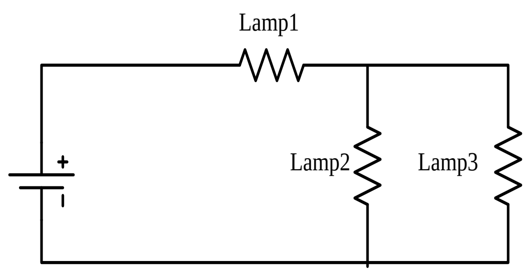
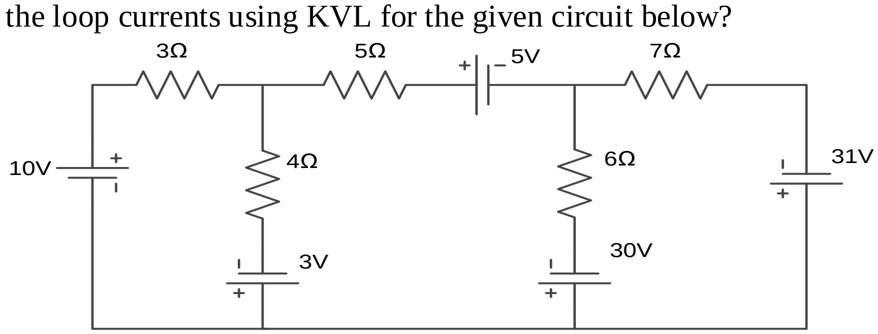
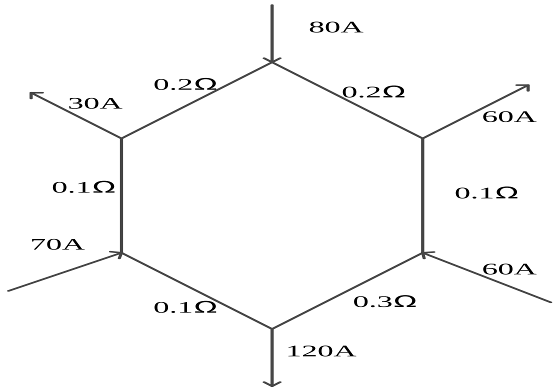
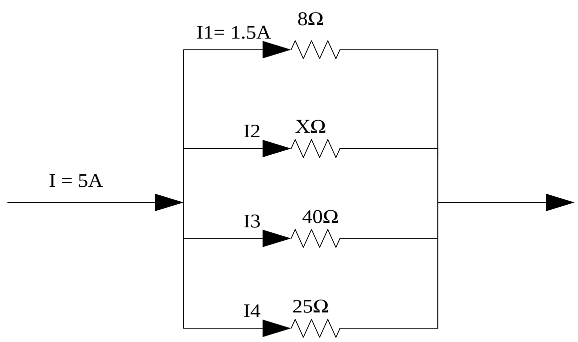
CMR INSTITUTE OF TECHNOLOGY		USN	

Internal Assessment Test –I

Sub:	Introduction to Electrical Engineering							Code:	*BESCK204B*
Date:	6/5/2025	Duration:	90 mins	Max Marks:	50	Sem:	II sem	Branch:	Chemistry cycle

Answer any FIVE FULL Questions

		Marks	OBE CO	OBE RBT
1 a)	State and explain Ohm's law, List out its limitation.	[4]	CO1	L1
b)	Three 60W 240V lamps are connected across a 240V power supply as shown in the figure. Calculate the i) Potential drop across each lamp ii)Total power dissipated in the lamp. 	[6]	CO1	L3
2 a)	Calculate the loop currents using KVL for the given circuit below? 	[5]	CO1	L3
b)	Explain with a neat block diagram of Nuclear power generation.	[5]	CO5	L2
3 a)	Explain voltage and current relationships with phasor diagram and waveforms in a pure resistive circuit	[5]	CO2	L3
b)	Define the following: (a)Instantaneous value (b)RMS value (c)Average value (d)Form factor (e)Peak factor for a sinusoidal alternating quantity	[5]	CO2	L1

4 a)	For the given circuit , calculate current through all the branches 	[5]	CO1	L3
b)	State and explain Kirchhoff's Laws, as applied to D.C. Circuit.	[5]	CO1	L2
5	Calculate i) Current through each resistor ii) Unknown resistance x? iii) Req. iv) Power consumed. 	[10]	CO1	L3
6.a	With a neat single line diagram explain the various steps of electrical power transmission and distribution system.	[6]	CO5	L3
b.	A pure inductive coil allows a current of 18A to flow from a 230V,50Hz supply. Calculate i) X_L ii) The value of L and iii) Power absorbed	[4]	CO2	L3
7	With the help of a neat block diagram, explain Solar and Wind Power Generation.	[10]	CO5	L1

CI CCI HOD

Solutions

1a

(1)

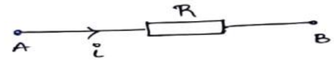
MODULE 1 :

* DC CIRCUITS

DC CIRCUITS :

OHM'S LAW :- (Dr. George Simon Ohm)

→ The potential difference between two ends of a conductor is directly proportional to the current flowing through it, provided temperature and other physical parameters remain constant.



$$V \propto I \quad \text{— (1)}$$

$$V = IR$$

R – constant of proportionality (resistance of the conductor)

unit ohm Ω

Another way of stating Ohm's law,

$$I \propto V \quad \text{— (2)}$$

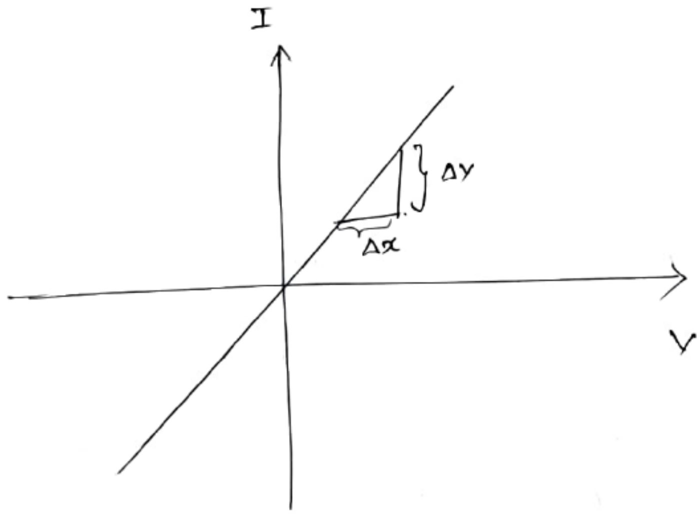
$$I = GV$$

G – conductance of the conductor

From (1), $I = \frac{V}{R} = \frac{1}{R} V$ i.e $G = \frac{1}{R}$.

Unit Siemens S

Graphical representation of Ohm's law:



$$\text{Slope} = \frac{\Delta Y}{\Delta X} = \frac{I}{V} = \frac{1}{R} = G$$

where G is conductance (siemens) ($\mho$).

Limitations - OHM'S LAW

1) It cannot be applied to non-linear devices like diodes, zener diodes, transistors, voltage regulator etc.
2) Ohm's law is applicable as long as tempe-rature and other physical parameters remains constant
3) It cannot be applied to complicated ckts having more no of branches and emf sources.
4) Not suitable for non-metallic conductors like silicon carbide, graphite etc.

1b

5)

1b) $R_L = \cancel{R/\ldots} = v^2/P = \frac{240^2}{60} = \underline{960\Omega}$

$R_{eq} = 960 + (960 \| 960) = 960 + 480$

$= \underline{1440\Omega}$

$I = V/R_{eq} = 240/1440 \approx 0.17A$

$V_1 = 0.17 \times 960 = 163.6V$

$V_2 = 76.8V = V_3$

$P = VI = 240 \times 0.17 = \underline{40.8W}$

2a

6

2a) $-3i_1 - 4(i_1 - i_2) + 3 + 10 = 0$

$-7i_1 + 4i_2 + 0i_3 = -13$ —— (1)

$-5i_2 - 5 - 6(i_2 - i_3) + 30 - 3 - 4(i_2 - i_1) = 0$

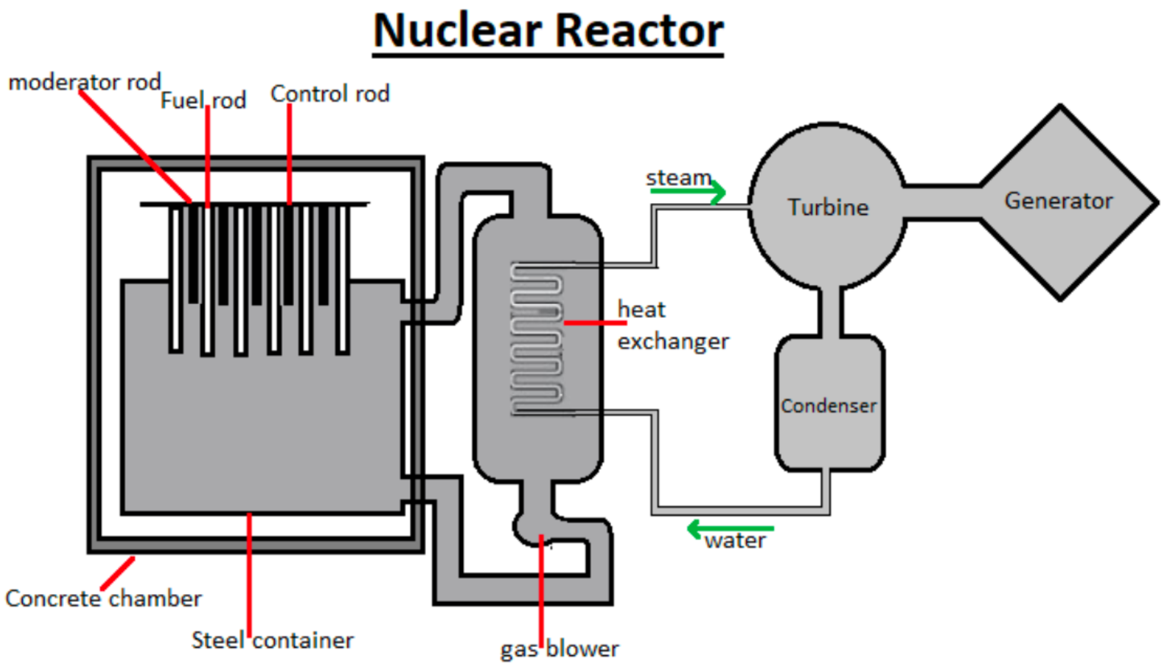
$4i_1 - 15i_2 + 6i_3 = -22$ —— (2)

$-7i_3 + 31 - 30 - 6(i_3 - i_2) = 0$

$0i_1 + 6i_2 - 13i_3 = -1$ —— (3)

$\therefore i_1 = 3.57A, \; i_2 = 3.01A, \; i_3 = \underline{1.46A}$

2b



NUCLEAR POWER PLANT

A nuclear power plant is a facility that generates electricity using nuclear reactions. Nuclear power plants use the heat generated by nuclear reactions to produce steam, which drives a turbine that generates electricity.

The basic components of a nuclear power plant include:

Reactor: The reactor is the heart of the nuclear power plant. It contains nuclear fuel, which undergoes controlled nuclear reactions, producing heat. The heat produced is then used to create steam.

Steam Generator: The steam generator takes the heat generated by the reactor and uses it to produce steam. The steam is then used to drive a turbine.

Turbine: The turbine converts the energy in the steam into mechanical energy that is used to turn a generator.

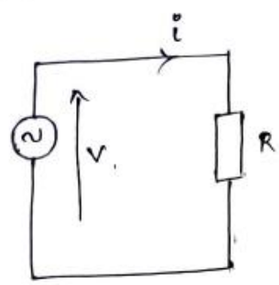
Generator: The generator uses the mechanical energy from the turbine to produce electricity.

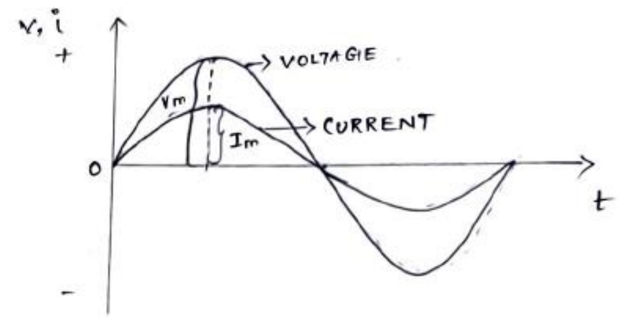
Cooling system: The cooling system is used to remove the heat produced by the nuclear reaction, ensuring that the reactor remains at a safe operating temperature.

Nuclear power plants can use different types of nuclear reactors, including pressurized water reactors (PWRs) and boiling water reactors (BWRs). In PWRs, water is used as both a coolant and a moderator to control the nuclear reaction. In BWRs, the water is allowed to boil and create steam directly in the reactor.

One of the main advantages of nuclear power plants is that they produce large amounts of electricity without emitting greenhouse gases, such as carbon dioxide. However, they also produce nuclear waste, which can remain radioactive for thousands of years and require careful handling and storage. Safety concerns, such as the risk of accidents or nuclear proliferation, are also important considerations for nuclear power plant operation.

3a





$$i = \frac{v}{R}$$

$\Rightarrow$ current and voltage both are in-phase.

PHASOR DIAGRAM:

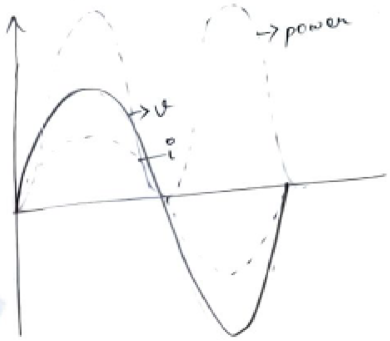
$$v = V_m \sin \omega t$$

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

POWER IN AC CIRCUITS:

power

i) Power thro pure R circuit,



$v = V_m \sin \omega t$

$i = I_m \sin \omega t$

instantaneous power

$p = vi = V_m I_m \sin^2 \omega t$

$= \frac{V_m I_m}{2} (1 - \cos 2\omega t)$

power $= \underbrace{\frac{V_m I_m}{2}}_{\text{constant part}} - \underbrace{\frac{V_m I_m}{2} \cos 2\omega t}_{\text{fluctuating part}}$.

for complete cycle average value of $\frac{V_m I_m}{2} \cos 2\omega t$ is 0.

$\therefore$ Power $= \frac{V_m I_m}{2} = \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}}$

$= V \times I$.

V - rms value of applied voltage

I - rms value of the current.

* in a purely resistive circuit power is never zero.

3b

The

Instantaneous value:

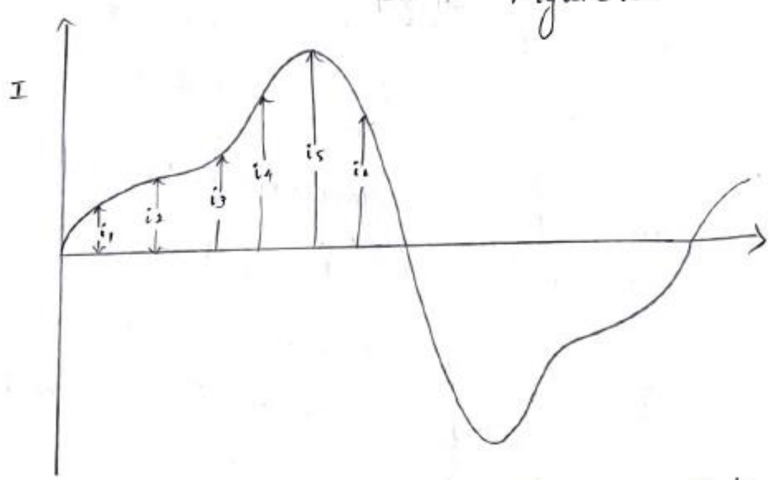
The magnitude of a waveform at any instant in time

AVERAGIE AND RMS VALUES

The voltage and currents from ac generators are for the most part sinusoidal, but with the use of electronic switching, the waveforms are altered.

Consider the current waveform of a transformer at no-load,

Figure: 1



The average value of current over half a cycle,

$$I_{av} = \frac{i_1 + i_2 + \dots i_n}{n}$$ [mid-ordinate method]

The average value of current (alternate method)

$$= \frac{\text{area enclosed over half-cycle}}{\text{length of base over half-cycle}} = \frac{1}{\pi}\int_0^{\pi} v \, d\omega t$$

If the current represented in figure 1, is passed thro a resistor R ohms, the heating effect of i_1 is $i_1^2 R$ and i_2 is $i_2^2 R$ and so on.

$$\therefore \text{ average heating effect} = \frac{i_1^2 R + i_2^2 R + \dots i_n^2 R}{n}$$

Suppose I to be the value of direct current thro the same R to produce a heating effect equal to the average heating effect of the alternating current

then $$I^2 R = \frac{i_1^2 R + i_2^2 R + \dots + i_n^2 R}{n}$$

$$\therefore I^2 \cancel{R} = \frac{\cancel{R}\,(i_1^2 + i_2^2 + \dots i_n^2)}{n}$$

$$I = \sqrt{\frac{i_1^2 + i_2^2 + \dots i_n^2}{n}}$$

= square root of the means of the squares of the current i.e root mean square (rms) value of the current.

value of the curr...

definition (RMS):-

The effective value of an alternating current
measured in terms of direct current that produces
the same heating effect produced by the ac
which when flowing thro the same circuit for same

alternate expression,

average heating effect over half-cycle

$$= \frac{\text{area enclosed by } i^2R \text{ curve over half-cycle}}{\text{length of base}}$$

$$= \sqrt{\frac{1}{T}\int_0^T i^2\, dt}$$

* The rms value is always greater than the average value except for a rectangular wave, in which the heating effect remains const so that the average and rms values are the same

FORM FACTOR K_f : $= \frac{\text{r.m.s. value}}{\text{average value}}$ importance → hysteresis loss

PEAK / CREST FACTOR K_a : $= \frac{\text{maximum value}}{\text{r.m.s value}}$ ⇒ dielectric insulation

amplitude

... sinusoidal

4a) $-0.2I - 0.1(I-60) - 0.3I - 0.1(I-120) - 0.1(I-50) - 0.2(I-80) = 0$

$I = 39\,A$

$I_{0.1} = -21\,A$

$I_{0.3} = 39\,A$

$I_{0.1} = -81\,A$

$I_{0.1} = -11\,A$

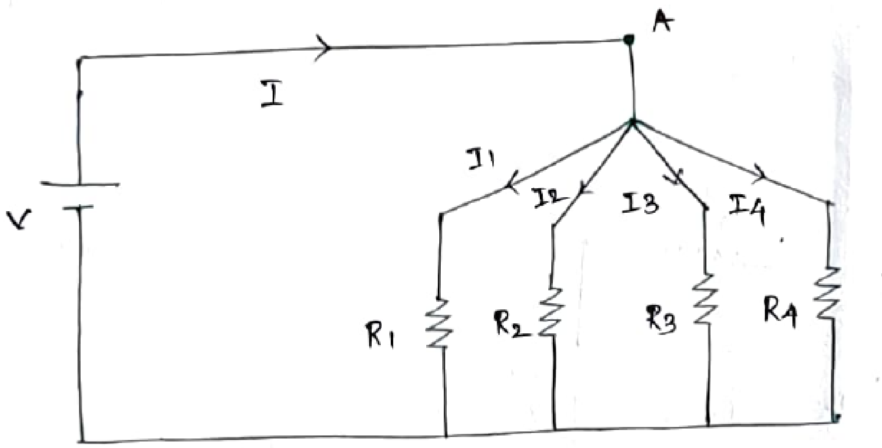
$I_{0.2} = -41\,A$

4B

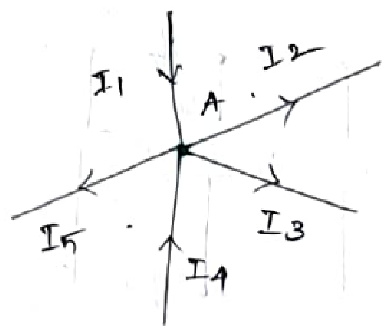
KIRCHHOFF'S CURRENT / POINT LAW: [KCL]

In any electrical network, the algebraic sum of the currents meeting at a point or junction is zero. i.e $\Sigma I = 0$.

i.e total current leaving a junction is equal to the total current entering that junction.



$$I = I_1 + I_2 + I_3 + I_4$$



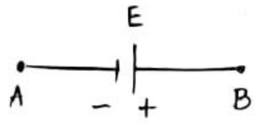
$$I_1 + I_4 = I_2 + I_3 + I_5$$

KIRCHHOFF'S VOLTAGE / MESH LAW: [KVL]

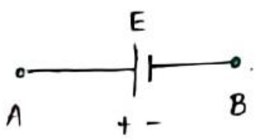
The algebraic sum of voltages [voltage dro around a closed loop or circuit is zero.

$$\Sigma IR + \Sigma e.m.f = 0.$$

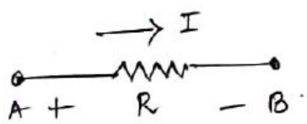
Determination of voltage sign :-



Rise in voltage +ve sign.



Fall in voltage −ve sign.



Fall in voltage −ve sign.

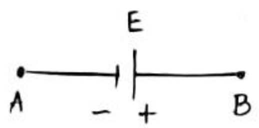
→ dir

KIRCHHOFF'S VOLTAGE / MESH LAW: [KVL]

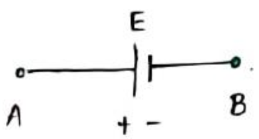
The algebraic sum of voltages [voltage dro around a closed loop or circuit is zero.

$$\sum IR + \sum e.m.f = 0.$$

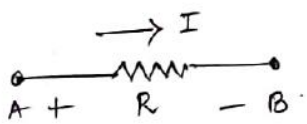
Determination of voltage sign :-



Rise in voltage +ve sign.



Fall in voltage −ve sign.



Fall in voltage −ve sign.

→ dir

5) $V_1 = 1.5 \times 8 = 12V$

$i_3 = 12/40 = 0.3A$

$i_4 = 12/25 = 0.48A$

$i_2 = 5 - (1.5 + 0.3 + 0.48)$

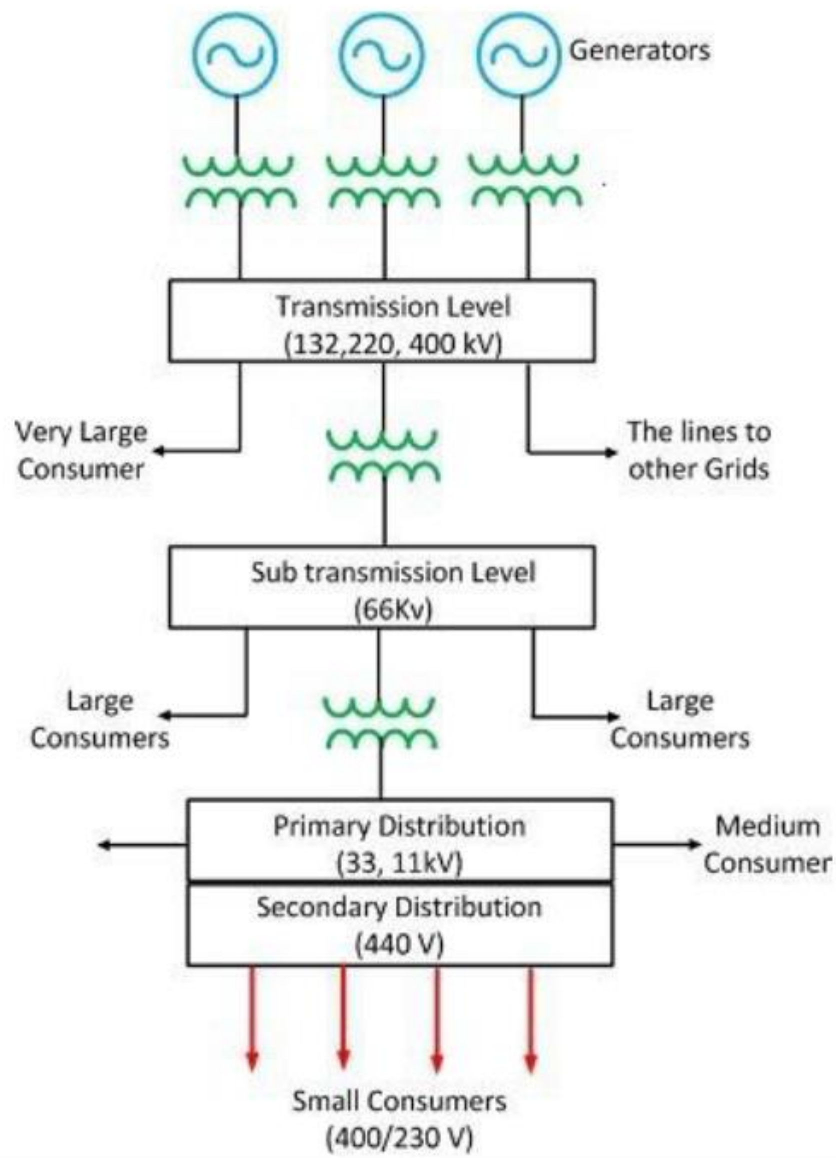
$= \underline{2.72A}$

$r = V/i_2 = \underline{4.41\Omega}$

$R_{eq} = 2.39\Omega$

$P = 59.9W$

6A


Generators
Transmission Level
(132,220, 400 kV)
Very Large
Consumer
The lines to
other Grids
Sub transmission Level
(66Kv)
Large
Consumers
Large
Consumers
Primary Distribution
(33, 11kV)
Medium
Consumer
Secondary Distribution
(440 V)
Small Consumers
(400/230 V)

Electrical power transmission and distribution system can be divided into several steps, including:

1. Generation: Electricity is generated at power stations using various sources such as coal, natural gas, nuclear energy, hydroelectricity, wind, or solar energy.
2. Step-up transformers: The voltage of the generated power is stepped up using step-up transformers to reduce energy losses during long-distance transmission.
3. Transmission: High-voltage transmission lines are used to transmit the electricity over long distances from the power station to the substations.
4. Substations: At the substations, the voltage is stepped down using step-down transformers for local distribution.
5. Distribution: Low-voltage distribution lines are used to distribute the electricity to residential, commercial, and industrial consumers.
6. Distribution transformers: At the end of the distribution lines, distribution transformers are used to step down the voltage to the levels suitable for consumer use.
7. Consumption: The electricity is finally consumed by various appliances and devices in homes, businesses, and industries.

Overall, electrical power transmission and distribution system involves the generation, transmission, distribution, and consumption of electricity to meet the needs of the society.

6B

6b) $X_L = \cancel{2\pi f L}\ \frac{V}{I}$

$= 230/18 = \underline{12.7\,\Omega}$

$h = 27/2\pi f = \underline{40.69\ mH}$

$P = 0$

7

SOLAR POWER GENERATION:

Solar power generation is the process of converting sunlight into electricity. This is done through the use of solar panels, which capture the energy from the sun and convert it into usable electricity.

The basic components of a solar power generation system include:

Solar Panels: Solar panels are made up of photovoltaic cells, which convert sunlight into direct current (DC) electricity. They are typically installed on rooftops or in fields where they can be exposed to the maximum amount of sunlight.

Inverter: The inverter is used to convert the DC electricity produced by the solar panels into alternating current (AC) electricity, which can be used to power appliances and equipment.

Battery Storage: Solar power generation systems can be equipped with batteries to store excess electricity generated during the day for use at night or during periods of low sunlight.

Monitoring System: A monitoring system is used to track the performance of the solar power generation system and identify any issues that may arise.

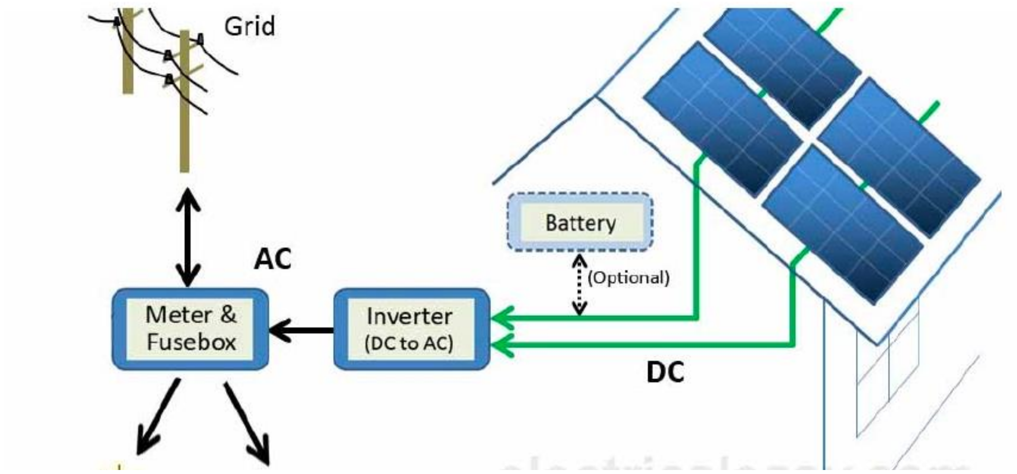
Solar power generation has several advantages over conventional energy sources, including:

Renewable: Solar power is a renewable energy source that will never run out.

Environmentally Friendly: Solar power generation produces no greenhouse gas emissions and has a minimal impact on the environment.

Cost-Effective: The cost of solar power generation has decreased significantly in recent years, making it more accessible to homeowners and businesses.

However, solar power generation also has some limitations, such as its dependence on sunlight and its intermittent nature, which means that energy storage solutions are needed to ensure a consistent supply of electricity. Additionally, the initial cost of installing solar panels can be high, although this is often offset by long-term savings on electricity bills.



WIND POWER GENERATION

Wind power generation is the process of converting the kinetic energy from the wind into electricity. This is done through the use of wind turbines, which capture the energy from the wind and convert it into usable electricity.

The basic components of a wind power generation system include:

Wind Turbine: A wind turbine consists of blades, a rotor, a shaft, and a generator. The blades capture the energy from the wind and turn the rotor, which in turn rotates the shaft. The rotation of the shaft drives a generator, which produces electricity.

Tower: The tower supports the wind turbine and elevates it to a height where it can capture the maximum amount of wind.

Inverter: The inverter is used to convert the DC electricity produced by the wind turbine into AC electricity, which can be used to power appliances and equipment.

Battery Storage: Wind power generation systems can be equipped with batteries to store excess electricity generated during periods of high wind for use during periods of low wind.

Monitoring System: A monitoring system is used to track the performance of the wind power generation system and identify any issues that may arise.

Wind power generation has several advantages over conventional energy sources, including:

Renewable: Wind power is a renewable energy source that will never run out.

Environmentally Friendly: Wind power generation produces no greenhouse gas emissions and has a minimal impact on the environment.

Cost-Effective: The cost of wind power generation has decreased significantly in recent years, making it more accessible to homeowners and businesses.

However, wind power generation also has some limitations, such as its dependence on wind speed and direction, which can vary significantly over time and can make it difficult to predict the amount of electricity that will be generated. Additionally, wind turbines can be noisy and can pose a risk to birds and other wildlife.