



Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS / B.TECH(PWE / EE(O)) / SEM-4 / EE-401 / 2011**

**2011**

**ELECTRICAL MACHINES**

Time Allotted : 3 Hours

Full Marks : 70

*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. Choose the correct alternatives for any *ten* of the following :

10 × 1 = 10

- i) An induction motor is preferred to a d.c. motor because it
- a) provides high starting torque
  - b) provides fine speed control
  - c) has simple and rugged construction
  - d) none of these.



- ii) Why are the transformer core made up of laminated sheet ?
- a) To reduce eddy current loss
  - b) To reduce hysteresis loss
  - c) To reduce frequency
  - d) None of these.
- iii) The full load slip of a 3-phase induction motor ranges from
- a) 10% - 20%
  - b) 20% - 30%
  - c) 2% - 5%
  - d) None of these.
- iv) A long shunt *d.c.* compound generator drives parallel connected 20 lamps each having a resistance of  $500\ \Omega$ . The terminal voltage shunt resistance, armature resistance and series resistance of the generator are 500 V,  $25\ \Omega$ ,  $0.08\ \Omega$  and  $0.045\ \Omega$  respectively. The generated e.m.f. is
- a) 505 V
  - b) 502.5 V
  - c) 497.5 V
  - d) 495 V.
- v) A delta-zigzag three-phase transformer can have the symbol
- a) Dz0 or Dz6
  - b) Dz1 or Dz11
  - c) Dz0 only
  - d) Dz6 only.



- vi) The utilization factor for transformer connected in open delta is
- a) 0.866                                      b) 0.75
- c) 0.667                                      d) 0.5.
- vii) A 3-phase, 400 V, 4-pole induction motor is fed from a 3-phase, 400 V, 50 Hz supply and runs at 1440 r.p.m. The frequency of the rotor *emf* is
- a) 2.0 Hz                                      b) 50 Hz
- c) 48 Hz                                      d) Zero Hz.
- viii) Tertiary winding is used in
- a) delta-delta                                      b) star-zigzag
- c) star-star                                      d) none of these.
- ix) When the induction motor is standstill, the slip is
- a) 0                                      b) 1
- c)  $\infty$                                       d) 0.5.
- x) In scott connections the teaser transformer operates on 0.866 of its rated
- a) impedance                                      b) current
- c) voltage                                      d) power.
- xi) The magnetizing current in a transformer is rich in
- a) 3rd harmonic                                      b) 5th harmonic
- c) 7th harmonic                                      d) 13th harmonic.



**GROUP – B**

**( Short Answer Type Questions )**

Answer any *three* of the following.  $3 \times 5 = 15$

2. Write down the conditions of parallel operation of 3- $\phi$  transformers.
3. What do you mean by cogging & crawling of induction motor ?
4. A 240V *dc* short shunt compound generator is supplying a load of 100 A at 240 V. The resistance of its armature, series field and shunt field windings are 0.1 ohm, 0.5 ohm and 50 ohm respectively. Find the induced *emf* and the armature current.
5. Write short notes on the following :
  - a) Interpoles
  - b) Compensating winding
  - c) Fleming's left and right hand rules.
6. Draw the torque-slip curve of 3- $\phi$  induction motor.



**GROUP – C**

**( Long Answer Type Questions )**

Answer any *three* of the following.  $3 \times 15 = 45$

7. a) Show that slip at which maximum torque of a Polyphase induction motor occurs is directly proportional to the rotor resistance  $r_2$  but the maximum torque  $T_{em}$  is independent of  $r_2$ . 5
- b) A 10 kW, 400 V, 3-Phase, 4-Pole and 50 Hz slip ring induction motor develops rated output ( i.e., 10 kW ) at rated Voltage and frequency and with its slip rings short circuited. The maximum torque equal to twice the full load torque occurs at a slip of 10% with zero external resistance in the rotor circuit. Stator resistance and rotational losses are neglected. Determine the
- (i) slip and rotor speed at full load torque (ii) rotor ohmic loss at full load torque (iii) starting torque at rated voltage and frequency. 10
8. a) Why are harmonics generated in a transformer although you impress sinusoidal voltage at the terminals of the Primary. 5
- b) Define Phasor group of a three-phase Transformer. Draw the EMF vector diagram and Winding & terminal diagram for any two of the following group and phase angle :
- Dz0, Yy6, Yd1, Dy11, Yz11. 4 + 6



9. a) Explain the nature of no-load and external characteristics of a D.C. shunt generator. 6
- b) Why does the external characteristic of this generator turn back as the generator is overloaded ? 4
- c) A belt driven 60 kW D.C. shunt generator running at 500 r.p.m is supplying full load to a bus bar at 200 V. At what speed will it run if the belt breaks and the machine continues to run taking 5kW from the bus bar ? The armature and field resistances are  $0.1\Omega$  and  $100\Omega$  respectively. Brush contact drop may be taken as 2V. Neglect armature reaction. 5
10. a) Show that the effect of armature m.m.f. on the main field/field flux, is entirely cross-magnetizing in an unsaturated D.C. machine. 4
- b) Explain briefly the bad effects of armature reaction and mention steps which should be taken at design & construction stage of dc machine, for minimizing armature reaction. 7
- c) A 4-pole, 100 kW, 200 V lap connected D.C. machine has 256 armature conductors. To reduce the effect on commutation by armature reaction, the brushes are given a shift of 10 mechanical degree. Find (i) the demagnetising ampere turns per pole (ii) cross-magnetising ampere turns/pole. 4



11. a) Bring out the difference between an auto-transformer and induction regulator. 3
- b) Explain with circuit diagram, the principle of operation of a single-phase induction regulator. 5
- c) Draw the circuit diagram of a 3-phase induction regulator and explain. 5
- d) Why is compensating winding necessary for single-phase induction regulator but not necessary for 3-phase ? 2

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