the voltage regulation for a transformer.

h) What is admittance? Give its units.

i) "*For electric traction DC series motors are best suited*". Why?

j) List the properties of an ideal fuse wire.

SECTION-B

2. Derive the relationship between voltage and current for a purely inductive circuit. Also show that the average power consumed by the circuit is zero.

3. An alternating voltage is given as v = 220sin 314t, determine its (i) maximum value (ii) effective value (iii) form factor (iv) value of voltage after 0.002 sec taking reckoning time from the instant when voltage is zero and becoming positive; (v) time after which voltage attains 110 V for the first time.

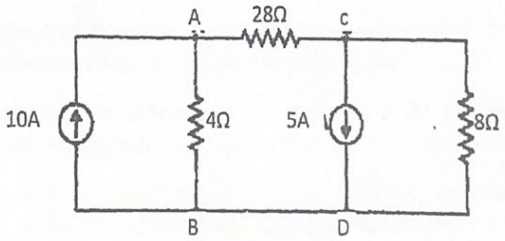
4. Discuss the principle of operation of a DC motor. Also, derive the emf equation.

5. Using a diagram explain the construction of an underground cable. Also write regarding is the function of each part.

SECTION-C

6. Distinguish between a three-phase squirrel cage induction motor and phase wound induction wound.

7. Find the current in 28Ω resister using source conversion method.



8. For the "one time use" type of fuse what do the following convey?

   a) Fuse Current Carrying Capacity
   b) Breaking capacity
   c) I^2t value of fuse
   d) Rated voltage of fuse.

9. Discuss the construction of an auto-transformer and derive the expression for the copper savings in it.

NOTE : Disclosure of identity by writing mobile number or making passing request on any page of Answer sheet will lead to UMC against the Student.

Section -A

Quest 0>

Ans. **Apparent Power:-**

The product of root mean square (RMS) value of voltage and current is known as Apparent Power.

Reactive Power:-

The power which flows back and forth that means it moves in both the direction in the circuit or reacts upon it is called reactive power, it is measured in Killo volt Amper reactive.

b>

Ans Capacitive reactance is inversly proportional to the frequency of the AC signal passing through the capacitor. As the frequency of the AC signal increases, the capacitive reactance decreases and as the frequency of the AC signal decreases the capacitive reactance increases.

d>

Ans. Difference between star and delta connection.

Star connection (Y connection):

i> In a star connection, the three phases are connected to a common point, forming a star shape.

ii> The other ends of the phases are connected to the load.

iii> The neutral point may or may not be connected, depending on the system requirements.

iv> The star connection provides a neutral point, which can be useful for balancing loads and providing a return path for unbalanced currents.

v> It is commonly used in low voltage distribution system.

Delta connection (Δ connection):

i> In a delta connection, the three phases are connected in a triangular shape, forming a closed loop.

ii> The load is connected across the three points of the triangle.

iii> Unlike the star connection, the delta connection does not have a neutral point.

iv> It is commonly used in high voltage transmission and distribution systems.

c> Series Resonance:-

Series resonance refers to a specific condition that occurs in an electrical circuit when the inductance (L) and capacitance (C) are connected in series

With an AC Power source.

f>

Ans i> The material commonly used for the commutator segments of a DC motor is copper. Copper is chosen for its excellent electrical conductivity and durability.

ii> The brushes of a DC motor are often made from a combination of carbon and other materials. Carbon brushes are commonly used due to their good electrical conductivity, low friction and ability to withstand high temperatures.

g>

Ans. Voltage regulation is the measure of how well a power transformer can maintain constant secondary voltage given a constant primary voltage and wide variance in load current.

h>

Ans. Admittance is a measure of how easily a circuit or device will allow a current to flow. It is defined as the reciprocal of impedance, analogous to how conductance and resistance are defined.

The SI unit of admittance is the Siemens. (Symbol S).

I>

Ans. DC series motor has develops high torque at low speeds, low torque at high speed, this is the basic requirement of traction unit.

j>

Ans An Ideal fuse wire possesses the following properties:-

i> Low resistance
ii> High melting point
iii> Fast acting
iv> Non-combustible
v> Durable.

c) $R = 15\ \Omega$, $L = 0.002\ H$
$V = 200\ v$, $f = 50\ Hz$

$$X_L = 2\pi fL$$
$$= 2 \times 3.14 \times 50 \times 0.02$$
$$= 6.28$$

$$Z = \sqrt{15^2 + 6.28^2}$$

$$Z = 16.26$$

i) $V = IZ$

$$I = \frac{200}{16.26} = 12.30 \text{ Ampere}$$

ii) $\cos\phi = \frac{R}{Z} = \frac{15}{16.26} = 0.92$ Ans

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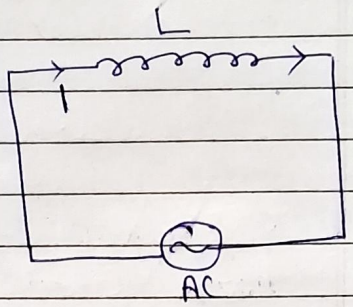
Section-B

Sol. 2.)

The relationship between voltage and current for purely inductive circuit :—



In purely inductive circuit,

Resistance = 0

* The equation of the alternating voltage :—

$$V = V_m \sin \omega t \quad \text{---} \quad (1)$$

we know that,

$$e = -L \frac{di}{dt}$$

Since, the induced emf is equal and opposite to the applied voltage.

$$V = -\left(-L \frac{di}{dt}\right)$$

$$V_m \sin \omega t = L \frac{di}{dt}$$

$$di = \frac{V_m}{L} \sin \omega t \, dt \quad \text{---} \quad (2)$$

Integrating both side of (2) we get,

$$i = \frac{V_m}{\omega L} \sin\left(\omega t - \pi/2\right) = \frac{V_m}{X_L} \sin\left(\omega t - \pi/2\right) \quad \text{---} \quad (3)$$

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* The maximum current will be when $\sin\left(\omega t - \pi/2\right) = 1$, Hence,

$$I_m = \frac{V_m}{X_L}$$

→ The average power consumed by the purely inductive circuit is zero:—

Since, We know that the current lags behind the applied voltage by $\pi/2$ radian i.e by 90°.

$$\therefore P_{av} = \frac{V_0 I_0}{2} \cos\phi$$

$$P_{av} = \frac{V_0 I_0}{2} \cos 90°$$

$$\therefore P_{av} = 0$$

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3.) Given,

$V = 220 \sin 314t$

$V_m = 220$

$\omega = 314$

i) maximum value $(V_m) = 220$ volts

ii) Efective value, $V_{rms} = 220 \times 0.707$

$= 155.54$ volt

iii) Form factor $= \frac{V_{rms}}{V_{avg}} = \frac{155.54}{140.05} = 1.11$

iv) When $t = 0.002$

$V = 220 \sin 314 \times (0.002)$

$= 220 \sin 0.628$

$= 220 \times 0.0109$

$V = 2.398$ volt

v) When, $V = 110$ v

$110 = 220 \sin 314t$

$0.5 = \sin 314t$

$\frac{30}{314} = t$

$t = 0.095$ sec Ans

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4.) A machine that converts DC electrical power into mechanical power is known as a Direct Current motor.

DC motor working is based on the principle that when a current carrying conductor is placed in a magnetic field, the conductor experiences a mechanical force.

The direction of this force is given by Fleming's left hand rule and magnitude is given by;

$F = BIL$ Newtons

According to Flemings left hand rule when an electric current passes through a coil in a magnetic field, the magnetic force produces a torque which turns the DC motors.

The direction of this force is perpendicular to both the wire and the magnetic field.

→ Working Principle of DC Motor :—

DC motors are electrical devices that converts electrical energy through the interaction of magnetic fields. They operate on the principle of Lorentz force, which states that when a current carrying conductor is placed in a magnetic field, it experiences a force perpendicular to both the current direction and the magnetic field direction.

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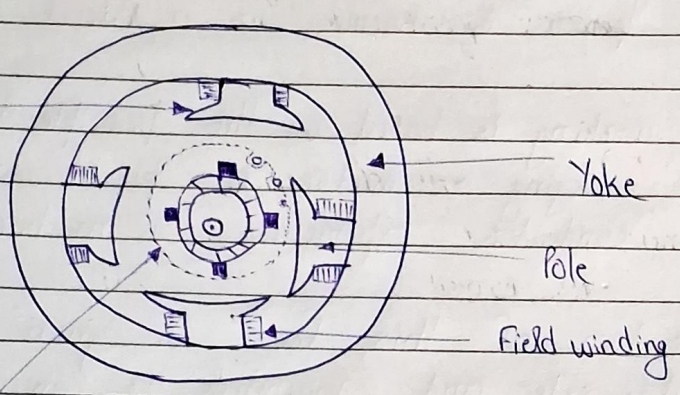
DC motor



Construction of a DC motor

i) Yoke – The yoke acts as the outer cover of a DC motor.

ii) Poles and Pole Shoe – The pole and pole shoe are fixed on the yoke by bolts.

iii) Field Winding – The coils around the poles are known as field coils and are connected in series to from the field winding.

iv) Armature Core – It is a cylindrical drum and keyed to the rotating shaft.

v) Armature Winding :— The armature winding plays very important role in the construction of a DC motor because the conversion of power takes place in armature winding.

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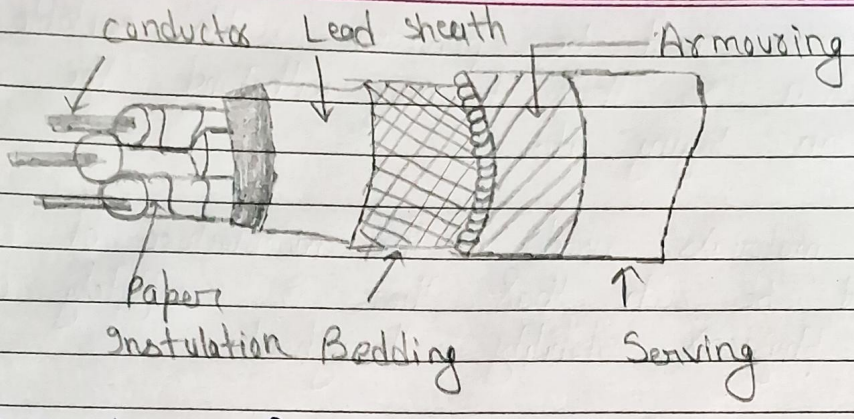
Ans 5.)



- Construction of Underground Cables :—

An underground cable essentially consists of one or more conductors ~~core~~ covered with suitable insulation and surrounded by a protecting cover.

Although several types of underground cables are available, the type of cable to be used will depend upon the working voltage and service requirements.

In general, an underground cable ~~just~~ must fulfill the following necessary requirements:

- The conductor used in cables should be tinned stranded copper or aluminium of high conductivity.
- The conductor size shoud be such that the cables carries the desired load current without overheating and causes voltage drop within permissible limits.
- The cable must have a proper thickness of insulation in order to give a high degree of safty and reliablity at the voltage for which it is designed.

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- The cable must be provided with suitable mechanical protection so that it may withstand the rough use in laying it.
- The materials used in the manufacture of cables should be such that there is completely chemical and physical stability throughout.

Section = C

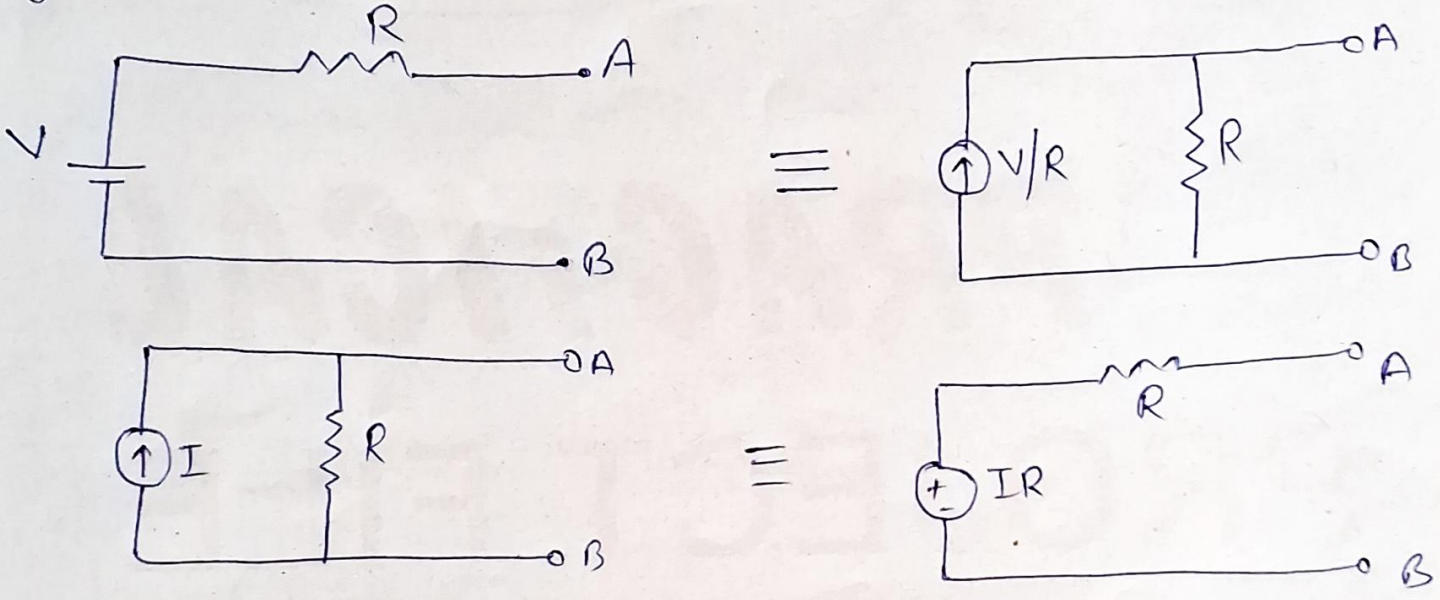
Any 6 :-

Squirrel Cage Induction Motor	Wound rotor induction motor
(i) High Current is used for starting.	(i) Low Current starting is possible.
(ii) Construction is Simple.	(ii) Construction is Complicated.
(iii) Low starting torque.	(iii) High Starting torque
(iv) The rotor would have rotor bars.	(iv) The rotor winding is similar to the stator.
(v) External resistance cannot be added.	(v) Can add external resistance.
(vi) There are no slip rings and brushes.	(vi) Slip rings and brushes are present.
(vii) Poor Speed Control.	(vii) Good speed Control.
(viii) Good efficiency during Operation.	(viii) Poor efficiency during operation.
(ix) Good heat regulation.	(ix) Poor heat regulation.
(x) Less maintenance cost.	(x) High maintenance cost.

Ans 7 ⇒ Source transformation:

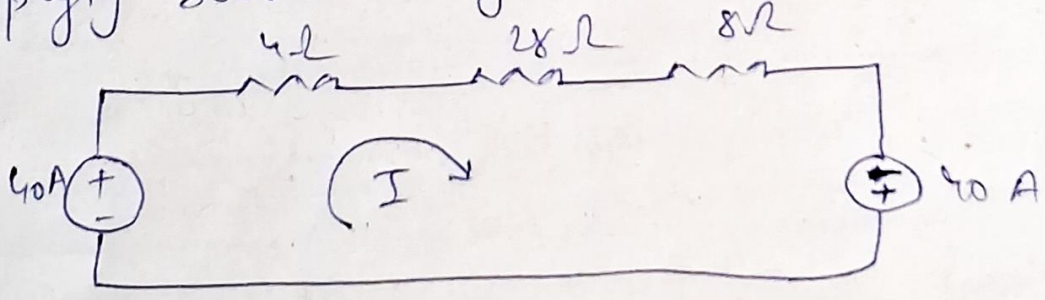
A current source in parallel with resistance can be represented as a voltage source in series with a resistance & vice versa.

The transformation ~~resistance~~ is represented in the diagram given below.



Calculation :-

By applying source transformation,



$$I = \frac{40+40}{4+2+8} = 2\ A$$

Ans 8 ⇒ (i) Fuse current Carrying Capacity

⇒ It is determined by its design materials. Its ~~Crucial~~ Crucial to select fuse with appropriate rating for the Circuit it protects. Exceeding this rating can lead to the fuse not providing proper protection.

(ii) Breaking Capacity

It refers to its ability to safely interrupt the flow of current under specific conditions without causing damage. It is crucial for preventing equipments damage or fire hazards.

(iii) I^2t Value of fuse

In fuse, when current flowing through it increases beyond its rated values, the fuse will heat up and eventually melt, breaking the circuit. So, as current increases, the fuse tends to blow out.

$$I \propto \frac{1}{t}$$

(iv) Rated Voltage

Max^m voltage at which the fuse is designed to operate safely. It represents the highest voltage level net fuse can handle.

Ans 9:- Construction of auto-transformer

⇒ An autotransformer is usually constructed from a single winding with multiple taps. For a step down application, the source is applied across the entire coil, which acts as the primary. The load is connected across a portion of the whole winding as shown in the figure. The portion connected to the load acts as the secondary.

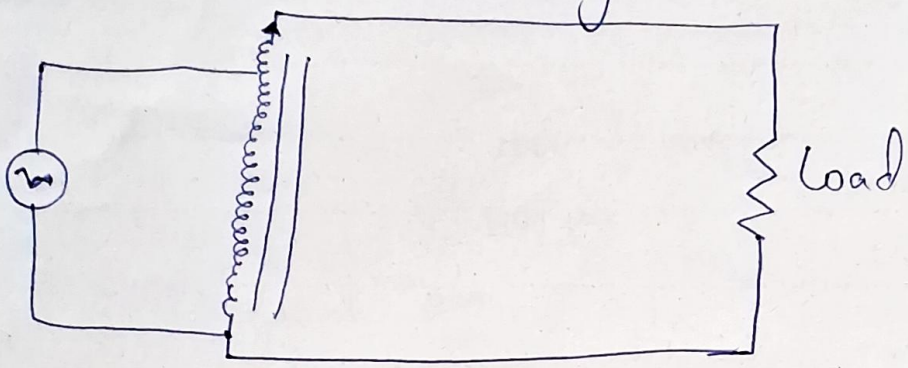


Fig 1: Auto transformer steps the voltage up

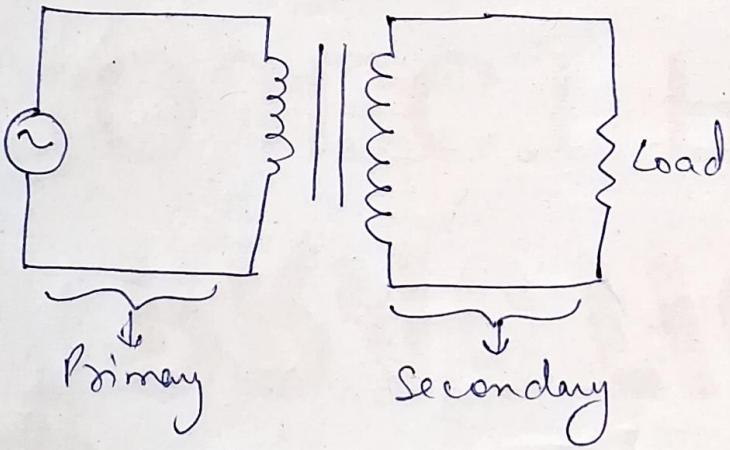
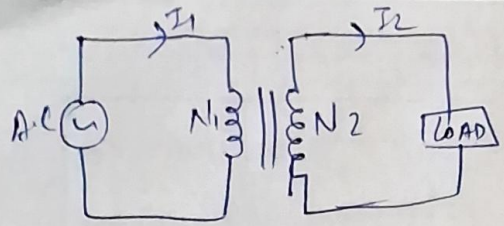


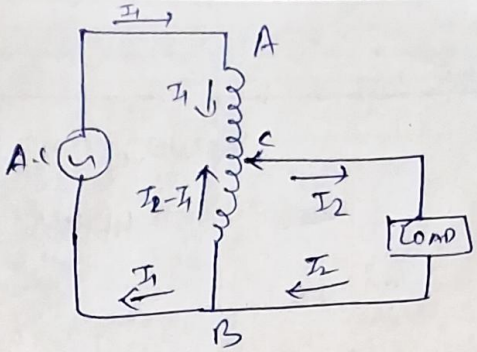
Fig 1: Auto transformer

∴ Copper Saving

Weight of Cu ∝ NI

I = Current in Windig
N = No of turns in Windig





$AB = N_1$
$BC = N_2$
$AC = N_1 - N_2$

$\therefore W_{TW}$ = total wt of Cu in two winding transformer

$\therefore W_{AT}$ = weight of Cu in autotransformer

$\Rightarrow$ In two winding transformer,

wt of Cu of primary $\propto N_1 I_1$

" " " " Secondary $\propto N_2 I_2$

$$W_{TW} \propto N_1 I_1 + N_2 I_2$$

$\therefore$ Also,

wt of Cu at AC $\propto (N_1 - N_2) I_1$

" " " " BC $\propto N_2 (I_2 - I_1)$

$$W_{AT} \propto (N_1 - N_2) I_1 + N_2 (I_2 - I_1)$$

$$\therefore \frac{W_{TW}}{W_{AT}} = \frac{N_1 I_1 + N_2 I_2}{(N_1 - N_2) I_1 + N_2 (I_2 - I_1)}$$

But, $K = \frac{N_2}{N_1} = \frac{I_1}{I_2}$

$$\therefore \frac{W_{TW}}{W_{AT}} = \frac{N_1 I_1 + K N_1 \cdot (I_1/K)}{N_1 I_1 + K N_1 \cdot (I_1/K) - 2(K N_1) I_1} = \frac{2 N_1 I_1}{2 N_1 I_1 - 2 K N_1 I_1} = \frac{1}{1-K}$$

$$\boxed{W_{AT} = (1-K) W_{TW}}$$

$\therefore$ Saving of Cu = ~~W_{TW}~~ $- W_{AT}$

$= W_{TW} - (1-K) W_{TW}$

$\boxed{\text{Saving of Cu} = K W_{TW}}$ Q Proved