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PES UNIVERSITY

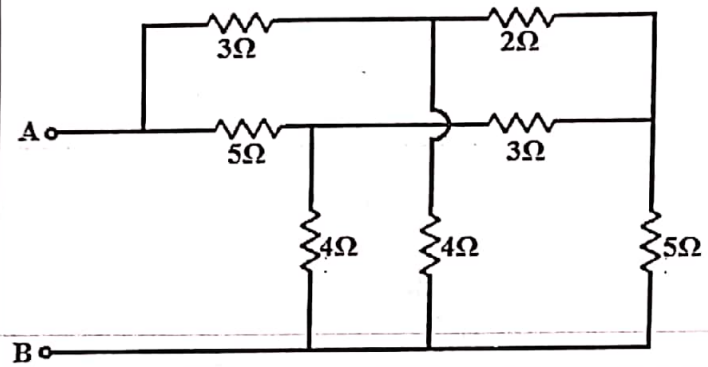
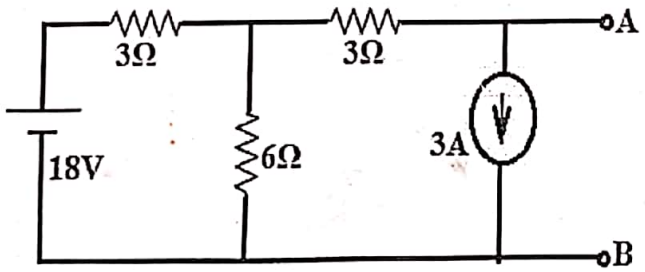
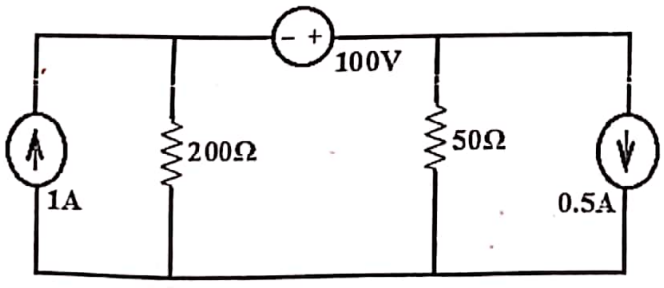
PES University, Bengaluru

(Established under Karnataka Act No. 16 of 2013)

UE18EE101

END SEMESTER ASSESSMENT B.TECH - I SEM
BASIC ELECTRICAL ENGINEERING
DECEMBER 2018

Time: 3 Hours | Answer All Questions | Max Marks: 100

1.	a)	Find the equivalent resistance between the terminals A & B in the network shown below: 	6
	b)	Find Thevenin's equivalent voltage and Thevenin's equivalent resistance between the terminals A & B for the network shown below: 	6
	c)	Find the current through 50Ω resistor in the network shown below using Superposition Theorem: 	8

USN

2.	a)	A non-inductive resistor is connected in series with a coil across 230V, 50Hz supply. The current in the circuit is 1.8A and the potential difference across the resistor and coil are 80V and 170V respectively. Find the inductance and resistance of the coil.	6
	b)	Two impedances Z_1 and Z_2 in parallel are connected across an AC supply voltage 100 $\angle 15°$ Volts. If the branch currents are 50 $\angle 10°$ Amps and 20 $\angle 30°$ Amps respectively. Determine i) Total Active Power ii) Total Reactive Power iii) Overall Power factor	6
	c)	In a series-parallel circuit, two parallel branches A & B are connected in series with third branch C. The branch impedances are $Z_A = (4+j3)\Omega$, $Z_B = (3-j4)\Omega$ and $Z_C = (2+j8)\Omega$. If the branch current I_C is 25A, determine i) Branch currents I_A and I_B ii) Branch Voltages & Supply Voltage iii) Draw the phasor diagram taking I_C as reference	8
3.	a)	A balanced three phase star connected load of 10KW takes a leading current of 20A when connected to a three phase, 400V, 50Hz supply. Find the resistance, impedance and the capacitance of the load per phase. Also calculate the power factor of the load.	6
	b)	A balanced three phase load consists of three coils of 10Ω resistance and 0.2H inductance each, connected in delta. If the supply voltage is 400V, 50Hz, determine i) Line current ii) Three phase apparent power iii) W_1 & W_2 readings, if two wattmeter method is used	6
	c)	With a neat circuit diagram and phasor diagram, show that two wattmeters are sufficient to measure power in a three phase AC system.	8
4.	a)	With proper nomenclature, derive the EMF Equations of a single-phase transformer.	6
	b)	Write a short note on the constructional details and principle of operation of a Squirrel Cage type Three Phase Induction Motor.	6
	c)	A DC shunt machine connected to 500V DC mains has armature winding and field winding resistances as 0.5Ω and 250Ω respectively. Determine its efficiency a) when working as a generator supplying an output power of 9KW b) when working as a motor drawing an input power of 9KW Mechanical and Iron losses are 500W and 300W respectively.	8

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5. a) Write a short note on the classification of types of cables. — 4

b) Write a short note on the following devices: — 6
   i) Fuse
   ii) ELCB

c) The list of loads and average consumption hours per day of a typical household is given below: — 10

S.No.	Name of the Appliance	Wattage	Average consumption hours per day
1.	Four Incandescent Bulbs	60W per bulb	10 hours each
2.	Four Ceiling Fans	75W per fan	12 hours each
3.	Geyser	1KW	1 hour
4.	Refrigerator	100W	16 hours
5.	Television	50W	10 hours
6.	Mixer Grinder	750W	1 hour

Considering a 30 day month, Determine

i) the total number of units consumed in a month.

ii) monthly bill for the above consumption units considering a domestic connection of 3KW sanctioned load with the tariff details listed in a table below

S.No.	Type of Charges	Tariff Details
1.	Fixed Charges for sanctioned load	Rs. 50/- for first KW Rs. 60/- for every additional KW
2.	Energy Consumption Charges	0 to 30 units ----- Rs. 3.50 per unit 31 to 100 units ----- Rs. 4.95 per unit 101 to 200 units ----- Rs. 6.50 per unit 201 to 300 units ----- Rs. 7.55 per unit 301 to 400 units ----- Rs. 7.60 per unit Above 400 units ----- Rs. 7.65 per unit

Consider a tax of 7.3% on total charges. Neglect any other charges.

END OF THE QUESTION PAPER

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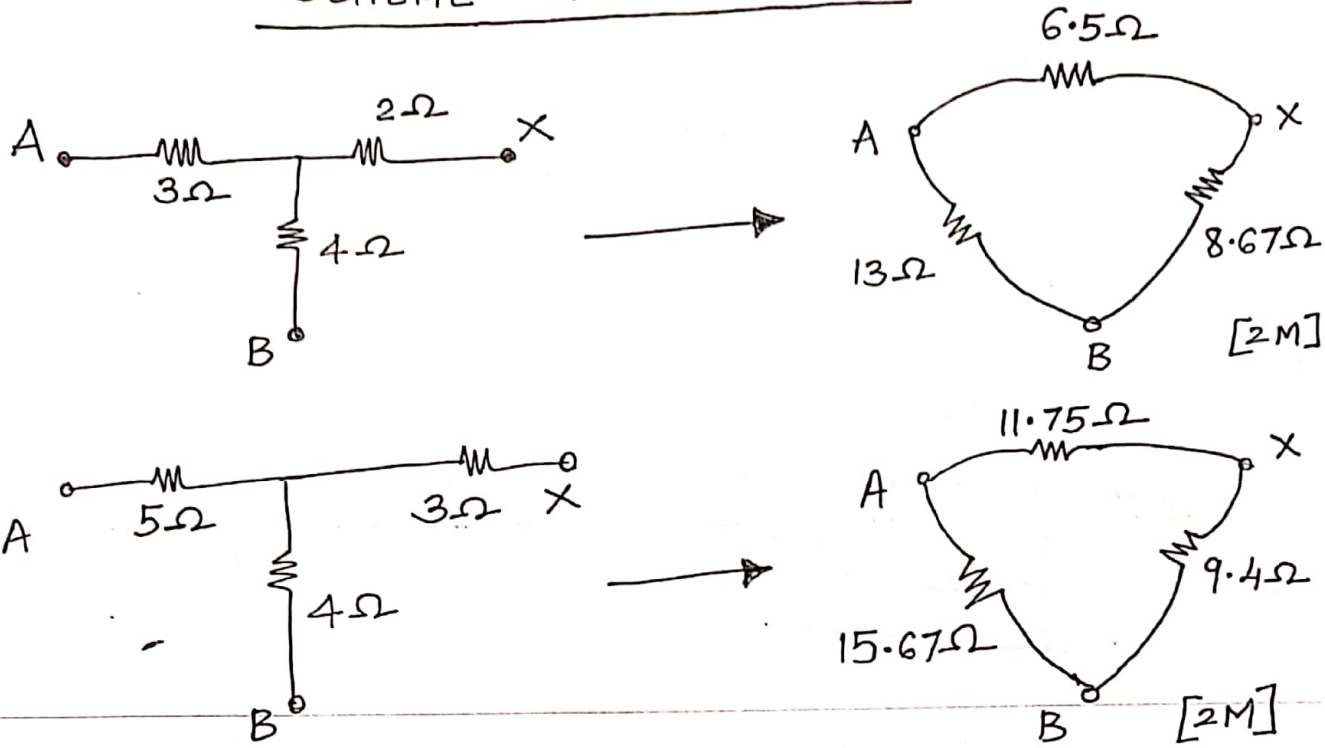
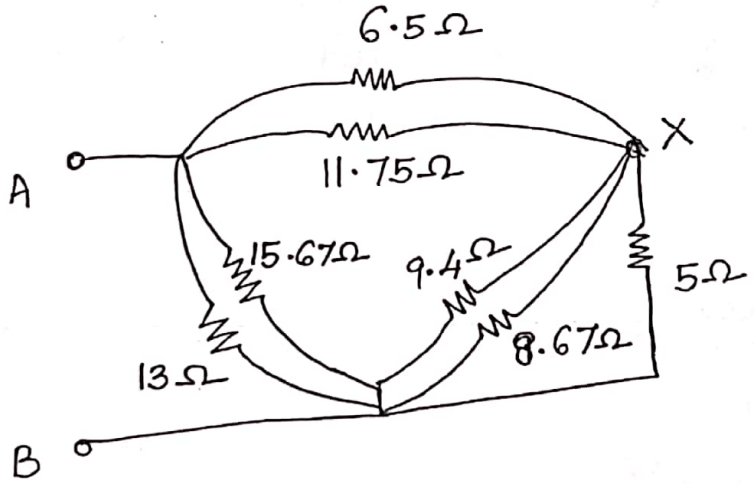
SCHEME & SOLUTION

1a)

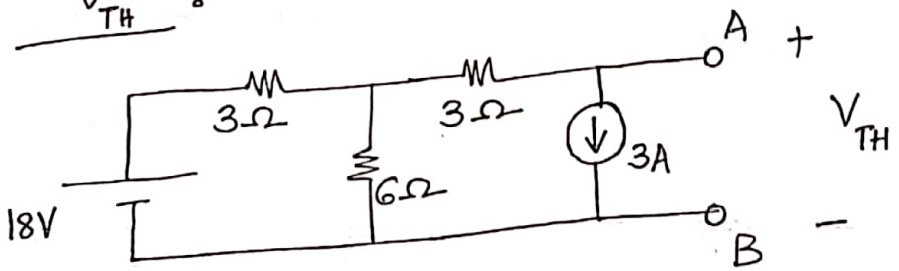


[2M] [2M]



$\Rightarrow R_{AB} = 3.41\Omega$ [2M]

b) V_{TH} :



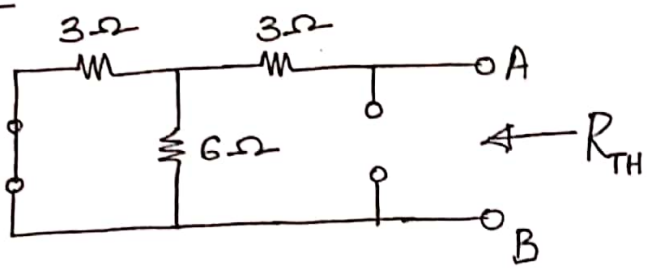
[4M]

Applying Mesh Analysis, $9I_1 - 6I_2 = 18$; $I_2 = 3$

$\Rightarrow I_1 = 4A$

KVL $+18 - 2I_1 - 3I_2 - V_{TH} = 0 \rightarrow V = -2V$

R_{TH} :

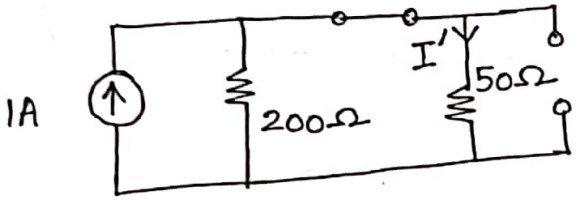


$R_{TH} = [3 // 6] + 3$

$= 5\Omega$

[2M]

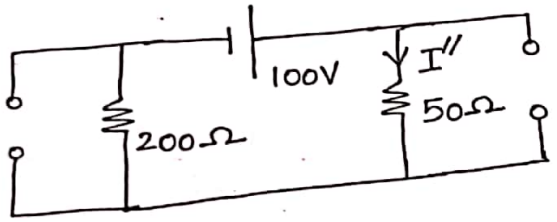
1c) With 1A source alone



$I' = 1 \times \frac{200}{250} = 0.8A$

[2M]

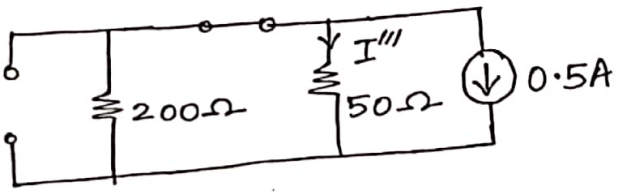
With 100V source alone



$I'' = \frac{100}{250} = 0.4A$

[2M]

With 0.5A source alone



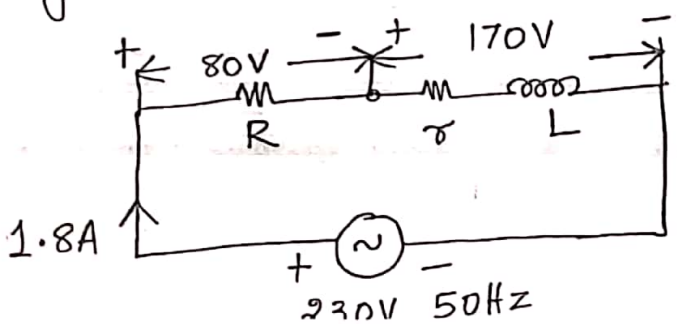
$I''' = -0.5 \times \frac{200}{250} = -0.4A$

[2M]

By superposition principle, $I = I' + I'' + I''' = 0.8A$

[2M]

2a)



$R = \frac{80}{1.8} = 44.44\Omega$

[1M]

Across coil, $\sqrt{r^2 + X_L^2} = \frac{170}{1.8} = 94.44\Omega \rightarrow (1)$

Similarly, $\sqrt{(R+r)^2 + X_L^2} = \frac{230}{1.8} = 127.78\Omega \rightarrow (2)$ [1M]

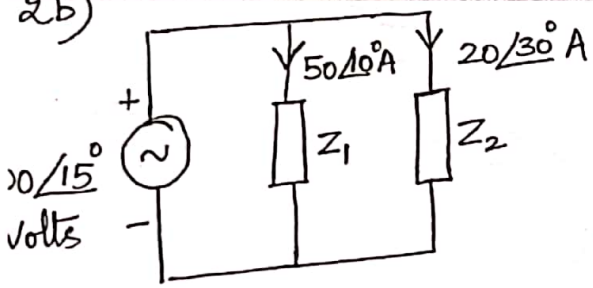
Solving (1) & (2),

$r = 61.14\Omega$ [1M]

$X_L = 71.98\Omega$ [2M]

Hence, $L = 0.229H$ [1M]

2b)



i) $P_T = P_1 + P_2$

$= 100 \times 50 \times \cos(15^\circ - 10^\circ) + 100 \times 20 \times \cos(15^\circ - 30^\circ)$

$= \underline{6.913\ KW}$ [2M]

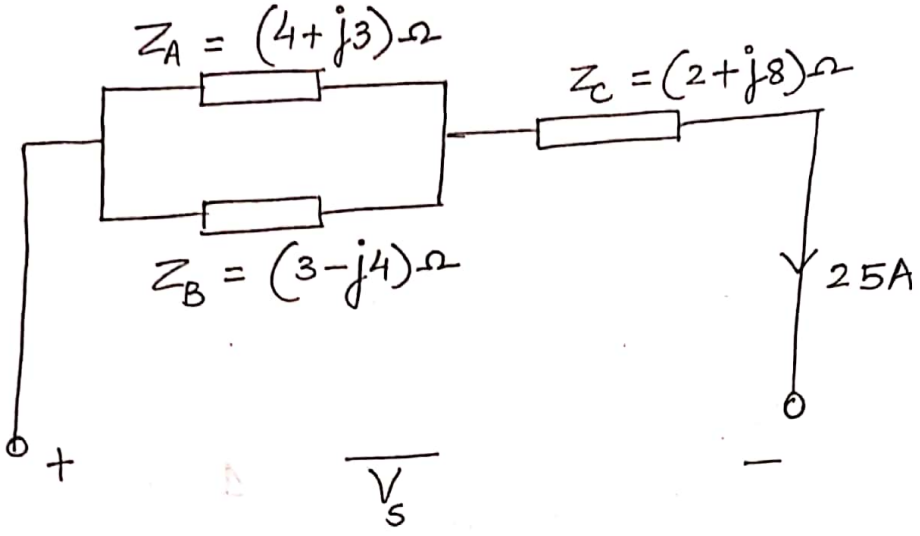
ii) $Q_T = Q_1 + Q_2$

$= 100 \times 50 \sin 5^\circ + 100 \times 20 \times \sin(-15^\circ)$

$= -81.86\ VAR$ [2M]

iii) Overall Powerfactor $= P_T/S_T = 0.999$ lead [2M]

2c)



i) Branch currents, $\overline{I_A} = 25\angle 0^\circ * \frac{Z_B}{Z_A + Z_B}$

$= 17.67\angle -45^\circ$ A [2M]

Similarly, $\overline{I_B} = 17.67\angle 45^\circ$ A [2M]

ii) $\overline{V_A} = \overline{V_B} = \overline{I_A} Z_A = \overline{I_B} Z_B = 88.35\angle -8.13^\circ$ V

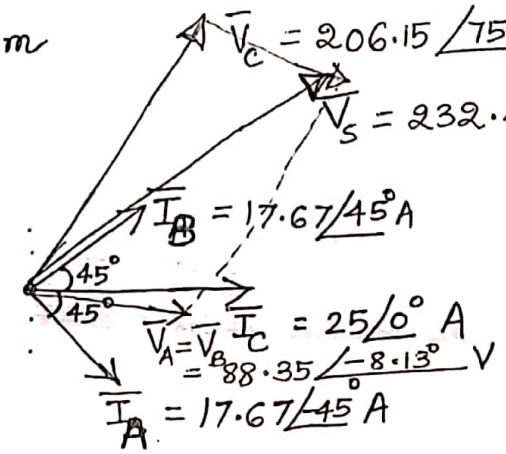
$\overline{V_C} = 206.15\angle 75.96^\circ$ V

Supply voltage, $\overline{V_s} = \overline{V_A} + \overline{V_C}$

(or) $\overline{V_B} + \overline{V_C} = 232.49\angle 53.7$

[2M]

iii) Phasor diagram



[2 M]

a)

Given, $V_L = 400V$

$I_L = 20A$

$P_{3-phase} = 10KW$

$P_{3-phase} = 3 I_{ph}^2 R_{ph} = 10KW \Rightarrow R_{ph} = 8.33\Omega$ [1M]

$Z_{ph} = \frac{V_{ph}}{I_{ph}} = \frac{400/\sqrt{3}}{20} = 11.54\Omega$

$\therefore X_{cph} = \sqrt{Z_{ph}^2 - R_{ph}^2} = 8\Omega$ [2M]

$\Rightarrow C_{ph} = 397.88\,\mu F \approx 398\,\mu F$ [1M]

Powerfactor of the load $= \frac{R_{ph}}{Z_{ph}} = 0.722$ lead [2M]

3b) Given, $V_L = 400V$; $R_{ph} = 10\Omega$; $L_{ph} = 0.2H$

$\therefore Z_{ph} = (10 + j62.83)\Omega$; $\phi = \cos^{-1}\left(\frac{R_{ph}}{Z_{ph}}\right) = 80.95^\circ$

$\Rightarrow I_{ph} = V_{ph}/Z_{ph} = 6.287A$

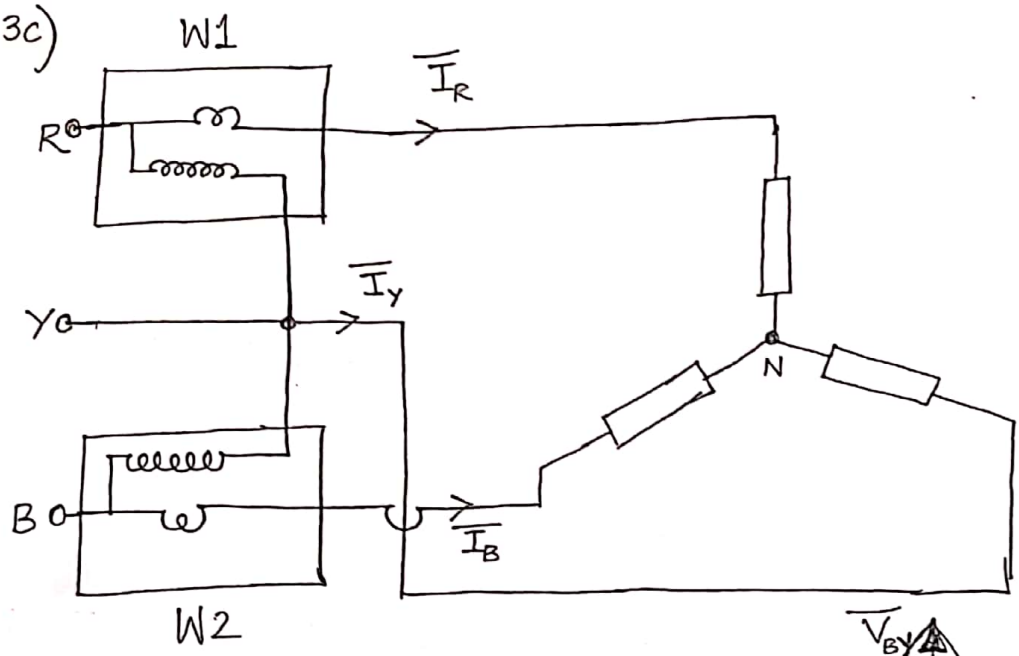
i) $I_L = \sqrt{3} I_{ph} = 10.89A$ [2M]

ii) $S_{3-phase} = \sqrt{3} V_L I_L = 7.545$ KVA [2M]

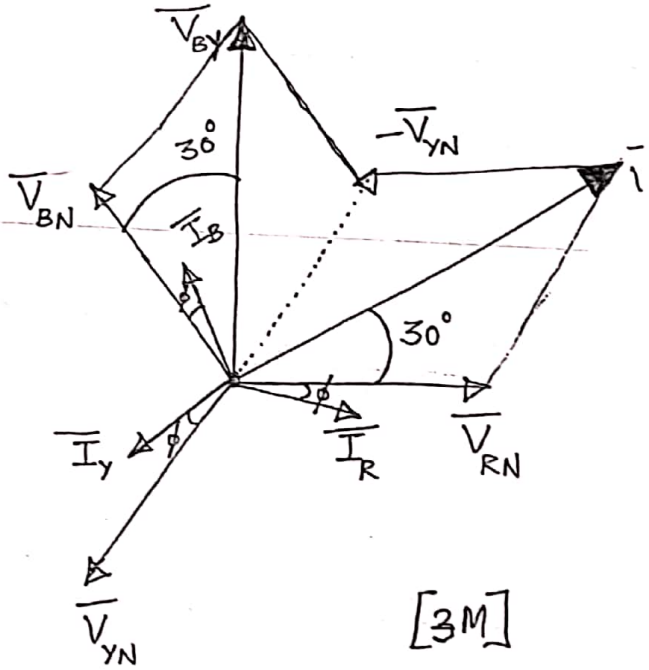
iii) $W_1 = V_L I_L \cos(30 + \phi) = -1.557$ KW

$W_2 = V_L I_L \cos(30 - \phi) = 2.744$ KW [2M]

3c)



[2M]



[3M]

Reading of Wattmeter 1,

$$W_1 = V_{RY} I_R \cos(30+\phi)$$

$$= V_L I_L \cos(30+\phi)$$

Reading of Wattmeter 2,

$$W_2 = V_{BY} I_B \cos(30-\phi)$$

$$= V_L I_L \cos(30-\phi)$$

$$\therefore W_1 + W_2 = V_L I_L \cos(30+\phi) + V_L I_L \cos(30-\phi)$$

$$= \sqrt{3}\, V_L I_L \cos\phi$$

$$= P_{3-phase}$$

[3M]

4a) Let N_1 = Number of primary turns
N_2 = Number of secondary turns
v_1 = supply voltage
e_1 = primary induced EMF
e_2 = secondary induced EMF [2M]

Let $\phi = \phi_m \sin\omega t$ represent the magnetic flux in the core where ϕ_m is maximum flux.

$$e_1 = -N_1 \frac{d\phi}{dt}$$

$$= -N_1 \phi_m \omega \cos\omega t = N_1 \phi_m \omega \sin(\omega t - 90^\circ) \text{ V}$$

[2M]

$\therefore E_1$ = RMS value of primary induced EMF

$$= \frac{e_m}{\sqrt{2}}$$

$$= 4.44 f \phi_m N_1 \text{ volts} \quad [2M]$$

Similarly, $e_2 = -N_2 \frac{d\phi}{dt}$

$$= N_2 \phi_m \omega \sin(\omega t - 90^\circ) \text{ V}$$

$$\Rightarrow E_2 = \frac{e_{2m}}{\sqrt{2}} = 4.44 f \phi_m N_2 \text{ volts}$$

[2M]

4b) Three phase Induction Motor construction details:
The stator has a three phase winding fed from supply.

Rotor of Squirrel cage Induction motor is a cylindrical structure which carries rotor conductors which are heavy bars made of copper or aluminium bolted on either side to short-circuiting end rings. [3M]

PRINCIPLE OF OPERATION:

When three-phase stator winding is connected to a three-phase balanced supply, a rotating magnetic field is created. As this field moves past rotor conductors, due to Electromagnetic induction, EMF is induced in these conductors which inturn circulates currents in rotor conductors The current carrying rotor conductors in presence of magnetic field experience force which rotates the rotor in same direction as rotating magnetic field in order to satisfy Lenz's law. [3M]

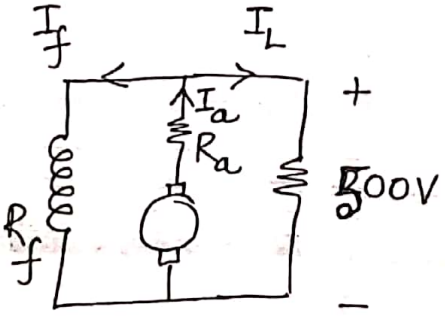
c)

a) As a Generator

P_{out} = 9KW (given).

$I_L = \frac{P_{out}}{V} = \frac{9000}{500}$

$= 18A$



$I_f = \frac{500}{250} = 2A$

$\Rightarrow I_a = I_L + I_f = 20A$

Total losses = $P_{mech} + P_{iron}$ + Arm. cu loss + Field cu loss

$= 500 + 300 + 20^2 \times 0.5 + 2^2 \times 250$ [2M]

$= 2000W$

$\therefore \eta_{Generator} = \frac{P_{out}}{P_{out} + losses} \times 100 = \frac{9KW}{11KW} \times 100$

$= 81.81\%$ [2M]

b) As a Motor

$P_{in} = 9KW \Rightarrow I_L = \frac{9000}{500} = 18A$

$I_a = I_L - I_f = 16A$

Total losses $= 500 + 300 + 16^2 \times 0.5 + 2^2 \times 250$

$= 1928W$ [2M]

$\therefore P_{out} = 7072W$

$\Rightarrow \eta_{Motor} = \frac{P_{in} - losses}{P_{in}} \times 100 = 78.57\%$ [2M]

5a)

Based upon Voltage rating

1) Low Tension cables with a max. Voltage of 1kV
2) High Tension cables " " " 11kV
3) Super Tension cables " " " 33kV
4) Extra High Tension cables " " 66kV
5) Extra super Voltage cables " " above 132kV

[2M]

Based on construction

1) Belted cables used upto 11kV
2) Pressure cables for voltages beyond 66kV
   Pressure cables can be Oil filled cables or Gas filled cables

[2M]

5b)

i) A fuse is an electric/electronic or mechanical device used to protect circuits from overload or overcurrent.
It is based on the heating effect of the electric current
It has inverse time-current characteristic
It is the cheapest form of protection available

[3M]

ii) ELCB Stands for Earth Leakage circuit breaker

It detects the earth leakage current & makes the power supply off (trips) during earth leakage

Voltage ELCB & current ELCB are the types of ELCB

It mainly consists of a sensing coil placed on a solenoid which energises the relay during fault condition. [3M]

5c) i)

S.No.	Name of the Appliance	Units per day	Units per month
1.	4 Bulbs.	$60 \times 4 \times 10 = 2400$ Whrs $= 2.4$ units	$= 2.4 \times 30 = 72$
2.	4 Fans	3.6 units	108
3.	Geyser	1 unit	30
4.	Refrigerator	1.6 units	48
5.	Television	0.5 units	15
6.	Mixer Grinder	0.75 units	22.5

Total Units consumed = 295.5 units [5M]

ii)

(I) Fixed charges = $1 \times 50 + 2 \times 60$

$= Rs.\ 170/-$

(II) Energy consumption charges = 30×3.5
$+ 70 \times 4.95$
$+ 100 \times 6.5$
$+ 95.5 \times 7.55$

$= Rs.\ 1822.525/-$

Total charges = (I) + (II) = $1992.525/-$

Tax @ 7.3 % = $145.454/-$

∴ Monthly bill = $\underline{Rs.\ 2137.979/-}$

[5M]