WEST BENGAL UNIVERSITY OF TECHNOLOGY

EE-401

ELECTRIC MACHINE-I

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP A
(Multiple Choice Type Questions)

1. Answer any *ten* questions. $10 \times 1 = 10$

(i) The magnetic stored-energy density in iron is given by

(A) $\frac{1}{2}\varphi^2\mu$ (B) $\frac{1}{2}B^2\mu$ (C) $\frac{1}{2}\frac{B^2}{\mu}$ (D) $\frac{1}{2}\frac{B}{\mu}$

(ii) The developed electromagnetic force and/or torque in electromechanical energy conversion systems act in such a direction that tends

(A) to increase the stored energy at constant mmf
(B) to decrease the stored energy at constant flux
(C) to decrease the co-energy at constant mmf
(D) to decrease the stored energy at constant mmf

(iii) D.C. generator works on the principle of

(A) Fleming's left hand rule (B) Fleming's right hand rule
(C) Lenz's law (D) none of these

(iv) In normal D.C. machines operating at full-load conditions, the most powerful electromagnet is

(A) Field winding
(B) Armature winding.
(C) Interpole winding
(D) Interpole and Compensating windings together

(v) At a certain speed and flux, the voltage generated by a D.C. generator is 230 volts. If the speed is increased by 20% and the flux is simultaneously reduced by 10%, the voltage will be

(A) increased by 10% (B) reduced by 20%
(C) increased by 8% (D) decreased by 8%

(vi) In a 4-pole, 25 KW, 200V wave wound D.C. shunt generator the current in each parallel path will be

(A) 62.5A (B) 125A (C) 31.25A (D) 250A

(vii) A starting torque at 80 Nm is developed in an induction motor by an auto-transformer starter with a tapping of 30%. If the tapping of auto – transformer is 60%, then the starting torque will be

(A) 40 Nm (B) 160 Nm (C) 240 Nm (D) 320 Nm

(viii) Synchronous speed of an induction motor can be increased by

(A) reducing the mechanical friction (B) increasing the supply voltage
(C) increasing number of poles (D) increasing supply frequency

(ix) An 8- pole wound rotor induction motor operating at 60 Hz supply is driven at 1800 r.p.m. by a prime mover in the opposite direction of the revolving field. The motor current frequency is

(A) 60 Hz (B) 120 Hz
(C) 180 Hz (D) none of these

(x) The flux in transformer core

(A) increases with load
(B) decreases with load
(C) remains constant irrespective of load
(D) none of these

(xi) A 3-phase transformer has its primary connected in delta and secondary in star. Secondary to primary turns ratio per phase is 5. For a primary voltage of 400V, the secondary voltage would be

(A) 2000V (B) 80V (C) 3464V (D) $80\sqrt{3}$ V

(xii) In which transformer, the tertiary winding is used?

(A) Star- delta (B) Delta- delta (C) Star- star (D) Delta- star

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. State and explain the three basic principles for electromechanical energy conversion.

3. "The D.C. shunt generators are self-protective against accidental short-circuit"- explain.

4. A 6- pole induction motor is fed from 50 Hz supply. If the frequency of rotor emf at full load is 2 Hz, find the full- load speed and slip.

5. Explain the significance of vector groupings of transformers. Mention different vector groupings of 3- phase transformers with their meanings.

6. What is open delta Connection? Explain its utility.

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. (a) Based on the principle of conservation of energy, write an energy balance equation for a motor. Also write briefly about the various energy terms involved. 9

(b) Two magnetic surfaces separated by a distance g have flux density of 1.6T in between them. This value is usually the saturation level for ferro-magnetic materials. Find the force between these two surfaces for area $A = 1m^2$. 4

(c) A coil of 1000 turns on a core would create a flux of 2 mWb when carrying 2

a current 1 A. Calculate the energy stored in the magnetic field.

8. (a) Explain the armature reaction of a D.C. machine. What is effect of armature reaction? How to minimize the effect of armature reaction? 9

(b) A 6-pole, 148A D.C. shunt generator has 480 conductors and is wave connected. Its field current is 2A. Find the demagnetizing and cross-magnetizing ampere-turns per pole at full load, if 6
(i) Brushes are at GNA. (ii) Brushes are shifted from GNA by 5° electrical
(iii) Brushes are shifted from GNA by 5° mechanical.

9. (a) Draw and explain the Torque-slip or Torque-speed curve of an 3-phase induction motor. In which portion of the curve the motor shall be operated and why? 7

(b) How the rotation of 3-phase induction motor can be reversed? 1

(c) An induction motor can never run at synchronous speed-Explain. 2

(d) A 3-phase induction motor has starting torque of 100% and a maximum torque of 200% of full-load torque. Find slip at maximum torque. 5

10. (a) Mention the conditions to be fulfilled for parallel operation of two 3-phase transformers. 6

(b) How Group-3 and Group-4 transformers can be made to run in parallel? 2

(c) A 500 KVA transformer with 1.5% resistive and 5% reactive drops is connected in parallel with a 1000 KVA transformer with 1% resistive and 4% reactive drops. The secondary voltage of each transformer is 400V on load. Determine how they share a load of 500 KVA at a p.f. of 0.8 lagging. 7

11. Write short notes on any *three* of the following: 3×5
(a) Regenerative braking of D.C. series motors.
(b) Star- delta starter of induction motor.
(c) Function of brush and commutator of D.C. Machines.
(d) Current Transformer.
(e) Grounding Transformer.