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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU)

I / II Semester B. E. Regular / Supplementary Examinations Feb-2024

Common to all programs

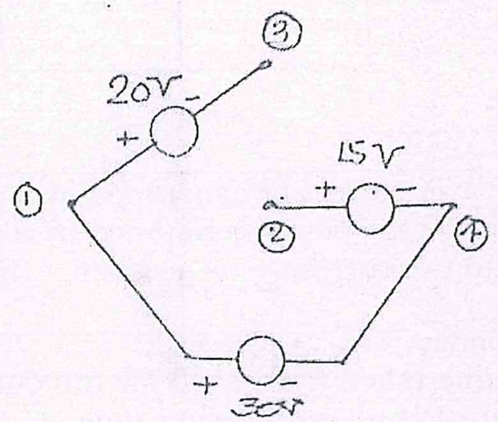
BASICS OF ELECTRICAL ENGINEERING

Time: 03 Hours ***Maximum Marks: 100***

Instructions to candidates:

1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer SIX full questions from Part B. In Part B question numbers 2 is compulsory. Answer any one full question from 3 and 4, 5 and 6, 7 and 8 & 9 and 10.

PART-A

1	1.1	Refer to Fig. 1.1 and find the voltages V_{12}, V_{23} and V_{34}.  Fig. 1.1	02
	1.2	An AC voltage of $e = 200\sin(314t - 30^0)$ $Volts$ drives a current of $i = 20\sin(314t + 30^0)$ $Amperes$. What will be the power factor and the average power?	02
	1.3	The necessary two conditions of a balanced three phase vectors are ________.	02
	1.4	What is hysteresis loss and how it is minimized in transformers?	02
	1.5	A $3-phase, 4-pole, 400V, 50Hz$ induction motor runs at a speed of $1440rpm$, calculate its slip.	02
	1.6	The vectorial sum of three balanced currents is ________.	01
	1.7	Mention the different types of single phase transformers.	01
	1.8	Why the core loss is considered as constant loss in transformers?	01
	1.9	What is the condition for maximum efficiency in a transformer?	01
	1.10	What do you mean by slip?	01
	1.11	The average value of a pure cosine wave having amplitude of $10V$ is ________.	01
	1.12	The rms value of a sine wave is $10units$, what is peak value?	01
	1.13	Define voltage regulation of a transformer.	01
	1.14	Why the efficiency of a transformer is always higher than other machines?	01
	1.15	Why the induction motors are also called asynchronous motors?	01

PART-B

2 a In the circuit shown in Fig. 2.a, find the potential difference across $x - y$ terminals and the power delivered by the 1 Ohm resistor.

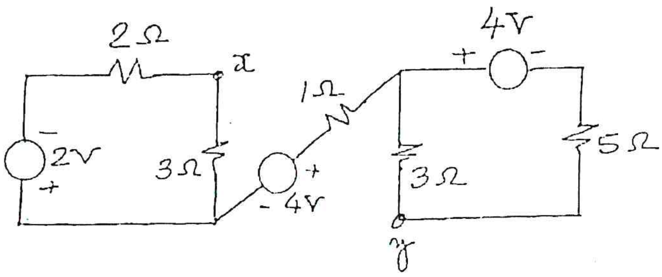


Fig. 2.a — **08**

b State and explain Thevenin's theorem, using this theorem find the power dissipated to a load resistance of 10 $Ohms$ in the circuit shown in Fig. 2.b

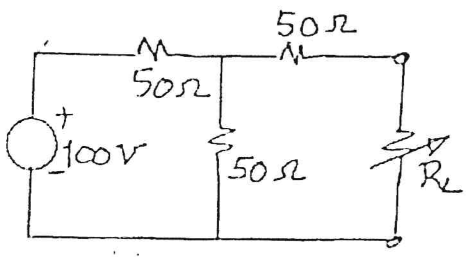


Fig. 2.b — **08**

3 a Show that the average power consumed in an AC circuit in $VIcos\phi$. — **06**

b Show that the average power consumed by a pure inductor is zero. — **04**

c An alternating current is given by : $i = 10\sin 942t\ A$. Determine:

- i) frequency,
- ii) the time taken from $t = 0$ for the current to reach a value of $6A$ for the first and second time,
- iii) the energy dissipated when the current flows through a 20 Ohm resistor for 30 $minutes$.

— **06**

OR

4 a Draw and explain the vector diagram of an $R - L - C$ series circuit excited by a supply of E volts when:

- i) $X_L = X_C$,
- ii) $X_L > X_C$,
- iii) $X_L < X_C$.

— **08**

b Find the value of R and C in the circuit shown in Fig. 4.b, so that $V_b = 3V_a$ and V_b are in quadrature. Also find the current I.

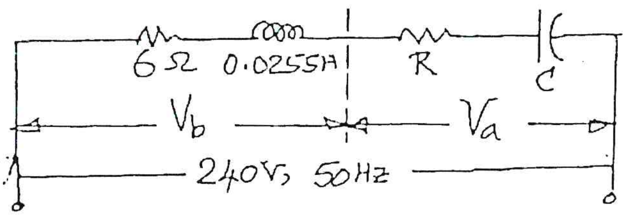


Fig. 4.b — **08**

Q.No.		Question	Marks
5	a	Write the mathematical representation of three phase voltages with i) instantaneous values, ii) RMS values, iii) vector diagrams.	08
	b	Show that two watt meters are sufficient to measure three phase power with a delta connected load.	08
		OR	
6	a	Show that the $e.m.f.$ induced per turn is same for both primary and secondary windings of transformers.	08
	b	The primary and secondary windings of a $500kVA$ transformer have resistances of 0.42 and 0.0019 Ohm respectively. The primary and secondary voltages are 11000 and 400V respectively and the core loss is $2.9kW$. Assuming the power factor of 0.8 calculate the efficiency at full load.	08
7	a	Explain the principle of torque production in three phase induction motors.	05
	b	Draw the typical torque slip characteristics of wound rotor induction motor and mark all the salient points on it.	05
	c	A $6-pole$ induction motor is supplied by a $3-phase, 50Hz$ supply has a rotor frequency of $2.3\ Hz$. Calculate: i) the percentage slip, ii) speed of the rotor. What will be these values if the stator is wound for 4 poles?	06
		OR	
8	a	Explain why the starting torque is zero for a single phase induction motor, and how this will be produced.	05
	b	Draw the electrical schematics of various types of single phase induction motors.	05
	c	Draw and explain the rotor construction of the two types of three phase induction motors.	06
9	a	Define the term 'Power System' and explain the same with the help of a block diagram showing all its components.	06
	b	Differentiate between 'Fuse' and 'MCB' and mention the advantages and disadvantages.	06
	c	What are preventive measures of electrical shock, explain.	04
		OR	
10	a	What is earthing, why it is necessary and explain with diagram 'plate earthing'?	08
	b	A domestic house uses the following appliances whose details are in the table below:	08

$Sl.No.$	$Appliances$	$Power\ Rating$	$Quantity\ Nos.$	$Usage\ per\ day\ (Hrs)$
1	$LED\ bulbs$	$9\ W$	10	4
2	$LED\ tube\ lights$	$20\ W$	3	6
3	$Geysers$	$2\ kW$	2	1
4	$Water\ pump$	$500\ W$	1	2
5	$Ceiling\ fans$	$55\ W$	6	3
6	$Mixer\ grinder$	$1200\ W$	1	1
7	$Induction\ top$	$1500\ W$	2	6

COURSE CODE: 22ES14D/24D COURSE: Basics of Electrical Engineering UG

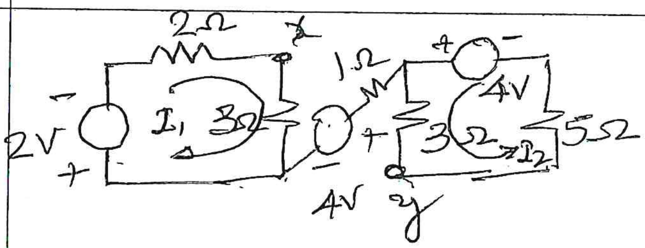
Question No		Marks
1.1	$V_{12} = 15\,V$, $V_{23} = 5V$, $V_{34} = 10V$.	
1.2	$\phi = 60^\circ$ pf $= \cos 60 = 0.5$, $P = \frac{200}{\sqrt{2}} \cdot \frac{20}{\sqrt{2}} \cos 60 = 1000\,W$	
1.3	Equal magnitude and 120° phase angle separation	
1.4	Due to the magnetic reversal in the core the molecular friction results in power loss in heating the core. To minimise high permeability core is used.	
1.5	$s = \frac{N_s - N}{N_s} = \frac{1500-1440}{1500}$ $N_s = \frac{120 \times 50}{4} = 1500\,rpm$ $= \underline{0.04 \text{ or } 4\%}$	
	2x5	10
1.6	Vectorial Sum is Zero	
1.7	Core type and Shell type	
1.8	Core loss is Constant as the Voltage V and frequency f are fixed/constant	
1.9	condition for max. efficiency is Iron loss = Cu loss	
1.10	Slip is the ratio of Slip speed to Syn-Speed.	
1.11	The avg Value of Cosine wave $= \frac{2V_m}{\pi} = \frac{20}{\pi} V$	
1.12	$V_{peak} = \sqrt{2}\, V_{RMS} = \sqrt{2} \times 10 = 14.14$ units	
1.13	It is the change in the Sec. t.v. between NL and FL expressed as a percentage of FL tv at a given power factor	
1.14	η is high, as there are no mechanical losses	
1.15	I.M's never runs at Syn. Speed hence the name asynchronous motor	
	1x10	10

SCHEME AND SOLUTION SEPT/OCT -2023

COURSE CODE: COURSE: UG

Question No		Marks

2(a)



$I_1 = \frac{2}{5} = 0.4A$

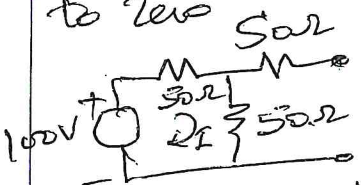
$I_2 = \frac{4}{8} = 0.5A$

$V_{xy} - 3I_1 + 4 - 3I_2 = 0$

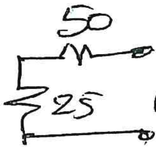
$V_{xy} = 3I_1 - 4 + 3I_2 = -3 \times 0.4 - 4 + 3 \times 0.5 =$

$V_{xy} = -3.7V$

(b) Thevenin's theorem Any active, linear, bilateral network with two output terminals can be represented by a single voltage in series with an equivalent single resistance / impedance across these two terminals, where the single source is the Thevenin source which is the OC voltage across the terminals and the single impedance is the equivalent impedance measured across the same two terminals with all the internal sources set to zero



R_{Th}:



$R_{Th} = 75\Omega$

V_{Th}: $I = \frac{100}{100} = 1A$, $V_{Th} = 50I = 50V$

∴ Th. Eq:

$I_L = \frac{50}{75+10} = 0.5882A$

$P_L = I_L^2 R_L = (0.5882)^2 \times 10$

$= 3.46W$

3(a) The avg power in an AC ckt is $VI\cos\phi$.

$v = V_m \sin\omega t$, $i = I_m \sin(\omega t \pm \phi)$

$p = vi = V_m I_m \sin\omega t \cdot \sin(\omega t \pm \phi)$.

$P = \int p\,dt = VI\cos\phi$

SCHEME AND SOLUTION

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COURSE CODE: COURSE:

Question No		Marks

3(b) The average power consumed by an inductor is zero

$v = V_m \sin\omega t$, $i = I_m \sin(\omega t - 90^\circ)$ (as I lags V)

$p = vi = V_m I_m \sin\omega t \cdot \sin(\omega t - 90)$

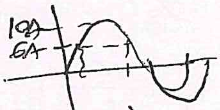
$= -V_m I_m \sin\omega t \cos\omega t$

$P = \int vi\,dt =$ Zero

(c) $i = 10\sin 942t$ $\omega = 942$

(i) $f = \frac{\omega}{2\pi} = \frac{942}{2\pi} = 150\,Hz$

(ii)



$6 = 10\sin 942t_1$

$\sin 942t_1 = 0.6$ rad

$t_1 = \frac{\sin^{-1} 0.6}{942} = 0.68\,ms$

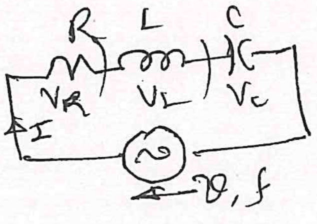
Period $= \frac{1}{f} = \frac{1}{150} = 6.67\,msec$

for 2nd time $t_2 = t_1 + T = 0.68 + 6.67 = 7.35\,msec$

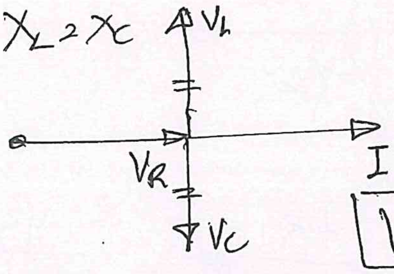
(iii) Energy $= I^2Rt$ Wsec

$= \left(\left(\frac{10}{\sqrt{2}}\right)^2 \times 20 \times \frac{30}{60}\right) 10^{-3} = 0.5$ kWhr

4(a)



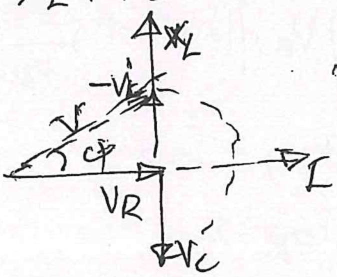
(i) $X_L = X_C$



$\phi = 0^\circ$

$\boxed{V = V_R}$

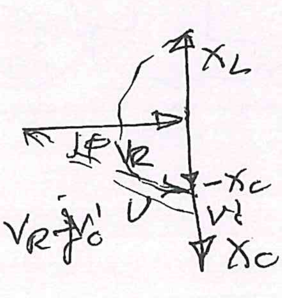
(ii) $X_L > X_C$



$V = V_R + jV_L'$

φ lag.

(iii) $X_L < X_C$



φ lead

$V = V_R - jV_C'$

One line explanation.

SCHEME AND SOLUTION

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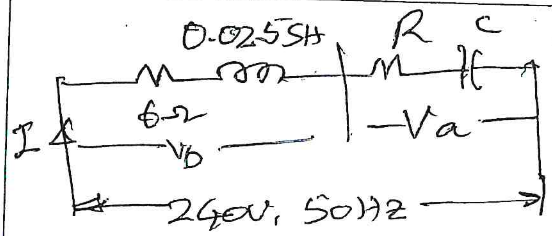
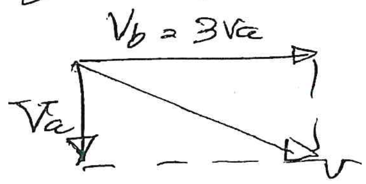
Question No		Marks

4(b)



$V_b = 3V_a$



$X_L = 314 \times 0.0255 = 8\,\Omega$

$V = 3V_a - j V_a = V_a(3 - j1) = 3.1623\, V_a \angle -18.13^\circ$

$3.1623\, V_a = 240 \quad \therefore V_a = 75.89\text{V}. \quad V_b = 227.67\text{V}$

$I = \dfrac{V_b}{Z_b} = \dfrac{227.67}{6 + j8} = 22.77 \angle -53.13^\circ$ A.

$Z_a = \dfrac{V_a}{I} = \dfrac{75.89 \angle -90^\circ}{22.77 \angle -53.13} = 3.33 \angle -36.87\ \Omega$

$= (2.66 - j2)\,\Omega$

$\therefore R = 2.66\,\Omega$

$X_C = 2\,\Omega = \dfrac{1}{314\,C} \quad \therefore C = \dfrac{1}{314 \times 2} = 1592\ \mu F$

5(a) (i) $\bar{V}_R = |V_R| \sin \omega t$

$\bar{V}_Y = |V_Y| \sin(\omega t - 120^\circ)$

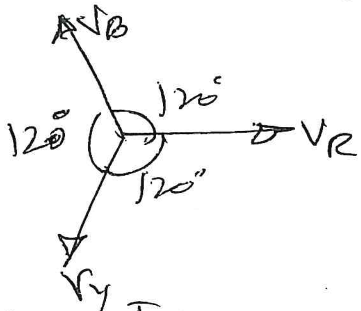
$\bar{V}_B = |V_B| \sin(\omega t + 120)$

(ii) $\bar{V}_R = V_R \angle 0^\circ$

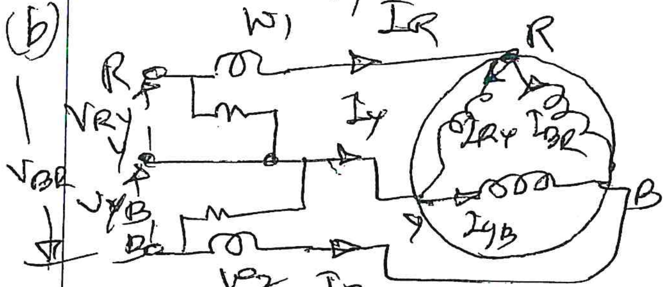
$\bar{V}_Y = V_Y \angle -120^\circ$

$V_B = V_B \angle 120^\circ$

(iii)



(b)

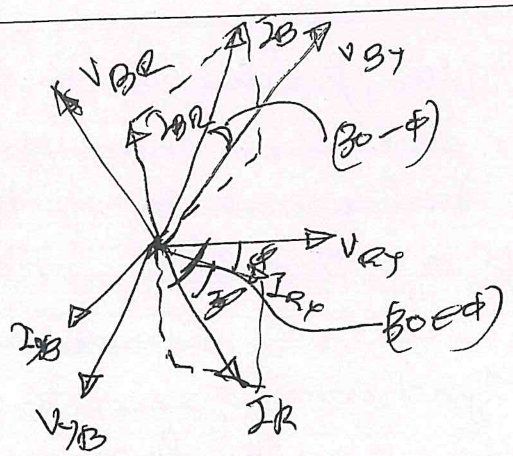


$W_1 = |V_{RY}||I_R| \cos \angle_{V_{RY}}^{I_R}$

$W_2 = |V_{BY}||I_B| \cos \angle_{V_{BY}}^{I_B}$

$I_R = I_{RY} - I_{BR}$

$I_B = I_{BR} - I_{YB}$

Question No		Marks
		

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

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

$\underline{W_1+W_2 = \sqrt{3} V_L I_L \cos\phi}$

6(a) Emf Eqn. $E_1 = 4.44 f \phi_m N_1$ volts (To derive)

& $E_2 = 4.44 f \phi_m N_2$ volts

$\frac{E_1}{N_1} = 4.4 f \phi_m = \frac{E_2}{N_2}$ Hence Emf per turn is same for both pri & sec.

(b) 500kVA, $E_1 = 11000$V, $E_2 = 400$.

$I_1 = \frac{500\times10^3}{11000} = 45.45A$, $I_2 = \frac{500\times10^3}{400} = 1250A$

Pri Cu loss $= I_1^2 R_1 = (45.45)^2 \times 0.42 = 867.59W$

Sec Cu loss $= I_2^2 R_2 = (1250)^2 \times 0.0019 = 2968.75 W$

Total Cu loss $= 867.59 + 2968.75 = 3836.34W$
$= 3.836$ kW

Core loss $= 2.9$kW.

output $= 500$ kVA $\times 0.8 = 400$ kW.

Input = output + Total losses $= 400 + 3.836 + 2.9$
$= 406.736$ kW.

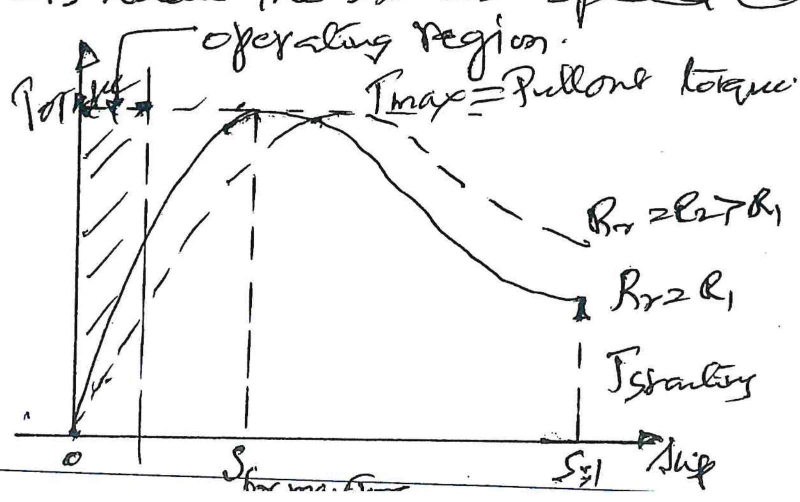
$\eta = \frac{\text{output}}{\text{Input}} = \frac{400}{406.736} \times 100 = \underline{98.34\%}$

SCHEME AND SOLUTION

SEPT/OCT -2023

COURSE CODE: COURSE: UG

Question No		Marks
7(a)	Principle of torque production in 3 ph IM's. Whenever a balanced three emfs are applied to a balanced set of three windings there sets up a revolving magnetic field which revolves electrically at a speed called synchronous speed given by $N_s = \frac{120f}{P}$ where f is the freq of the applied emf and P the total no. of poles for which the stator windings are wound. In this revolving field if a closed coil system mounted on a freely rotating cylinder is placed, the revolving stator flux cuts the stationary coils, inducing an emf in these coils. As the coils are shorted (closed) there sets up a current which in turn establishes a second flux. These two fluxes interact resulting in a force acting on the rotor coils (tangential force) which makes the rotor to rotate in the direction of the stator field but cannot catch up the stator speed. The rotor speed is always less than the stator speed causing a slip.	
b)		



SCHEME AND SOLUTION SEPT/OCT -2023 UG

COURSE CODE: COURSE:

Question No		Marks
6(c)	$P=6, f=50\,Hz \quad f_r=2.3\,Hz$	

(i) $Slip = \frac{f_r}{f} = \frac{2.3}{50} = 0.046$ or 4.6%.

(ii) $N_s = \frac{120f}{P} = \frac{120\times 50}{6} = 1000$ rpm.

$N = N_s(1-s) = 1000(1-0.046) = 954$ rpm.

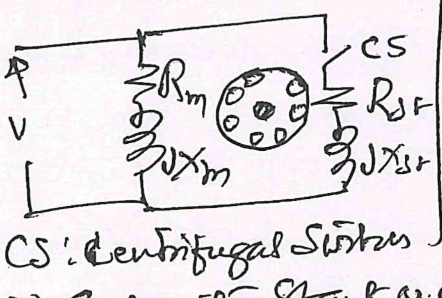
If $P=4$, $N_s = 1500$.

$N = 1500(1-0.046) = 1431$ rpm.

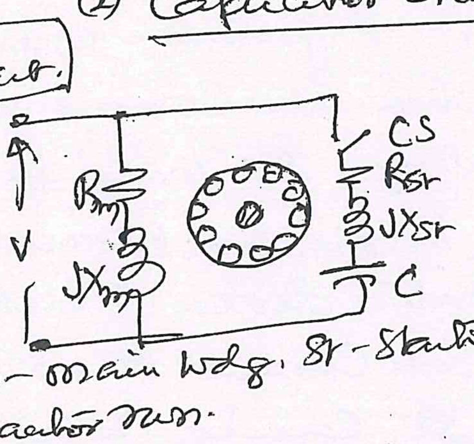
8(a) Whenever a coil is excited by 1φ AC Supply there will not be any revolving magnetic field as a result the torque is zero at the starting. Hence as it is 1φ IM are not self starting. In order to create a rotating field, we introduce one more coil in parallel with the main winding, their planes are at 90°. The two fluxes in quadrature setup a field which revolves (Double field reaction) (Split phase) thereby torque is produced in the stationary rotor.

(b) Types of 1φ IM's.

(1) Split phase/Resistance Start.

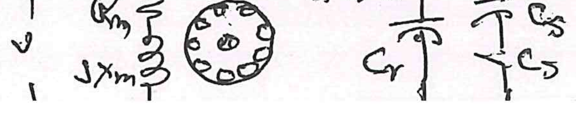


(2) Capacitor Start



CS: Centrifugal Switch   m – main wdg. st – Starting winding.

(3) Capacitor Start & Capacitor run.



C_r = Capacitor run

C_s = Capacitor Start.

SCHEME AND SOLUTION

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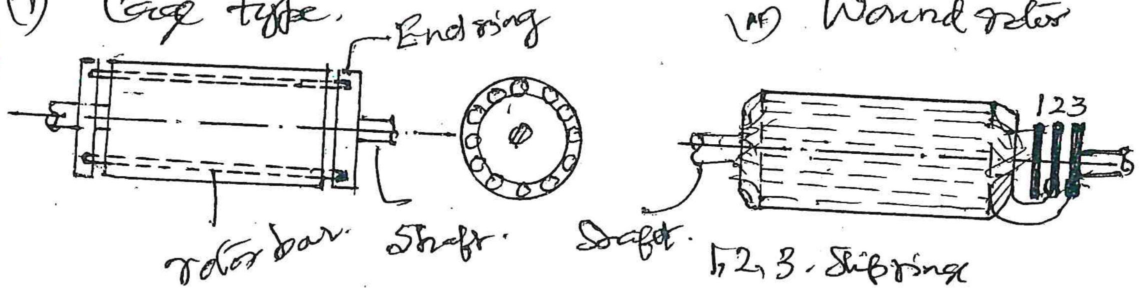
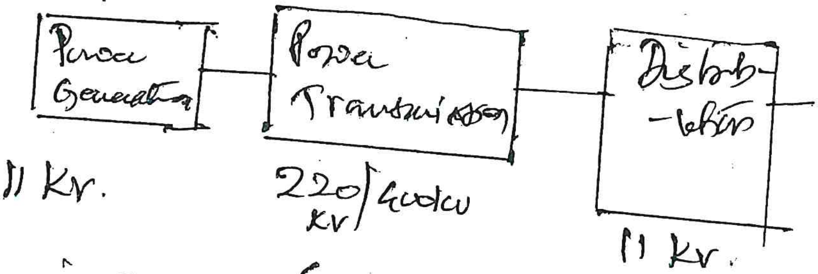
Question No		Marks
8C	Rotors of 3ph IM's	

(i) Cage type. (ii) Wound rotor



Plus explanation on each.

9(a) Power System: It is the combination of Electrical power generation, transmission and distribution.

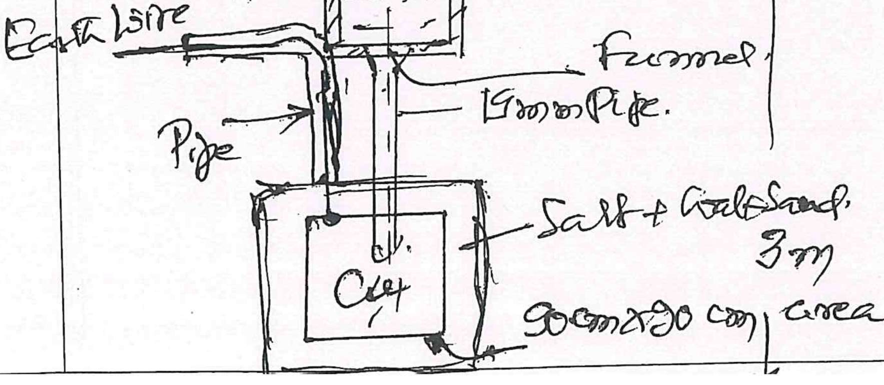


Power is generated (Transformed) at generating Stations (Hydro, thermal & Nuclear) at 11 kV and the Voltage is stepped up to 220kV or 400V through stepup transformers and transmitted over long distances and stepped down to 66 kV and then 11 kV for distribution. Three phase power generation & Transmission

(b) Fuse: - A protective element (wire) which fuse out when the current through this exceeds its rating. It need to be replaced everytime.

MCB: Miniature Circuit breaker is an automatic device which trips off the circuit when the current thro' it exceeds its preset Value. It can be reset after the fault is cleared

Question No		Marks
9(c)	Preventive measures for electrical shocks.	
	(1) Insert plastic safety caps in all unused electrical outlets if small children are at home.	
	(2) Do not plug too many things on a single outlet	
	(3) Periodic inspection of electrical wirings and sockets	
	(4) Replace old electrical points/gadgets.	
	(5) Proper grounding is to be maintained.	
	6) Wear rubber shoes and gloves while operating on electrical equipments	
	(7) Do not touch electrical gagets with wet hands	
10(a)	Earthing is a process of creating a least resistance path for any fault current occur due to the failure of insulation or any other reason. It is necessary to safe guard the life of a person, when he touches the faulty device, It prevents severe electric shock as the major fault current is diverted to the earthing point.	



With explanation.

SCHEME AND SOLUTION

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Question No		Marks
(10 b)	LED bulbs 1) $10 \times 9 \times 4 \times 10^{-3} = 0.36$ Kwhr. 2) LED tube lights : $3 \times 20 \times 6 \times 10^{-3} = 0.36$ Kwhr 3) Geysers : $2 \times 2 \times 1$ = 4 Kwhr 4) Water pump : $0.5 \times 1 \times 2$ = 1 Kwhr 5) Fans : $55 \times 6 \times 3 \times 10^{-3}$ = 0.99 Kwhr 6) Mixer : $1.2 \times 1 \times$ = 1.2 Kwhr 7) Induction Stove : $1.5 \times 2 \times 6$ = 18 Kwhr. Total Consumption/day = 25.91 Kwhr Monthly Consumption : $25.91 \times 30 = 773.3$ Units At the rate of Rs 7/- per unit Total amount = $773.3 \times 7 = 5441.10$ Rs 8% tax = 435.30 Rs Total Monthly Bill : 5441.10 + 435.30 = 5876.40 Rs verified Nandan G. 06/03/2024.	