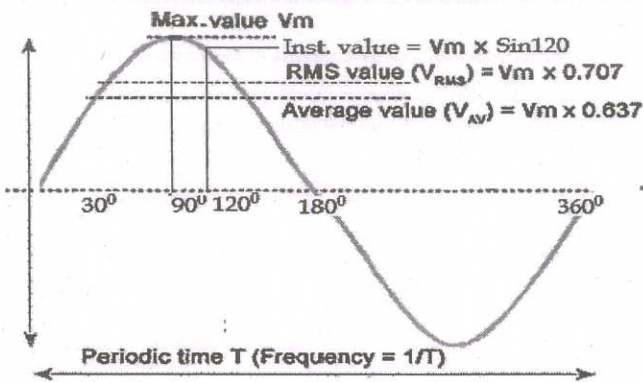
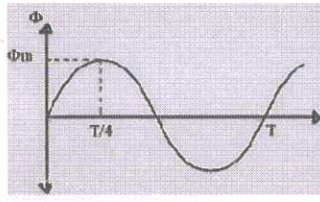
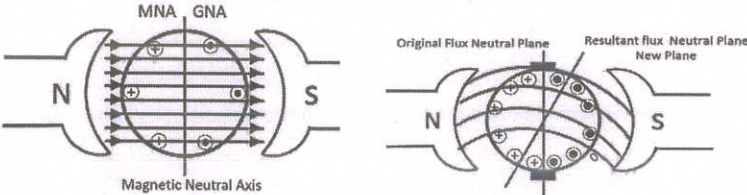
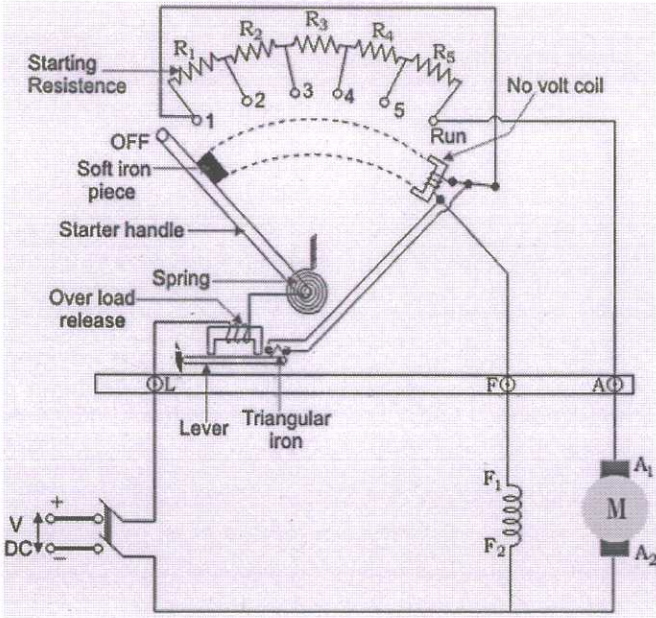


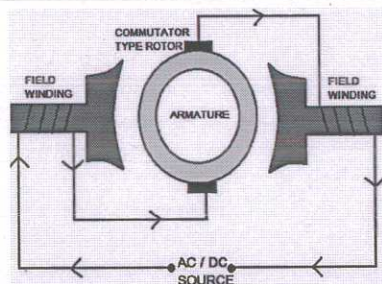
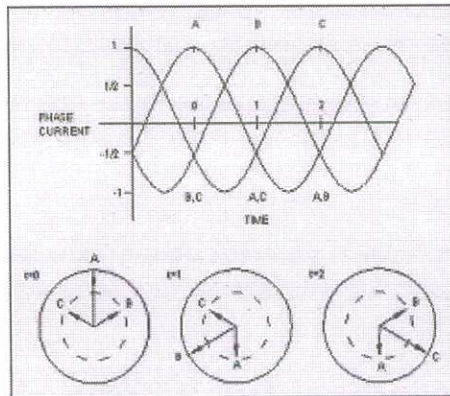
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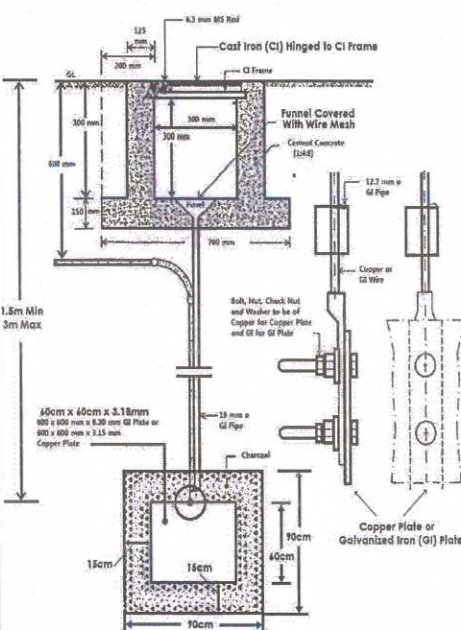
Q. No.	Scoring Indicators	Split score	Total Score
<u>PART-A</u>			
I			
1.	It is analogous to the resistance in a circuit. $X_L = 2\pi fL \Omega$	2	2
2.	The current has Max. value I_m , instantaneous value $i = I_m \sin\omega t$, $i = I_m \sin 2\pi f t$ Average value $I_{av} = 2I_m/\pi$, RMS value $I = I_m/\sqrt{2}$	Any 2	2
3.	$E_1 = 4.44 N_1 \phi_m f$ Volts $E_2 = 4.44 N_2 \phi_m f$ Volts	1+1	2
4.	It is a type of compound wound DC motor, in which series field and shunt field fluxes are mutually supportive.	2	2
5.	Blowers, Drills, domestic appliances like food mixers, vacuum cleaners, hair dryers, washing machines	Any 2	2
<u>PART-B</u>			
II			
i.		2 X 3	6
ii.	<p>If max. value is V_m</p> <p>Instant. value, $v = V_m \sin\omega t$</p> <p>Average value is $V_{av} = 2V_m/\pi = 0.632 V_m$</p> <p>RMS value = $V_m/\sqrt{2} = 0.707 V_m$</p>	3	

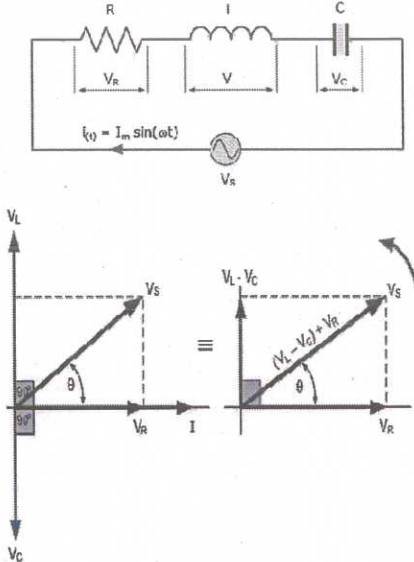
Q. No.	Scoring Indicators	Split score	Total Score
<p>.... II ii.</p>		3	6
<p>iii.</p>	<p>N_1 = Number of turns in primary winding N_2 = Number of turns in secondary winding Φ_m = Maximum flux in the core (in Wb) = $(B_m \times A)$ f = frequency of the AC supply (in Hz) Also $T = 1/f$ From the wave form, the flux rises sinusoidally to its maximum value Φ_m from 0. and it reaches the maximum value in one quarter of the cycle i.e in $T/4$ sec Therefore, average rate of change of flux = $\Phi_m / (T/4)$ $= \Phi_m / (1/4f)$ Average rate of change of flux = $4f \Phi_m$ (Wb/s). As per Faraday's law, Induced emf per turn = rate of change of flux per turn Therefore, average emf per turn = $4f \Phi_m$(Volts). Form factor = RMS value / average value = 1.11 for Sine wave RMS value of emf per turn = $1.11 \times 4f \Phi_m$ $= 4.44f \Phi_m$. & $N4.44f \Phi_m$ for N turns of coils</p> 	<p>Fig 2 Exp.3 Eqn.1</p>	6
<p>iv.</p>	<p>The armature reaction is the effect of the armature flux on the main flux. When armature conductors rotate in the main field flux, it will produce its own flux which will affect the main flux. The flux distribution becomes uneven and results in sparking and humming, reduced output and reduced generator efficiency.</p>	2	

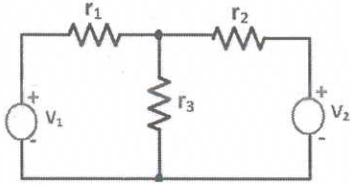
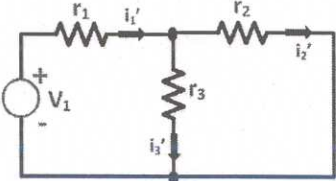
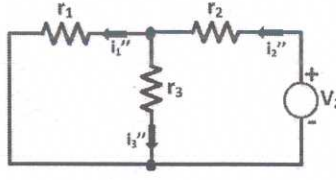
Q. No.	Scoring Indicators	Split score	Total Score
<p>.... II iv.</p>	 <p>Effects: Armature reaction weakens the main flux, which results in reduced generated voltage. Armature reaction distorts the main flux, hence the position of M.N.A. gets shifted (M.N.A. is perpendicular to the flux lines of main field flux) and sparking in commutator and brush contacts happens</p>	<p>2 2</p>	<p>6</p>
<p>v.</p>	<ol style="list-style-type: none"> 1. 'L' Line terminal (Connected to positive of supply) 2. 'A' Armature terminal (Connected to the armature winding) 3. 'F' Field terminal (Connected to the field winding) <p style="text-align: center;"><u>3 point starter</u></p> 	<p>6</p>	<p>6</p>

Q. No.	Scoring Indicators	Split score	Total Score
II vi.	<p>When 3-phase windings placed 120° apart spatially, carry 3-phase currents, it produces magnetic fluxes in each phase with a 120° phase difference. A resultant flux will be created, which will be rotating in the air gap with synchronous speed. From the 3-phase wave forms, we can find the direction of resultant flux at each instant as shown. It is due to this resultant rotating magnetic field, the armature conductors of the rotor get induced emf and current. As the armature conductors carrying induced current will produce its own magnetic field, which in turn will oppose the effect which produced it. Thus, the rotor starts rotating in such a direction that, the relative speed between rotor and rotating stator magnetic flux reduces. But rotor will never be able to catch up with the synchronous speed of stator flux and will settle down at speed slightly less than synchronous speed. The difference in speeds of rotor and rotating magnetic field is called slip of an induction motor.</p>	<p>Fig. 3 Exp 3</p>	<p>6</p>
vii	<p>Universal Motor: They are series motors which works on ac and dc. The core and poles are laminated. Same current flows through field and armature as they are in series. magnetic fields are developed in the armature and field windings. In these motors, the current induced in the series field coils and armature coil interacts with each other and corresponding magnetic fields act on each other, which leads to generate the primary torque to move the rotor shaft. They develop unidirectional torque.</p>	<p>Fig. 3 Exp. 3</p>	<p>6</p>

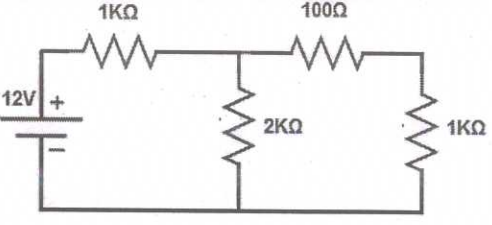
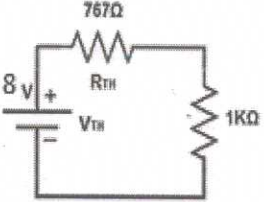


Q. No.	Scoring Indicators	Split score	Total Score
<p>III a)</p>	<p style="text-align: center;"><u>PART-C</u></p> <p>Earthing is the conductor to connect the metallic parts of electric machinery and devices to the earth plate or earth electrode (which is buried in the moisture earth) through a thick conductor wire (which has very low resistance) for safety purpose is known as <i>Earthing or grounding</i>. It is meant to avoid or minimize danger during discharge of electrical energy.</p> <p>In plate earthing system, a plate made up of either copper with dimensions 60cm x 60cm x 3.18mm (i.e. 2ft x 2ft x 1/8 in) or galvanized iron (GI) of dimensions 60cm x 60cm x 6.35 mm (2ft x 2ft x 1/4 in) is buried vertical in the earth (earth pit) which should not be less than 3m (10ft) from the ground level. The plate is used as an earth electrode which has very low resistance and carry the fault current safely towards ground. The earth plate is inserted into auxiliary layers of coke and salt for a minimum thickness of 15 cm. The earth wire (GI or copper wire) is tightly bolted to an earth plate with the help of nut or bolt. Usually, to maintain the moisture condition, 25mm (1inch) coal and lime mixture around the earth plate is put.</p> 	<p>Fig. 4</p> <p>Exp 4</p>	<p>8</p>
<p>b)</p>	<p>$V = V_m \sin \omega t = 200 \sin 314t$</p> <p>$R = 10 \Omega \quad C = 200 \mu F$</p> <p>$V_m = 200 \text{ V or } V = 200/\sqrt{2} = 141.44 \text{ V}$</p> <p>$\omega = 2\pi f = 314 \quad \text{or } f = 314/2\pi = 50 \text{ Hz}$</p> <p>$X_c = 1/(2\pi f C) = 1/(2\pi \times 50 \times 200 \mu F) = \mathbf{15.9 \Omega}$</p> <p>$Z = \sqrt{R^2 + X_c^2} = \sqrt{10^2 + 15.9^2} = \mathbf{18.7 \Omega}$</p> <p>Power factor $\cos \phi = R/Z = 10/18.7 = \mathbf{0.534}$</p> <p>Current $I = V/Z = 141.44/18.7 = \mathbf{7.56 \text{ A}}$</p> <p>Power = $VI \cos \phi = 141.44 \times 7.56 \times 0.534 = \mathbf{570.8 \text{ W}}$</p>	<p>2</p> <p>2</p> <p>2</p> <p>1</p>	<p>7</p>

Q. No.	Scoring Indicators	Split score	Total Score
<p>IV a)</p>	<p>V- applied voltage I - resultant current $V_R = IR$ - Drop across R $V_C = IX_C$ - Drop across C Due to capacitance, V_C lags V_R by 90° Due to inductance, V_L leads V_R by 90° By the combined effect, From the vector diagram, It is $(V_L - V_C)$. The resultant vector, $V = \sqrt{V_R^2 + (V_L - V_C)^2}$ $(IZ)^2 = (IR)^2 + (I(X_L - X_C))^2$ Or $Z = \sqrt{R^2 + (X_L - X_C)^2}$ Current $I = V/Z = V/\sqrt{R^2 + (X_L - X_C)^2}$ $p.f = \cos \phi = \frac{R}{Z}$ $\tan \phi = (X_L - X_C)/Z$ Power = $v \times i = V_m \sin \omega t \times I_m \sin(\omega t \pm \phi)$ $P = \frac{V_m I_m \times 2 \sin \omega t \sin(\omega t + \phi)}{2}$ as the pulsating component has an average value of zero, Resistive component only develops true power. $P = V \times I \times \cos \phi$</p> 	<p>Fig. 2 Exp-4 Eqn. 1</p>	<p>7</p>
<p>IV b)</p>	<p>$R=50 \text{ Ohms}$ $V=230 \text{ V}$ $f=50 \text{ Hz}$ $L=0.015 \text{ H}$ $X_L = 2 \times 3.14 \times 50 \times 0.015 = 4.71 \text{ Ohms}$ $C=250 \mu\text{F}$ $X_C = 1000 / (314 \times 25) = 12.7 \text{ Ohms}$ $Z = \sqrt{R^2 + (X_C - X_L)^2} = \sqrt{50^2 + 8^2} = \sqrt{2500 + 64} = 50.6 \text{ Ohms}$ $I = V/Z = 230/50.6 = 4.54 \text{ A}$ $P.F. = \cos \phi = R/Z = 50/50.6 = 0.98 \text{ leading}$ $P = VI \cos \phi = 230 \times 4.54 \times 0.98 = 1024.5 \text{ W} = 1.024 \text{ kW}$</p>	<p>2 2 2 2</p>	<p>8</p>

Q. No.	Scoring Indicators	Split score	Total Score
<p>V a)</p>	<p>Superposition Theorem states that in a network of linear resistances containing more than one source, the current that flows at any branch in the circuit will be the algebraic sum of the currents which would flow at that point, if each source is considered separately while all other sources are made to zero or replaced by their internal resistances.</p> <p>Considering the circuit shown, First consider the first source alone is acting</p>   $i_1' = \frac{V_1}{\frac{r_2 r_3}{r_2 + r_3} + r_1} \dots \dots \dots (1)$ $i_2' = i_1' \frac{r_3}{r_2 + r_3} \dots \dots \dots (2)$ <p>Consider second source alone is acting</p>  $i_2'' = \frac{V_2}{\frac{r_1 r_3}{r_1 + r_3} + r_2} \quad \text{and} \quad i_1'' = i_2'' \frac{r_3}{r_1 + r_3}$ <p>Combining the effects, by superposition,</p> <p>$i_1 = i_1' - i_1''$ $i_3 = i_3' + i_3''$ $i_2 = i_2' - i_2''$</p>	<p>Def 2</p> <p>Fig. Eqn. 4</p> <p>2</p>	<p>8</p>
<p>V b)</p>	<p>Based on Construction:- 1. Core type 2. Shell type</p> <p>Based on voltage level:- 1. Step-up 2. Step-down</p> <p>Based on application:</p> <ol style="list-style-type: none"> 1. Power transformer 2. Distribution transformer 3. Instrument transformer-CT,PT <p>Based on Supply system:- 1. Single phase 2. 3-phase</p> <p>Based on winding:-</p> <ol style="list-style-type: none"> 1. Auto transformer 2. Two winding transformer <p>Based on installation:- Indoor & outdoor</p>	<p>Any relevant 7</p>	<p>7</p>

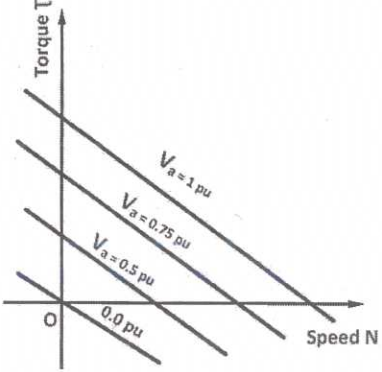
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Q. No.	Scoring Indicators	Split score	Total Score
<p>VI a)</p>	 <p>Removing the load from the circuit,</p>  <p>Circuit current = $I = 12 / (2k\Omega + 1k\Omega) = 4mA$ Voltage at load terminals $V_{Th} = 4mA \times 2k\Omega = 8V$ Removing the source and short circuiting , Resistance at load terminals, $R_{TH} = (1k\Omega / / 2k\Omega) + 100\Omega = 767\Omega$ Load current $I = V_{Th} / (R_{TH} + R_L)$ $= 8 / (767\Omega + 1k\Omega) = 2 \times 4 = 4.5 mA$ Voltage Across Load = $4.5 mA \times 1k\Omega = 4.5 V$</p>	<p>Thev. Ckt. 2 2 2 2</p>	<p>8</p>
<p>VI b)</p>	<p>In an ideal transformer, the power to the primary coil is transferred to the secondary coil without any loss or with zero loss. Windings are assumed to be purely inductive in nature, core is of pure ferromagnetic material and the transformer is having 10% efficiency.</p> <p>In practical transformers, there are losses occurring in core and windings of the transformer. Due to this some of the power is lost in the core and windings.</p> <p>There are two types of losses in a transformer- core loss (iron loss) and copper loss.</p> <p>Iron loss: Mainly happens in core material. It is due to the magnetic property of the core. Hysteresis and eddy current losses are the main components of this core loss. It is practically constant at any load condition</p> <p>Hysteresis Loss is due to the heat generated due to the hysteresis of magnetization of core material. Silicon content is added more to the steel to reduce hysteresis loss. Hysteresis Loss, $W_h \propto f$</p> <p>Eddy current loss is due to the heating effect of eddy currents formed in the core material. It is reduced by splitting the circulating area by using smaller laminations insulated from each other. Eddy current loss, $W_e \propto f^2$</p> <p>Copper loss: Due to the I^2R loss arising from the ohmic resistance of the copper windings of primary and secondary.</p>	<p>2 2 2 1</p>	<p>7</p>

Q. No.	Scoring Indicators			Split score	Total Score
VII b)	Type of Motor	Characteristics	Applications	7	7
	Shunt	Approx. const. speed Adjustable speed Medium starting torque	Lathes Centrifugal pumps Machine tools Blowers Fans Reciprocating pumps		
	Series	Variable speed Adjustable variable speed Very high starting torque	Traction work Elect. locomotives Trolley cars Conveyors Cranes and hoists		
	Cumulative Compound	Variable speed Adjustable variable speed High starting torque	For shears and punches Elevators Conveyors Heavy planners Printing presses Rolling mills Air compressors		
VIII a)	<p><u>Significance of back emf in DC motors</u> In DC motors, when DC supply is given, armature rotates in the field. Hence, armature conductors will cut the field flux, and an emf called back emf(E_b), will be induced in them. The direction of this induced emf will be opposite to that of applied voltage according to Fleming's right hand rule. The applied voltage has to drive armature current I_a against the opposition of E_b. The power required to overcome this opposition is $E_b I_a$. The electric work done in overcoming and causing the current to flow against E_b is converted into mechanical energy developed in the armature. The energy conversion in a dc motor is only possible due to the production of back emf E_b. We have, $I_a = (V - E_b) / R_a$ and $E_b = (\phi ZN / 60) \times (P / A)$ E_b depends on armature speed. If speed is high, E_b is large and I_a is small. If speed is low, E_b is less and more will be I_a and torque.. So back emf acts like a self regulating mechanism to draw sufficient current only to get sufficient torque.</p>			1 2 2 2	7

Q. No.	Scoring Indicators	Split score	Total Score
<p>.... IX a)</p>	<p>(a) Schematic representation</p> <p>(b) Phasor diagram</p> <p>Fig. 3</p> <p>A capacitor is connected in series with starting winding. so that current I_{st} leads the applied voltage by some angle, ϕ_{st}. The running winding is inductive in nature so, the current flowing in running winding lags behind applied voltage by an angle, ϕ_m. There will be a phase differences between these two currents which will produce fluxes with phase differences and a resultant current, I and a rotating magnetic field. Since the torque produced by these motors depends upon the phase angle difference, which is almost 90°, these motors produce very high starting torque. A centrifugal switch is provided so as to disconnect the starting winding when the motor attains a speed up to 75 to 80% of the rated speed. In capacitor start capacitors run induction motor there is no centrifugal switch so, the capacitor remains in the circuit</p>	<p>2</p>	<p>8</p>
<p>IX b)</p>	<p><u>PM type Stepper motor</u> It has stator coils with projected poles and rotor salient poles made of Permanent Magnet. The rotor coils are energized by the electric pulses of either polarity. This will make the stator poles magnetize in either polarity and accordingly the PM rotor teeth will take a position. The stator windings may have 2, 3, or 4-phases, which are given by solid state switches.</p>		

Q. No.	Scoring Indicators	Split score	Total Score
<p>.... IX b)</p>	<p>A 2-phase PM type stepper motor is shown. When the stator windings are excited with a DC supply, it produces magnetic flux and creates N and S poles. Due to the force of attraction and repulsion between PM rotor and stator poles, the rotor will move up to a position for which pulses are given to the stator. When the phase A is energized with a positive pulse, the N and S poles are created as shown and the rotor poles align with stator poles such that the magnetic pole axis of rotor adjusts with that of stator as shown in figure. When B is excited with positive pulse after switching off A, the rotor further adjusts to magnetic axis of phase B, and thus rotates through 90 degrees in clockwise direction. Next, if the phase A is energized with a negative current with respect to A', the N and S poles of stator will reverse and will cause the rotor to move through another 90 degrees in clockwise direction. Now, if coil B is excited with negative current by closing phase A switch, the rotor rotates through another 90 degrees in the same direction. Next, if the phase A is excited with positive current, the rotor comes to the original position thus making a 360 degrees complete revolution. This implies that, whenever the stator is excited, the rotor tends to rotate through 90 degrees in clockwise direction. The step-angle of this 2-phase 2-pole permanent magnet rotor motor is expressed as, $360 / (2 \times 2) = 90$ degrees.</p>	<p>Fig. 3</p> <p>Exp. 4</p>	<p>7</p>

Q. No.	Scoring Indicators	Split score	Total Score
<p>X b</p>	<p>The speed and torque of the rotor are controlled by the phase difference between the control voltage and the reference phase voltage. By reversing the phase difference from leading to lagging or vice versa, the direction of the rotation of the rotor can be reversed. The torque speed characteristic of the two phase AC servomotor is shown</p> <p>The negative slope represents a high rotor resistance and provides the motor with better stability. The curve is linear for almost various control voltages.</p> <p>They usually run on frequency of 60Hz to 400 Hz.</p> 	<p>2</p> <p>2</p>	<p>8</p>