WINTER– 2018 EXAMINATION

Model Answer **Subject Code: 22221**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.		**Attempt any FIVE of the following:**	**10 M**
	a	**State Faraday's laws of Electromagnetic induction.**	
		Ans:	
		First Law: Whenever change in the magnetic flux linked with a coil or conductor, an EMF is induced in it. **OR** Whenever a conductor cuts magnetic flux, an EMF is induced in conductor.	**01**
		Second Law: The Magnitude of induced EMF is directly proportional to (equal to) the rate of change of flux linkages.	**01**
		$e = \frac{-N}{dt} d\varphi$	
	b	**Define: (i) Amplitude (ii) Cycle with reference to AC waveform.**	
		Ans:	
		1. **Amplitude:** It is defined as the maximum or peak value attained by an alternating quantity during its positive or negative half cycle.	**01**
		2. **Cycle with reference to AC waveform:** A complete set of variation of an alternating quantity which is repeated at regular interval of time is called as a cycle. **OR** Each repetition of an alternating quantity recurring at equal intervals is known as a cycle.	**01**
	c	**Define: (i) Phase (ii) Phase Difference.**	
		Ans:	
		1. Phase: It is the instantaneous angle covered by a sinusoidal waveform with respect to positive zero crossing.	**01**
		2. Phase Difference: It is the difference, expressed in degrees or radians, between two waves having the same frequency and referenced to the same point in time.	**01**
	d	**Define: (i) Phase Voltage (ii) Line Voltage with reference to polyphase A.C. circuits.**	
		Ans: Phase Voltage: The RMS value of the voltage between any lines to neutral point is called as phase voltage.	**01**
		Line Voltage: The RMS value of the voltage between any two lines is called as line voltage.	**01**

	e	**State how to reverse the rotation of 3-phase induction motor.** **Ans:** Direction of rotation of a three phase I.M. can be changed by interchanging any two supply terminals i.e. by reversing the direction of rotating magnetic field.	**02**
	f	**State any two applications of DC servomotor.** **Ans:** 1) CNC machines 2) Robotic arms 3) Pick and Place machines 4) Auto focus mechanism of camera 5) Antenna position control	**02**
	g	**State the principle of operation of ELCB.** **Ans:** **Operation of ELCB (Earth Leakage Circuit Breaker) :** It works on principle of relaying when the current in the earth path exceeds a set value. Under normal conditions (IL–IN) = If is very low or nearly zero. The CT surrounding the phase and neutral senses the differential current under earth fault and actuates the CB to operate (open). The difference current If through fault path resistance Re is the leakage to earth. If this value exceeds a preset value, then the ELCB opens. **OR** The ELCB detects fault currents from live to the Earth (ground) wire within the installation it protects. If sufficient voltage appears across the ELCB's sense coil, it will switch off the power, and remain off until manually reset. A voltage-sensing ELCB does not sense fault currents from live to any other earthed body.	**02**
2.		**Attempt any THREE of the following:**	**12 M**
	a	**Compare electric circuit with magnetic circuit on the basis of any two similarities and any two differences. Any Four Point expected : (1 Mark each)** **Ans:**	**04**

Sr. No.	Electric circuit	Magnetic circuit
1	Path traced by the current is known as electric current.	The magnetic circuit in which magnetic flux flow
2	EMF is the driving force in the electric circuit. The unit is Volts.	MMF is the driving force in the magnetic circuit. The unit is ampere turns.
3	There is a current I in the electric circuit which is measured in amperes.	There is flux φ in the magnetic circuit which is measured in the weber.
4	The flow of electrons decides the current in conductor.	The number of magnetic lines of force decides the flux.
5	Resistance (R) opposes the flow of the current. The unit is Ohm	Reluctance (S) is opposed by magnetic path to the flux. The Unit is ampere turn/weber.
6	$R = \rho. l/a$. Directly proportional to l. Inversely proportional to a. Depends on nature of material.	$S = l/(\mu_0\mu_r a)$. Directly proportional to l. Inversely proportional to $\mu = \mu_0\mu_r$. Inversely proportional to a
7	The current I = EMF/ Resistance	The Flux = MMF/ Reluctance

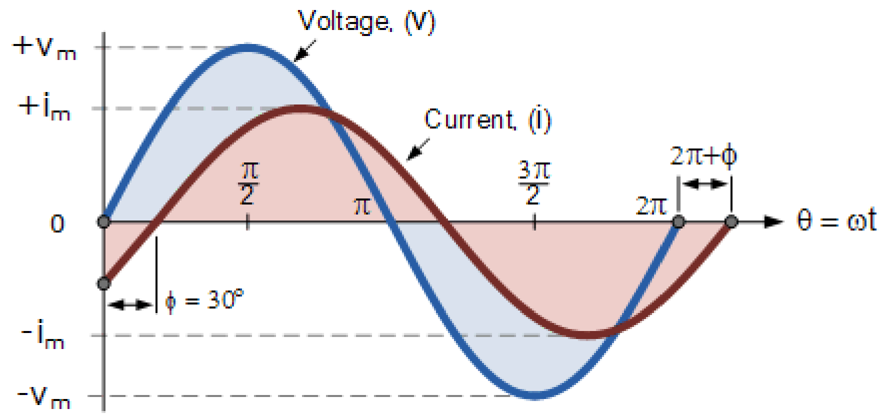
8	The current density	The flux density
9	Kirchhoff current law and voltage law is applicable to the electric circuit.	Kirchhoff mmf law and flux law is applicable to the magnetic flux.

Table: Compare Magnetic and Electric circuit

b **Draw neat waveforms and explain the concept of lagging and leading quantity.**

Ans:

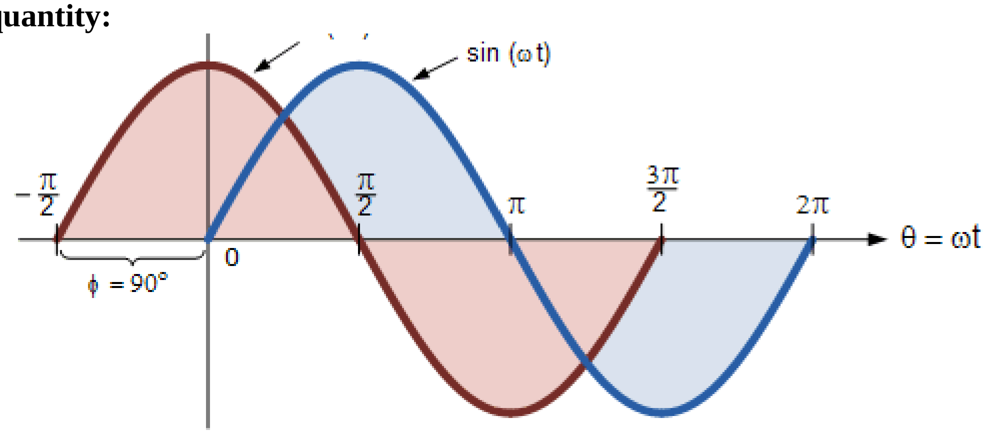
Lagging quantity:



01

The voltage waveform above starts at zero along the horizontal reference axis, but at that same instant of time the current waveform is still negative in value and does not cross this reference axis until 30 deg later. Then current waveform is lagging w.r.t voltage 01

leading quantity:



01

In the above figure, current waveform has already started before voltage waveform crosses horizontal reference axis. In this case current waveform is said to be leading voltage waveform. 01

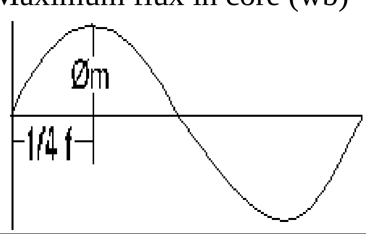
c **Derive the emf equation of single-phase transformer.**

Ans: EMF equation of single phase Transformer:

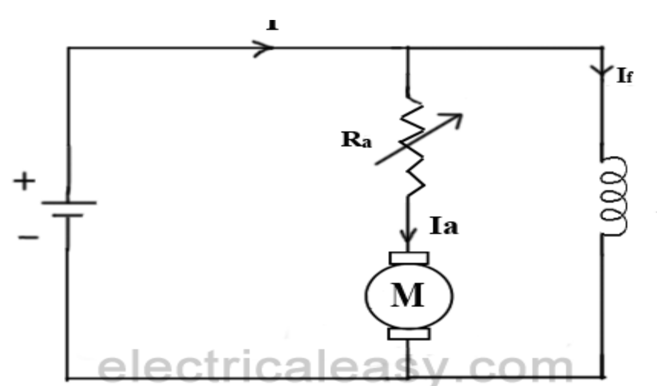
Let, N_1= Number of turns in the primary

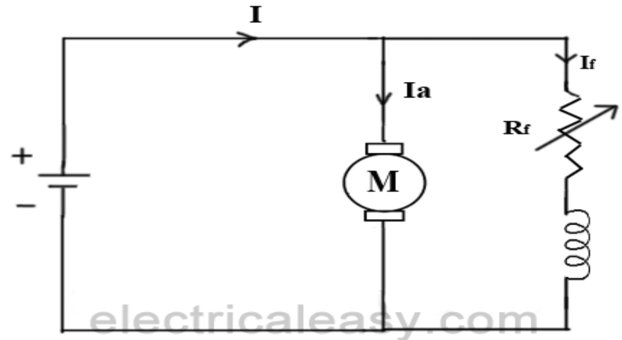
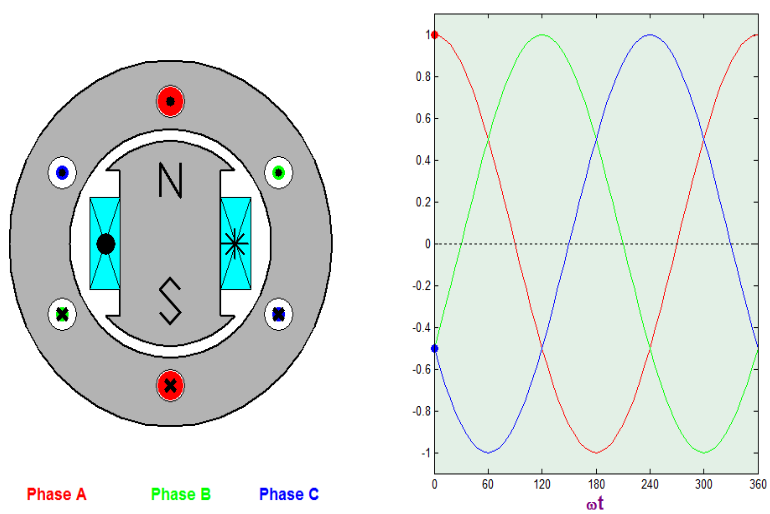
N_2= Number of turns in the Secondary

Øm= Maximum flux in core (wb)= BmxA and **F=** Frequency



1/2

		As shown in figure, flux increases from its zero value to maximum value Øm in one quarter of the cycle (i.e. ¼ f) sec **1. Average rate of change of flux** **2.** $\frac{\phi m}{1/4f}$ **= 4** $f\phi m$ **(wb/sec)** Rate of Change of flux per turn means induced emf, If flux various sinusoidally then r.m.s value of induced emf is obtained by multiplying the average value with form factor. From factor = $\frac{R.M.S\ Value}{average\ value}$ = 1.11 R.M.S. value of emf /turn = 1.11 x 4 f Øm= 4.44 f Øm R.M.S value in the whole primary winding = (induced emf / turn) x No. of primary turns E_1 = 4.44 f $\phi m N1$ **E_1 = 4.44 f BmAN_1** **OR E_1 = 4.44 ϕm f N_1** R.M.S. value in the secondary winding **E_2 = 4.44 f Bm A N_2** **OR E_1 = 4.44 ϕm f N_2**	1/2 1/2 1/2 01 01
	d	**Draw neat circuit diagrams and describe the methods of speed control of D.C. Shunt motor.** **Ans:** For DC shunt motor following is the equation for speed control $N \propto \frac{k \times E_b}{\Phi}$ Where, Eb is backing EMF and Φ is the flux. Eb is related to armature voltage as V = Eb + IaRa The speed of dc shunt motor is directly proportional to armature voltage and inversely proportional to flux. **Armature voltage control method:**  In this method armature voltage is controlled and it directly controls the speed below rated speed of motor.	02

		Flux control method:  In this method, field current is controlled which controls the speed above rated speed. Decrease in field current increases the speed.	02
3.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a	**Explain the concept of Dynamically induced emf and Statically induced emf.** **Ans:** **Dynamically induced emf:** If flux linking with a particular conductor is brought about by moving the coil in stationary field or by moving the magnetic field w.r.t. to stationary conductor. Then the e.m.f. induced in coil or conductor is known as “Dynamically induced e.m.f. E = B l. v. sinθ volts **Statically induced emf:** In the Statically induced emf flux linked with coil or winding changes (dΦ/dt) and coil or winding is stationary such induced emf is called Statically induced emf. E = - N (dΦ/dt)	02 02
	b	**Draw schematic diagram of elementary 3-phase generator and describe its operation in brief. Draw waveform of 3-phase emfs.** **Ans:**  The elementary 3-phase 2-pole synchronous generator is shown in the figure. It has a stator equipped with 3 coils displaced 120 deg from each other. The rotor produces magnetic field. It has electromagnets which are excited by supplying dc voltage. The magnetic field produced by rotor induces sinusoidal voltages are generated in the 3 stator phases, displaced 120deg in time and having a frequency directly related to rotor speed.	02 02

	c	**Compare Squirrel Cage Induction Motor and Slip Ring Induction Motor on the basis of any four points. (Any four points each 1 Mark)** **Ans:** **Comparison:**	04

Sr. No.	Squirrel Cage Induction Motor	Slip Ring Induction Motor
1	Rotor is in the form of bars	Rotor is in the form of 3-ph winding
2	No slip-ring and brushes	Slip-ring and brushes are present
3	External resistance cannot be connected	External resistance can be connected
4	Small or moderate starting torque	High Starting torque
5	Starting torque is of fixed	Starting torque can be adjust
6	Simple construction	Completed construction
7	High efficiency	Low efficiency
8	Less cost	More cost
9	Less maintenance	Frequent maintenance due to slip-ring and brushes.
10	Size is compact for same HP	Relatively size is larger
11	Speed control by stator control method only	Speed can be control by stator & rotor control method

d **State types of fuses and describe the operation of fuse. (Any Two Types expected: 1 Mark each)**

Ans:

Types of Fuses: (02)

1. Rewirable Fuses
2. HRC Fuse
3. Cartridge type Fuses
4. D-type Cartridge Fuse
5. Link Type Fuse
6. Blade and Bolted type Fuses
7. Striker type Fuse
8. Switch type Fuse
9. HV (High Voltage) Fuses
10. Cartridge Type HRC Fuse
11. Liquid Type HRC Fuse
12. Expulsion Type HV Fuse

Operation of Fuse: (02)

1. To break the circuit under fault condition.
2. To provide overcurrent protection to the circuit.
3. To provide short circuit protection to the circuit.
4. To provide safety to the users.

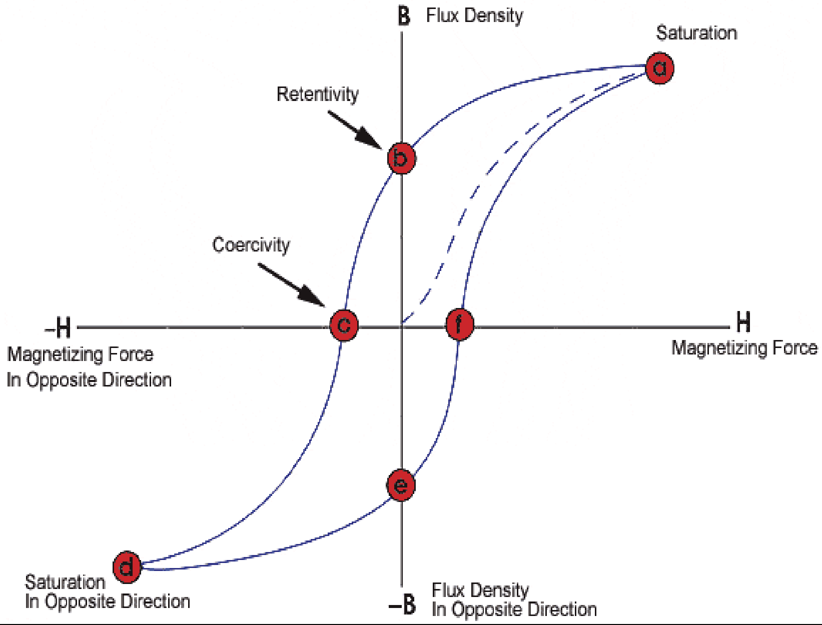
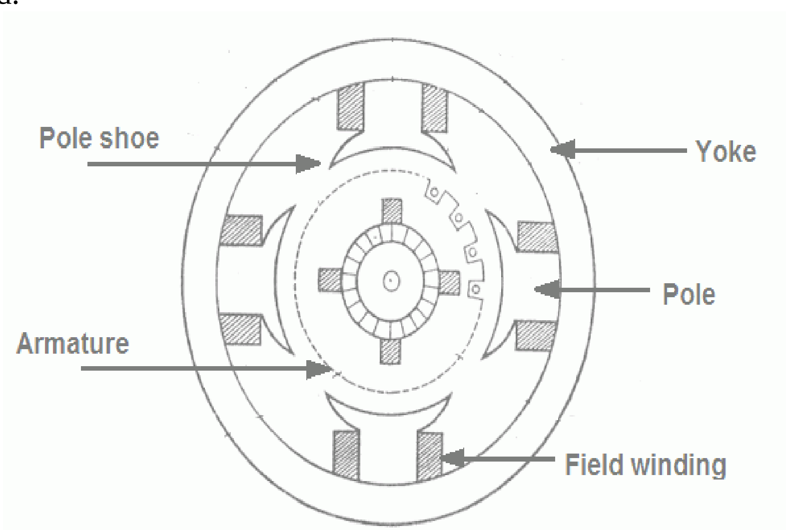
4. **Attempt any <u>THREE</u> of the following:** **12 M**

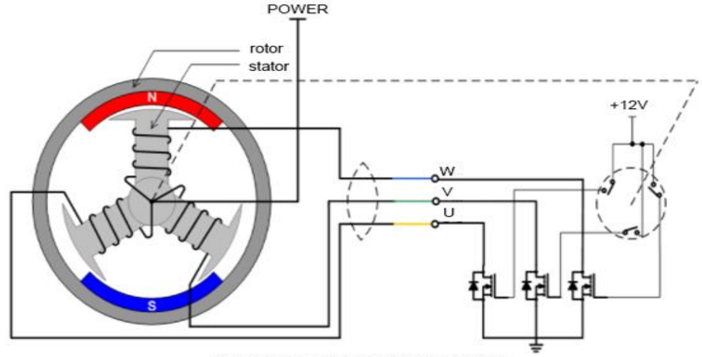
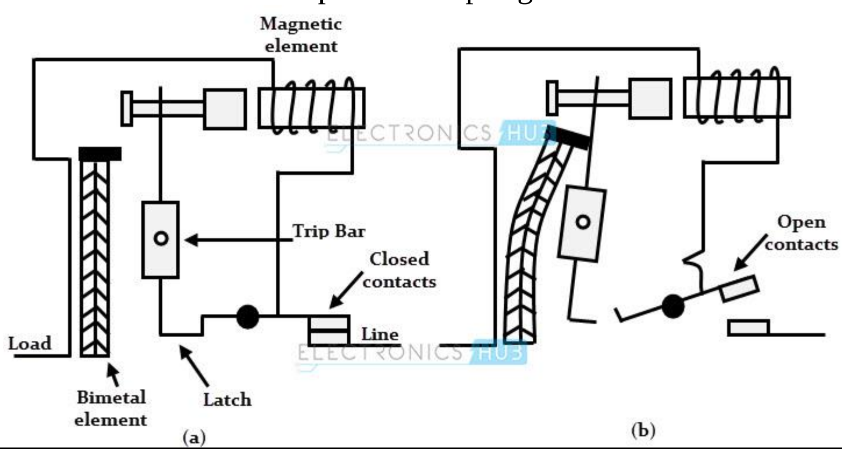
a **Draw hysteresis loop and define: (i) Magnetic hysteresis and (ii) Hysteresis loss.**

Ans:

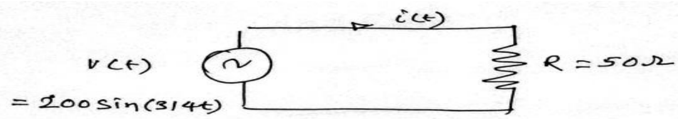
Magnetic Hysteresis: Defined as the loop that is generated by measuring the magnetic flux (BxA) of a ferromagnetic material while the magnetizing force (H) is changed. **01**

Hysteresis loss: It is the loss associated with hysteresis loop. It is defined as the power consumed by the magnetic domains for changing the orientation after every half cycle. **01**

			02
	b	**Draw constructional sketch of DC motor and state basic motor principle.** **Ans:** The principle of working of a DC motor is that "whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force". The direction of this force is given by Fleming's left hand rule and its magnitude is given by F = BIL. Where, B = magnetic flux density, I = current and L = length of the conductor within the magnetic field.	02
			02
	c	**Explain the working of three-phase induction motor.** **Ans:** **Working principle of 3-phase induction motor:** When 3-phase stator winding is energized from a 3-phase supply, a rotating magnetic field is set up in air gap which rotates round the stator at synchronous speed Ns (= 120 f/P). The rotating field passes through the air gap and cuts the rotor conductors, which as yet, are stationary. Due to the relative speed between the rotating flux and the stationary rotor, e.m.f. is induced in the rotor conductors. Since the rotor circuit is short-circuited, currents start flowing in the rotor conductors. These rotor current produces flux According to faradays law of electromagnetic induction torque is produced due to interaction between stator and rotor flux Which tends to move the rotor.so rotor starts rotating In the same direction as the rotating field according to Lenz's law.	04

	d	**Explain the basic principle of operation of Brushless D.C. motor.** **Ans:** The basic difference between ordinary DC motor and brushless dc motor (BLDC) is that commutator is not used in BLDC motor. An electronic switching circuit is used to carry out function of commutator. A BLDC motor also has a stator and a rotor. Permanent magnets are mounted on the rotor of a BLDC motor, and stator is wound with specific number of poles. This is the basic constructional difference between a brushless motor and a typical dc motor. Stator windings of a BLDC motor are connected to a control circuit (an integrated switching circuit). The control circuit energizes proper winding at proper time, in a pattern which rotates around the stator. The rotor magnet tries to align with the energized electromagnet of the stator, and as soon as it aligns, the next electromagnet is energized. Thus the rotor keeps running.  Brushless DC motor working principle	**04**
	e	**Describe the operation of MCCB.** **Ans:** A miniature circuit breaker basically is an electromagnetic device that automatically operates (or breaks) the circuit, if the current in the circuit reaches to a predetermined value. It can replace conventional Rewirable fuse in distribution board and are designed to operate accurately under both overloading and short circuit conditions. When overload current flows through the MCB, the bimetallic strip gets heated and causes to deflect. In doing so, it moves the trip lever and releases the latch mechanism and hence the contacts open under spring mechanism.  	**04**
5.		**Attempt any <u>TWO</u> of the following:**	**12 M**
	a	**A sinusoidal voltage v = 200 sin (314.2t) volt is applied across a resistance of 50 Ω. Determine :** **(i) Peak current Ip** **(ii) Average value of current** **(iii) RMS current I_{Rms}** **(iv) Frequency of current** **(v) Angular frequency of current** **(vi) Equation for instantaneous value of current.**	

Ans:



Current in the circuit i(t)

$i(t) = \frac{v(t)}{R} = \frac{200 \sin(314t)}{50} = 4 \sin(314.2t)$

$\therefore \quad i(t) = 4 \sin(314t)$

compare with

$i(t) = I_m \sin(\omega t) \Rightarrow I_m = 4A, \ \omega = 314.2 \ \frac{rad}{sec}$

i) Peak current $I_p = 4A$

ii) Average current $= 0.637 \ I_p = 0.637 \times 4A$

$= 2.548 A$

iii) RMS current $= I_{peak}/\sqrt{2} = \frac{4A}{\sqrt{2}} = 2.82 A$

iv) freq. of current $f = \frac{\omega}{2\pi} = \frac{314.2}{2\pi} = 50 Hz$

v) Angular Frequency $= \omega = 314.2$ rad/sec

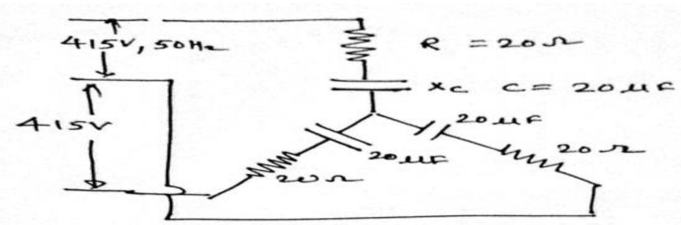
vi) Equation for inst value of current

$i(t) = 4 \sin(314.2t)$

06

b **Three identical impedances, each having resistance of 20 Ω and capacitance of 20 μF in series, are connected in star to the 3-phase, 415 volt, and 50 Hz supply. Determine: (i) Capacitive reactance, (ii) Impedance per phase (iii) Phase voltage (iv) Phase current (v) Power factor (vi) Total 3-phase power consumed by the load.**

Ans:



~~Zph = R+~~

$Z_{ph} = R - jX_C$

$R = 20\Omega \qquad X_C = \frac{1}{2\pi f C}$

① $C = 20 \mu F \qquad X_C = \frac{1}{2\pi \, 50 \times 20 \times 10^{-6}} \ \Omega$

$= \frac{1}{2\pi \times 10^{-3}} = 159.5 \Omega$

② $Z_{ph} = 20 - j\,159.5\Omega = 160.74 \angle -82.85°$

③ $V_{ph} = \frac{V_L}{\sqrt{3}} = \frac{415V}{\sqrt{3}} = 239.60V$

④ $I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{239.60}{160.74} = 1.5A$

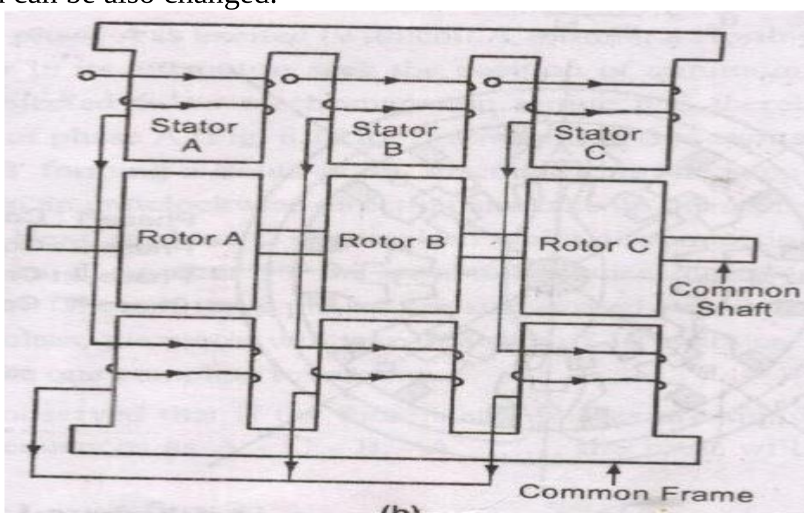
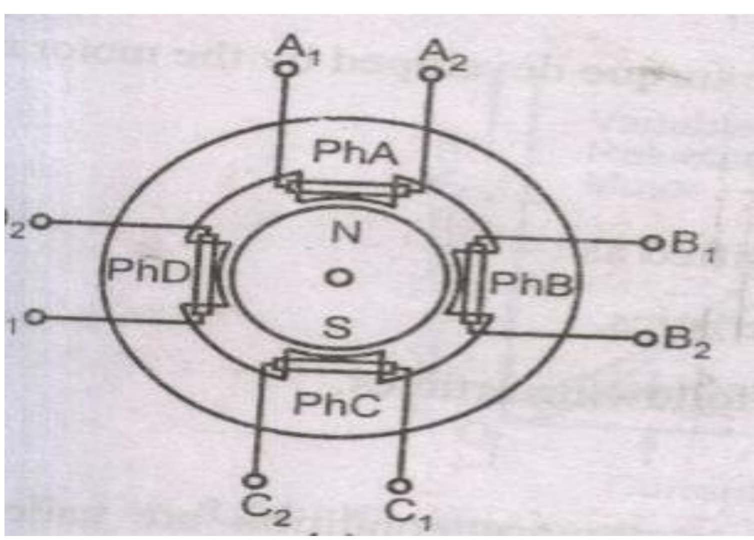
⑤ $PF = \cos\phi = \cos(82.85) = 0.12$ lead

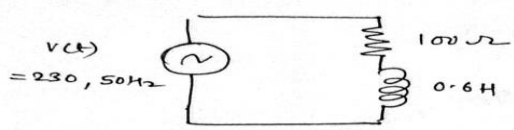
⑥ Total 3ph. power $= \sqrt{3} \ V_L I_L \cos\phi$

$= \sqrt{3} \times 415 \times 1.5 \times 0.12$

$= 134.22 \ W = 0.1342 \ kW$

06

	c	**State types of stepper motor. Draw a neat sketch and describe working of any one type of stepper motor. State any two applications of stepper motor.** **Ans:** **Types of Stepper Motor :-** 1) Variable Reluctance Motor 2) Permanent Magnet Motor **(Any One Type of Stepper Motor Expected: Figure : 1 Mark & Explanation : 1 Mark)** **1) Variable Reluctance Motors:** When phase A is excited rotor attempts minimum reluctance between stator and rotor and is subjected to an electromagnetic torque and there by rotor rotates until its axis coincides with the axis of phase A. Then phase 'B' is excited disconnecting supply of phase 'A' then rotor will move 30 anticlockwise directions. The Same process is repeated for phase 'C' In this way chain of signals can be passed to get one revolution and direction can be also changed.  **Or equivalent dia.** **OR** **2) Permanent Magnet Motor:** If the phase is excited in ABCD, due to electromagnetic torque is developed by interaction between the magnetic field set up by exciting winding and permanent magnet. Rotor will be driven in clockwise direction.  **Or equivalent dia.**	**02** **01** **01**

		Applications of stepper motor: **(Any two applications are accepted from following or equivalent 1 Mark each point)** 1.Suitable for use with computer controlled system 2. Widely used in numerical control of machine tools. 3. Tape drives 4. Floppy disc drives 5. Computer printers 6. X-Y plotters 7. Robotics 8. Textile industries 9. Integrated circuit fabrication 10. Electric watches 11. In space craft's launched for scientific explorations of planets. 12 Automotive 13. Food processing 14. Packaging	**02**
6.		**Attempt any <u>TWO</u> of the following:**	**12 M**
	a	**A series R-L circuit, consisting of a resistance of 100 Ω and an inductance of 0.6 H, is connected to 230 V, 50 Hz supply mains.** **Determine :** **(i) Inductive reactance (ii) Circuit impedance (iii) Circuit current (iv) Circuit power factor (v) Power consumed by the circuit (vi) Reactive power** **Ans:**  i) Inductive Reactance $X_L = 2\pi f L$ $= 2\cdot\pi\cdot 50 \times 0.6$ $= 188.49\ \Omega$ ii) Impedance $Z = \sqrt{R^2 + X_L^2}$ $= \sqrt{(100)^2 + (188.49)^2}$ $= 213.37\ \Omega$ iii) Current $= \frac{V}{Z} = \frac{230}{213.37} = 1.07\ A$ iv) PF $= \frac{R}{Z} = \frac{100}{213.37} = 0.4686$ lag. v) Power $= VI\cos\phi = 230 \times 1.07 \times 0.4686$ $= 115.33\ W$ vi) Reactive Power $= Q = VI\sin\phi$ $= 230 \times 1.07 \times \frac{188.49}{213.37} \left(\frac{X}{Z}\right)$ $= 217.40$ VAR	**06**

	b	**State any two applications of following each motor. Describe the reason of using these motors in their respective applications.** **(i) Shaded Pole Induction Motor** **(ii) Universal Motor** **(iii) AC Servo Motor** **Ans:** **i) Applications of Shaded Pole Induction Motor: (Any Two expected: 1 Mark each)** 1. In clocks 2. Exhaust fans 3. Hair dryers 4. Timing motors **ii) Applications of Universal Motor : (Any Two expected: 1 Mark each)** 1) Mixer 2) Food processor 3) Heavy duty machine tools 4) Grinder 5) Vacuum cleaner 6) Refrigerators 7) Driving sewing machines 8) Electric Shavers 9) Hair dryers 10) Small Fans 11) Cloth washing machine 12) Portable tools like blowers, drilling machine, polishers etc. **iii) Applications of AC servo motor : (Any Two expected: 1 Mark each)** 1. Robotics 2. Conveyor Belts 3. Camera Auto Focus 4. Robotic Vehicle 5. Solar Tracking System 6. Metal Cutting & Metal Forming Machines 7. Antenna Positioning 8. Woodworking/CNC 9. Textiles 10. Printing Presses/Printers 11. Automatic Door Openers	**02** **02** **02**
	c	**Describe the necessity of earthing and explain the methods of reducing earth resistance.** **Ans:** **Necessity of Earthing: (Any Two points are expected)** 1. To provide an alternative path for the leakage current to flow towards earth. 2. To save human life from danger of electrical shock due to leakage current. 3. To protect high rise buildings structure against lightening stroke. 4. To provide safe path to dissipate lightning and short circuit currents. 5. To provide stable platform for operation of sensitive electronic equipment's. **Methods of reducing earth resistance: (Any four points are expected)** 1. By adding mixture of salt and water to the earth pit. 2. By adding salt, charcoal and sand mixture to the pit. 3. By using a bigger grounding plate 4. By burying the ground plate as deep as possible 5. By having parallel ground plates with a distance of 10m between grounds 6. By using salt, charcoal etc., to reduce resistivity.	**02** **04**