CMR INSTITUTE OF TECHNOLOGY	USN											CMRIT

Internal Assesment Test 2 – Aug-2023

Sub:	Introduction to Electrical Engineering							Code:	BESCK204B
Date:	11/08/2023	Duration:	90 mins	Max Marks:	50	Sem:	2	Section:	Chemistry cycle

Note: Answer any **FIVE FULL** Questions

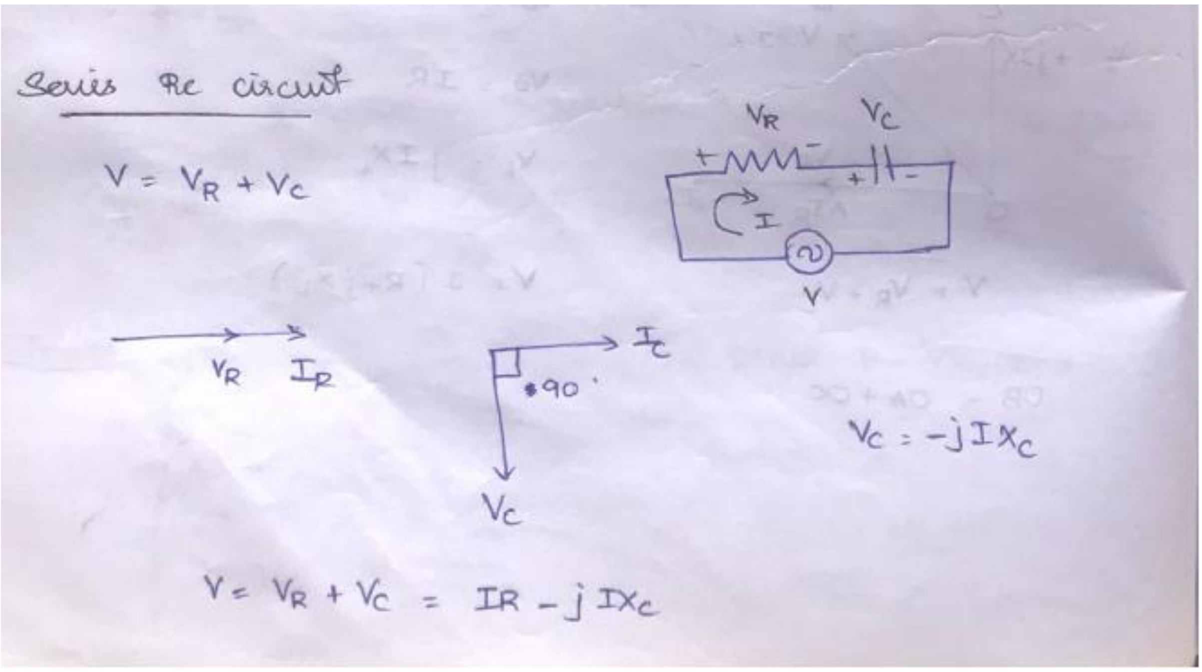
Sketch neat figures wherever necessary. Answer to the point. **Good luck!**

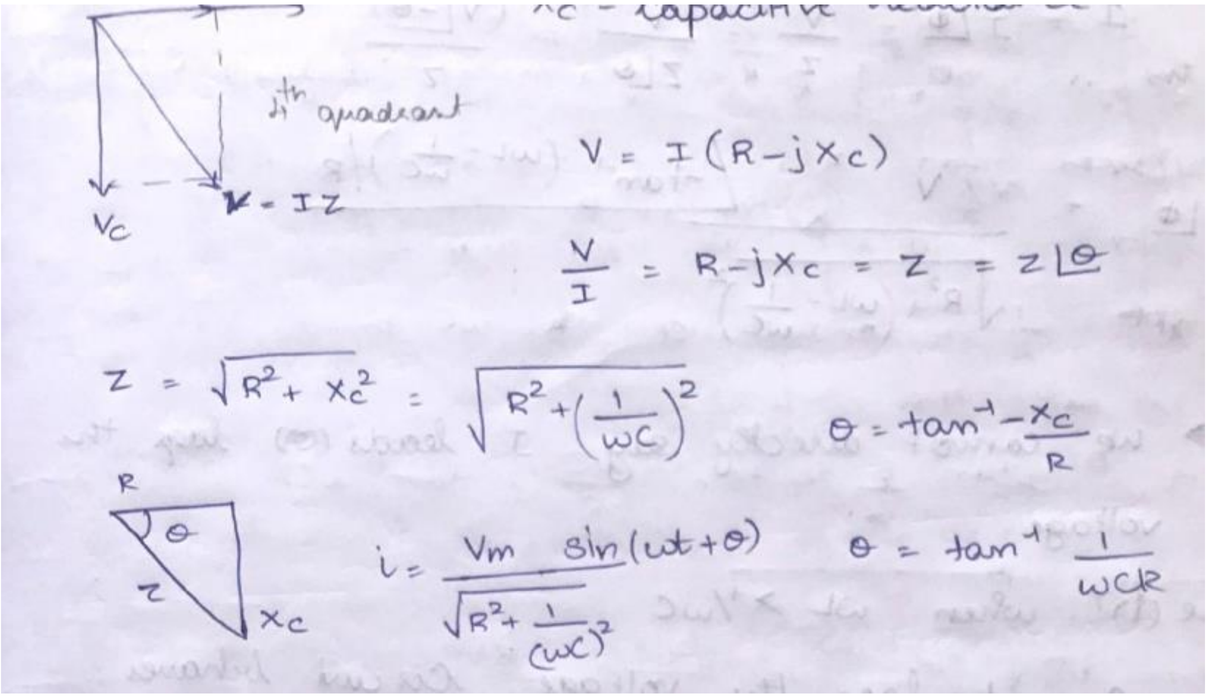
		Marks	OBE CO	OBE RBT
1 a)	Explain in detail about RC series circuit with necessary waveform and phasor diagram.	[5]	CO2	L2
1b)	The equation of an alternating current is given by i=42.2sin628t A. Calculate its i) Maximum value ii) Frequency iii) RMS Value iv) Average value v) Form factor	[5]	CO2	L3
2	Explain the different types of wiring with a neat diagram	[10]	CO5	L2
3	Draw the connection diagram and switch operation table for i) Two way control ii) Three way control of Load	[10]	CO4	L2

4 a)	Each phase of a delta connected load consists of a resistor of 50 Ω in series with a capacitor of 50 μF in series. Calculate (a)line current & phase current (b)total power when the load is connected to a 440 V, 3phase, 50 Hz supply.	[5]	CO2	L3
4 b)	Three coils having resistance of 10Ω and inductance of 0.02H are connected in star across 440V, 50Hz three phase supply. Calculate the line current, power factor and total power consumed.	[5]	CO2	L3
5	Draw the circuit, waveform and phasor diagram of i) Pure resistive circuit and (ii)pure inductive circuit	[10]	CO2	L2
6a)	Obtain the expression for Three phase power in Delta connected System	[5]	CO2	L2
6b)	Discuss the personal safety measures in electric circuit.	[5]	CO5	L2
7	A coil of power factor 0.6 is in series with 100μF capacitor. When connected to 50 Hz supply, the potential difference across the coil is equal to the potential difference across the capacitor. Find the resistance and inductance of the coil.	[10]	CO2	L3

Solution of IAT2

1(a)**RC Series Circuit**





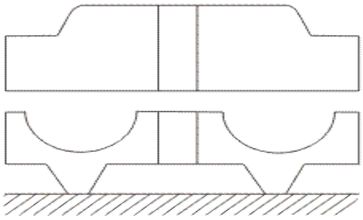
2. Types of Wiring

- Cleat wiring
- Casing wiring
- Surface wiring
- Conduit wiring

Cleat Wiring

- In this type of wiring , wood or plastic cleats are fixed to walls or ceilings at regular intervals i.e.,0.6m between each cleat.
- PVC insulated cables are taken through the holes of each cleat .
- Cleat support and hold wires.
- This is cheap method .
- Is used for temporary installations.
- It is not suitable for home .

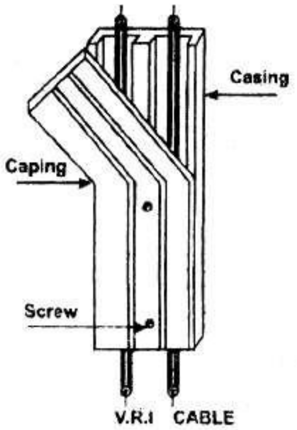
- It is an outdated method .



Cleat with two grooves

Casing and Capping

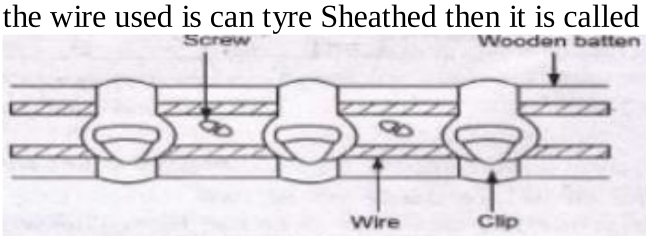
- In this cable runs through a wooden casing having grooves.
- The wood casing is of required fixed length with parallel grooves that accommodates the cables.
- The wooden casing is fixed to the walls or ceiling with screws.
- After placing the cables inside the grooves of casing , a wooden cap with grooves is placed on it to cover the cables.
- There is a high risk of fire in case of short circuits.



Surface Wiring

- In this type, the wooden battens are fixed on the surface of the wall, by means of screws and raw plugs.
- The metal clips are provided with the battens at regular intervals.
- The wire runs on the batten and is clamped on the batten using the metal clips.

The wires used may be lead sheathed wires or can tyre sheathed wires. Depending upon type of wire used surface wiring is also called lead sheathed wiring or can tyre sheathed wiring. If the wire used is tough rubber Sheathed then it is called T.R.S. wiring while if the wire used is can tyre Sheathed then it is called C.T.S wiring.

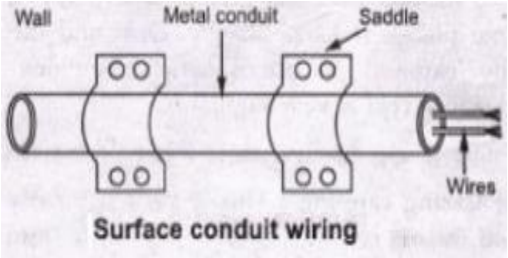


Wooden batten wiring

Conduit Wiring

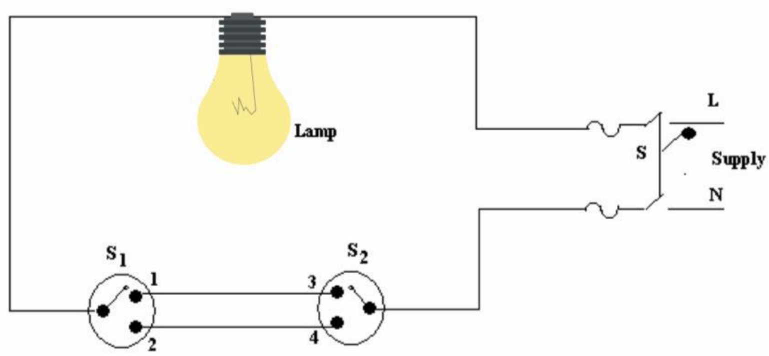
- In this method, metallic tubes called as conduits are used to run the wires. This is the best system of wiring as it gives full mechanical protection to the wires.
- This is most desirable for workshops and public Buildings.
- Depending on whether the conduits are laid inside the walls or supported on the walls, there are two types of conduit wiring which are :
    - **Surface Conduit wiring** - In this method conduits are mounted or supported on the walls with the help of pipe books or saddles. In damp situations, the conduits are spaced apart from the wall by means of wooden blocks.

- **Concealed Conduit wiring -** In this method, the conduit are buried under the wall at the some of plastering. This is also called recessed conduit wiring.



3. **Two Way Control of Lamps**

- Two-way control is usually used for staircase lighting.
- The lamp can be controlled from two different points: one at the top and the other at the bottom -using two-way switches which strap wires interconnect.
- They are also used in bedrooms, big halls and large corridors.



- Switches S1 and S2 are two-way switches with a pair of terminals 1&2, and 3&4respectively.
- When the switch S1 is in position1 and switch S2 is in position 4, the circuit does not form a closed loop and there is no path for the current to flow and hence the lamp will be OFF.
- When S1 is changed to position2 the circuit gets completed and hence the lamp glows or is ON.
- Now if S2 is changed to position3 with S1 at position2 the circuit continuity is brokenand the lamp is off.
- Thus,the lamp glows only when the circuit iscomplete & I tcan be controlled from two different points.

Table

POSITION OF S1	POSITION OF S2	CONDITION OF LAMP
1	3	ON
1	4	OFF
2	3	OFF
2	4	ON

Three Way control of Lamps

In case of very long corridors it may be necessary to control the lamp from 3 different points. In such cases, the circuit contains three switches S1, S2 and an intermediate switch S3. An intermediate switch is a combination of two, two-way switches coupled together. It has 4 terminals ABCD.

It can be connected in two ways:

(a)Straight connection (b) Cross connection

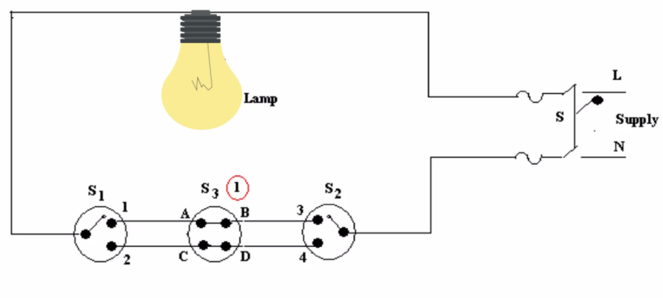


Figure 1 (a) Straight connection

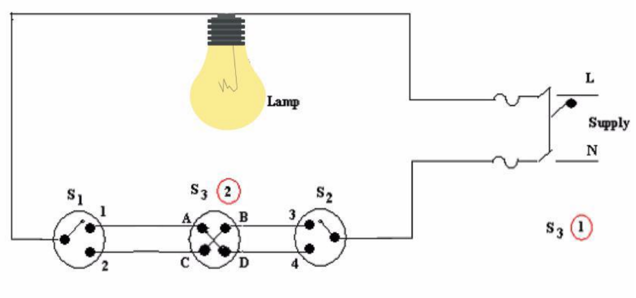


Figure 1 (b) Cross connection

• In case of straight connection, the terminals or points AB and CD are connected as shown in figure 1 (a).

• While in case of cross connection, the terminals AB and CD is connected as shown in figure 1 (b).

• As explained in two-way control, the lamp is ON if the circuit is complete and is OFF if the circuit does not form a closed loop.

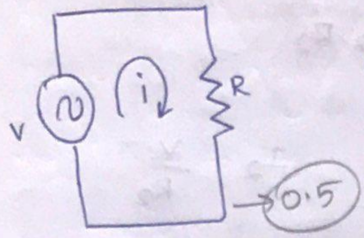
Table

POSITION OF S3	POSITION OF S1	POSITION OF S2	CONDITION OF LAMP
1 Straight Connection	1	3	ON
	1	4	OFF
	2	3	OFF
	2	4	ON
2 Cross Connection	1	3	OFF
	1	4	ON
	2	3	ON
	2	4	OFF

5) Pure Resistive Circuits

Single phase circuits

Purely R circuit



Assume a resistor of resistance R is connected to an ac source of

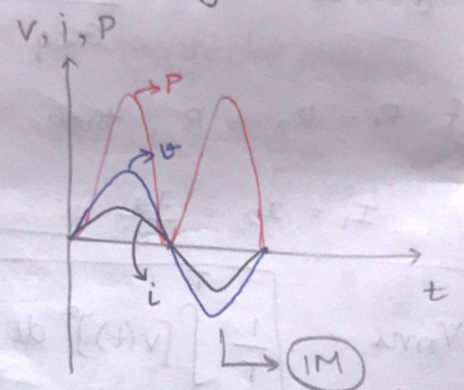
$v = V_m \sin \omega t$

Current i flowing through the circuit $i = \frac{v}{R}$

$i = \frac{V_m \sin \omega t}{R} \Rightarrow i = I_m \sin \omega t$

when $I_m = \frac{V_m}{R}$ → (1M)

Voltage & current waveform



Instantaneous power

$P = \int P_i = \int v \times i$

$= \int V_m \sin \omega t \times I_m \sin \omega t$

$= \int V_m I_m \sin^2 \omega t$

$P = \frac{V_m I_m}{2} = V_{rms} I_{rms}$ (1M)

Real power $P = VI \cos \theta$

θ - angle between V & I. Here θ is 0°

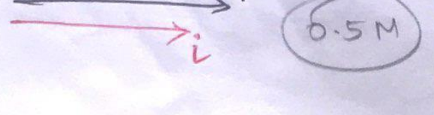
$P = VI \cos 0° = V_{rms} I_{rms} = V \times I =$ ~~Apparent~~ power

Power factor $Pf = \cos \theta$

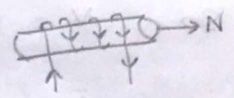
$= \cos 0° = 1$

PF of a purely resistive circuit is unity → (1M)

Phasor diagram



Thumb rule.



Purely inductive circuit

Case(i) : DC supply given to inductor.

→ Whenever current is passed through a coil, magnetic poles are produced.

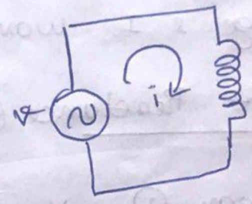
→ By thumb rule, can tell the north pole & South pole

→ DC - const I - inductor behaves like a magnet

→ Sometimes very high I, coil gets damaged because the resistance of inductor is very low.

Case (ii) AC supply given to inductor

→ Whenever an AC is passed through a coil, there is a change in flux linked with the coil



→ According to Faradays law of Electro-magnetic induction, whenever there is a change in the flux linked with a coil, an emf is induced in it which opposes the supply voltage.

$\phi \propto i$

Induced emf is given by $e = -L \frac{di}{dt}$

$\sin(\theta - 90^\circ) = -\cos\theta$

Assuming current $i = I_m \sin \omega t$.

$e = -L \frac{d}{dt}(I_m \sin \omega t) = -\omega L I_m \cos \omega t$

~~[illegible]~~

Induced emf opposes the supply voltage.

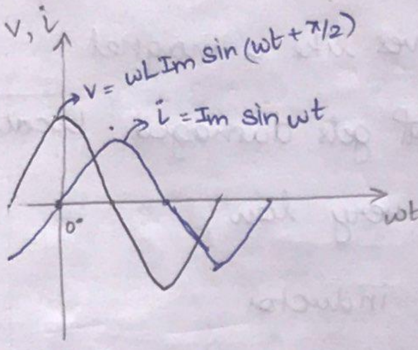
$v = -e =$ ~~[illegible]~~

$v = \omega L I_m \cos \omega t = \omega L I_m \sin(\omega t + \pi/2)$

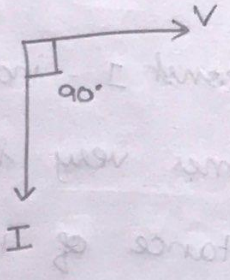
So, $V = \omega L I_m \sin(\omega t + \pi/2)$ → ①

$i = I_m \sin \omega t$

from V & i, it can be inferred that, in a purely inductive circuit, current i lags behind the voltage by $\pi/2$ (or) 90°



Voltage & I waveform



Phasor representation with V reference

<u>Inductive Reactance (X_L)</u>

From eqn ①, V_m can be written as

⇒ At $\omega t = 0°$ $V_m = \omega L I_m$ $\omega = 2\pi f$

$$\frac{V}{I} = \frac{V_m/\sqrt{2}}{I_m/\sqrt{2}} = X_L = 2\pi f L$$

The ratio of V/I is called inductive reactance X_L.

Unit : ohm

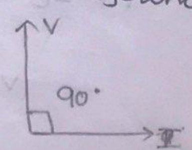
$$\boxed{X_L = 2\pi f L = \omega L}$$

For a gn ac voltage V, I in a purely inductive circuit, according to ohm's law,

$$I = \frac{V}{X_L} = \frac{V}{\omega L} = \frac{V}{2\pi f L}$$

V is along +j axis

$V = +jIX_L$



Phasor diagram with I reference

V along +j axis

For AC, f = finite value, $X_L = 2\pi \times$ finite value $\times L$

= finite value

⇒ implies some R to AC.

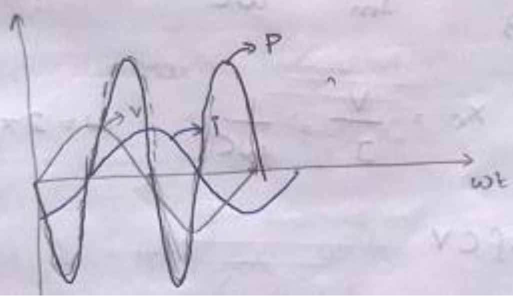
Real power $P = VI \cos\theta$

Here $\theta = 90°$ $P = VI \cos 90° = 0$

Power factor

$pf = \cos 90° =$ zero lagging

Note: Power consumed by the circuit is zero. Thus Pure inductor is lossless



6(a)Three Phase Power in Delta Connected System

Power of each phase, Power / Phase = $V_{PH} \times I_{PH} \times \cos\Phi$

Total Power = $P = 3 \times V_{PH} \times I_{PH} \times \cos\Phi$ ….. (1)

We know that the values of Phase Current and Phase Voltage in Delta Connection;

$I_{PH} = I_L / \sqrt{3}$ ….. (From $I_L = \sqrt{3}\, I_{PH}$)

$V_{PH} = V_L$

Putting these values in power eq……. (1)

$P = 3 \times V_L \times (I_L/\sqrt{3}) \times \cos\Phi$ …… ($I_{PH} = I_L / \sqrt{3}$)

$P = \sqrt{3} \times \sqrt{3} \times V_L \times (I_L/\sqrt{3}) \times \cos\Phi$ …{ $3 = \sqrt{3}\times\sqrt{3}$ }

$P = \sqrt{3} \times V_L \times I_L \times \cos\Phi$ …

Hence proved;

Power in Delta Connection,

$P = 3 \times V_{PH} \times I_{PH} \times \cos\Phi$ …. or

$P = \sqrt{3} \times V_L \times I_L \times \cos\Phi$

6(b)Personal Safety Measures in Electric Circuit

The hazardous effects of electrical shock are the following:

- Loose of motion control
- Respiratory arrest
- Pain
- Physical fatigue
- Ventricular fibrillation
- Cardiac arrest
- Burns

Personal Safety Measures in Electric Circuit

- Avoid contact with power lines.
- 2 Ground electrical equipment.
- 3 Take care with power tools.
- 4 Wear protective clothing.
- 5 Stay on top of housekeeping.

1 b)

$i = 42.2 \sin 628t$

$I_m = 42.2$ A

$\omega = 2\pi f$

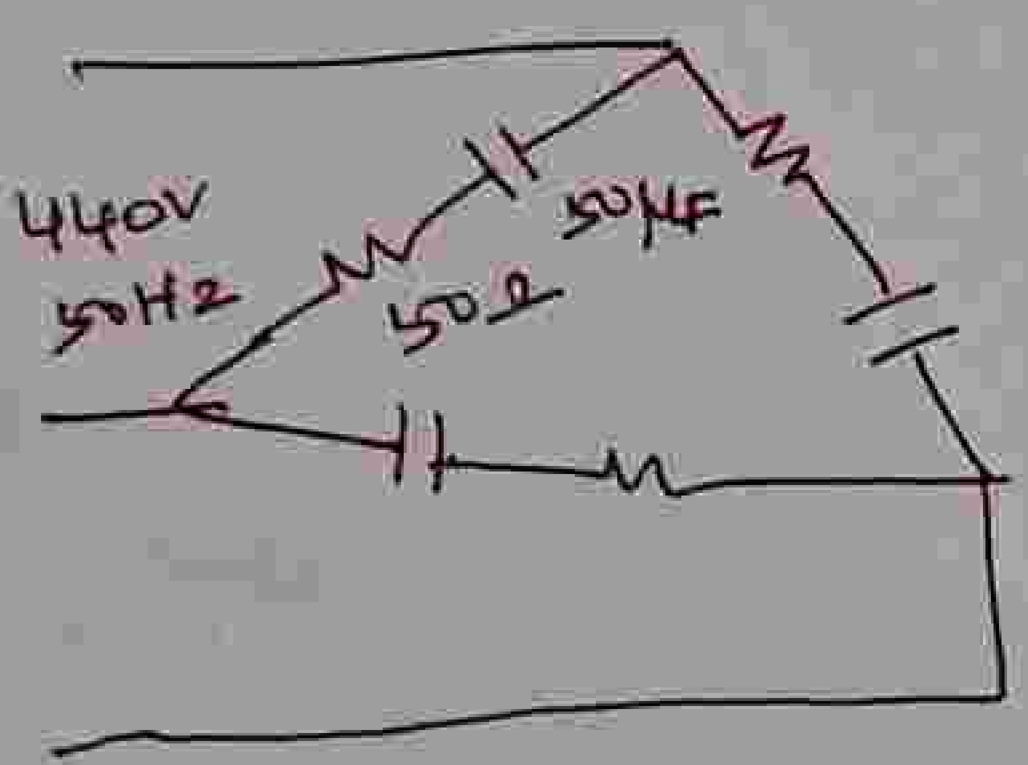
$f = \frac{\omega}{2\pi} = \frac{628}{2\pi} = 100$ Hz

$I_{rms} = \frac{I_m}{\sqrt{2}} =$ 29.7 A

$I_{av} =$ 0.637 Im=26.88 A

$K_f = \frac{rms}{Av.\ value} =$ 29.7/26.88 $= 1.11$

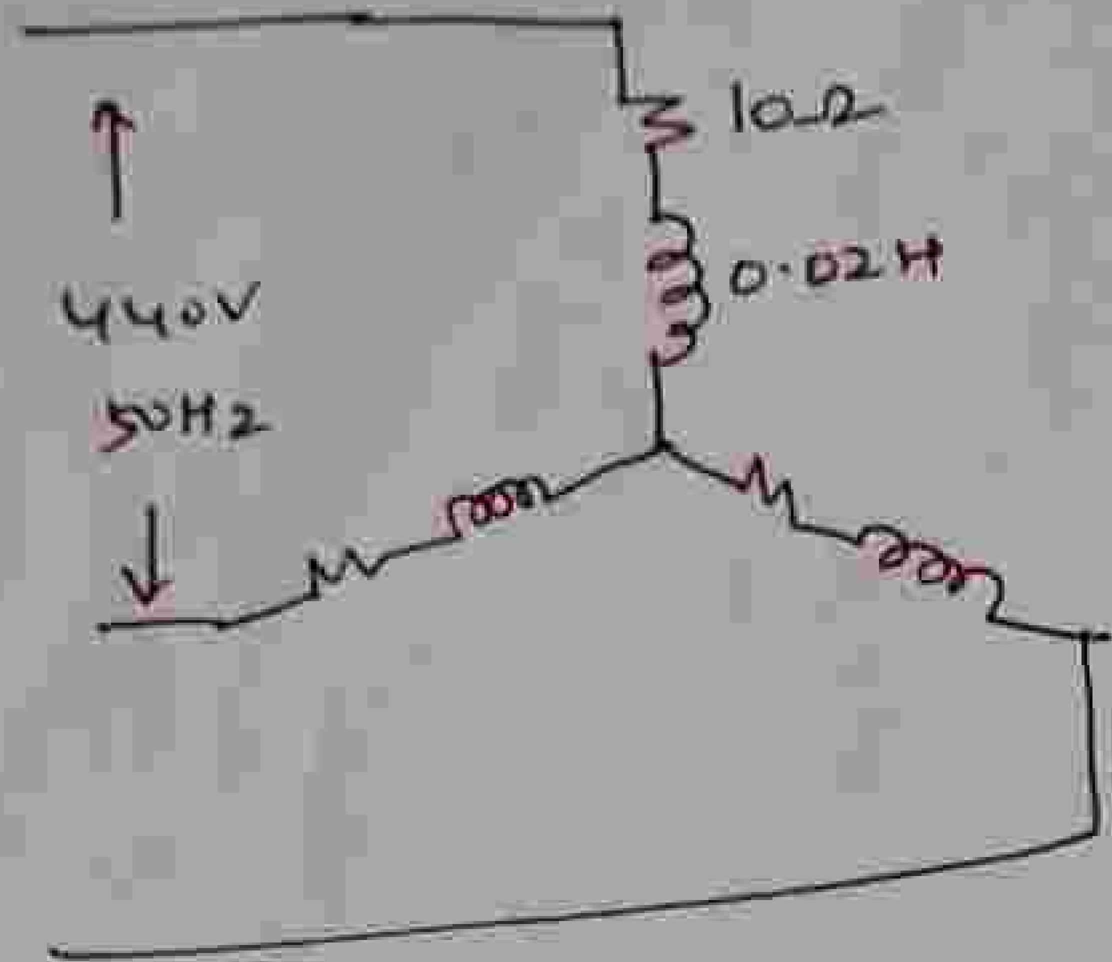
4 a)



$Z_{ph} = \sqrt{R^2 + X_c^2}$

Z ph=80.97<-51.87 ohms
Iph=Vph/Zph=5.43<51.87A
Iline=1.732*I ph=9.39A
P=3 VphIphcos(phi)=4.422 KW

4. b)



$X_L = 2\pi f L$
$= 2\pi \times 50 \times 0.02$
$= 6.283\,\Omega$.

$I_L = I_{ph}$.

$Z_{ph} = \sqrt{10^2 + 6.283^2}$
$= \sqrt{100 + 39.4784}$
$= 11.81\,\Omega$

$$I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{440/\sqrt{3}}{11.81} = 21.51A.$$

$I_L = 21.51A$.

$$\cos\varphi = \frac{R}{Z} = \frac{10}{11.81} = 0.84$$

$P = \sqrt{3} \times 440 \times 21.51 \times 0.84 = 13769$ watts.

7.

$pf = 0.6$, $C = 100\mu F$, $f = 50Hz$, $V_L = V_C$.

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi \times 50 \times 100 \times 10^{-6}} = 31.83\,\Omega$$

$V_L = V_C$
$I Z_{coil} = I X_C$
(or)
$Z_{coil} = X_C = 31.8\,\Omega$.

$R = Z_{coil} \cos\varphi = 31.8 \times 0.6 = 19.08\,\Omega$.

$X_L = Z_{coil} \sin\varphi = 31.8 \times 0.8 = 25.44\,\Omega$.

~~$\omega = 2\pi f L$~~

$X_L = 2\pi f L$

$$L = \frac{25.44}{2\pi \times 50} = 0.08H$$