

Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech(EE/EEE-New)/SEM-4/EE-401/2012

2012

ELECTRICAL MACHINES-I

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) For a P -pole machine, the relation between electrical and mechanical degrees is given by

a) $\theta_{\text{elec}} = \frac{2}{P} \theta_{\text{mech}}$ b) $\theta_{\text{elec}} = \frac{4}{P} \theta_{\text{mech}}$

c) $\theta_{\text{mech}} = \frac{P}{2} \theta_{\text{elec}}$ d) $\theta_{\text{elec}} = \frac{P}{2} \theta_{\text{mech}}$.

ii) For eliminating n^{th} harmonic from the *emf* generated in the phase of a 3-phase alternator, the chording angle should be

a) $n \times \text{full-pitch}$ b) $\frac{1}{n} \times \text{full-pitch}$

c) $\frac{2}{n} \times \text{full-pitch}$ d) $\frac{3}{n} \times \text{full-pitch}$.



- iii) The waveform of armature mmf in a dc machine is
- a) square
 - b) rectangular
 - c) triangular
 - d) sinusoidal.
- iv) The developed electromagnetic force and/or torque in electro-mechanical energy conversion system act in a direction tends to
- a) increase the stored energy at constant flux
 - b) decrease the stored energy at constant flux
 - c) decrease the co-energy at constant mmf
 - d) decrease the stored energy at constant flux.
- v) A lap wound dc generator has 400 conductors and 8 poles. The voltage induced per conductor is 2 V. The generator generates a voltage of
- a) 100 V
 - b) 200 V
 - c) 400 V
 - d) 800 V.
- vi) The flux is maximum in which of the following parts of a dc motor ?
- a) Pole core
 - b) Under the interpole
 - c) Under leading pole tip
 - d) Under trailing pole tip.



vii) A star-delta starter is equivalent to an auto-transformer starter with a tapping of

- a) 86.6%
- b) 57.73%
- c) 75%
- d) 70.2%.

viii) Maximum torque in a 3-phase induction motor varies as

- a) f
- b) $\frac{1}{f}$
- c) $\frac{1}{f^2}$
- d) $\frac{1}{f^3}$.

ix) The core flux in transformer depends mainly on

- a) supply voltage
- b) supply voltage and frequency
- c) voltage, frequency and load
- d) voltage, load but not frequency.

x) A 1 : 1 transformer is used as

- a) isolation transformer
- b) current transformer
- c) potential transformer
- d) pulse transformer.



xi) The secondary of a transformer in star has an output voltage of 400V. If this secondary is reconnected in interstar, then the output voltage becomes

- a) 346.4 volts b) 400 volts
c) 460 volts d) 360 volts.

xii) The utilization factor for transformers in open-delta is

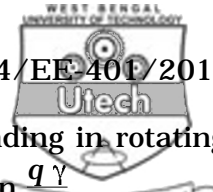
- a) 0.75 b) 0.667
c) 0.866 d) 0.5.

GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. What is meant by armature reaction ? Mention the effects of armature reaction on the operation of the *DC* machine. How is the armature reaction minimised ? 1 + 2 + 2
3. Draw the torque-slip characteristics of a 3-phase induction motor. Indicate clearly on it full-load torque, starting torque, maximum torque, stable and unstable zone. Why do these motors run below synchronous speed ? 1 + 2 + 2
4. What is reluctance torque ? Explain whether a *dc* motor can develop any reluctance torque. 1 + 4



5. What are the advantages of distributing a winding in rotating electric machine ? Show that $k_d = \frac{\sin \frac{q\gamma}{2}}{q \sin \frac{\gamma}{2}}$, where k_d = distribution factor, q = slots per pole per phase, γ = slot pitch in electrical radian. 2 + 3

6. Name two materials used for transformer core. Why does transformer core require to be laminated ? Why oil is used in transformer ? What type of oil is it ? 1 + 2 + 1 + 1

GROUP - C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) What is voltage build-up of a *dc* shunt generator ? What are the necessary conditions of voltage build-up ?
- b) Draw the external characteristics of a *dc* separately excited generator, shunt generator, series generator, cumulatively compounded and differentially compounded generator. Use same axes for all the curves.
- c) A *dc* shunt generator delivers 40 kW to 240 V when running at 450 rpm. The armature and field resistances are 0.03 ohm and 60 ohm respectively. Calculate the speed of the machine running as a shunt motor and taking 40 kW input at 240V. Allow 1V drop per brush.

(3 + 3) + 3 + 6



8. a) Define slip of a 3-phase induction motor. Can it be negative ?
- b) Draw the equivalent circuit of 3-phase induction motor and phasor diagram when it is operating on load.
- c) The shaft output power of a 3-phase induction motor is 20 kW at 1440 rpm. Total stator $i^2 r$ loss is 650 W. Friction and windage losses amount to 1.2% of shaft output power. Determine the rotor and stator input.

(1 + 1) + (3 + 3) + (3 + 4)

9. a) Explain the working principle of a 3-phase induction motor.
- b) Show that the ratio of torque T at any slip s of a 3-phase induction motor to its maximum torque T_m can be derived as

$$\frac{T}{T_m} = \frac{2}{\frac{S_m}{S} + \frac{S}{S_m}}$$

where S_m is the slip at maximum torque. Make necessary assumptions.

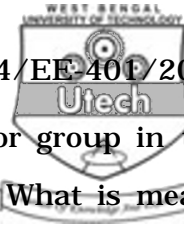
- c) No-load and blocked rotor test of a 415V, 3-phase, 50Hz, star connected induction motor gave the following results :

No-load test (line values) : 415 V, 3.5 A, 250 W

Blocked rotor test (line value) : 115V, 13A, 1660 W

Stator resistance/ph is 1.5 ohm.

Calculate equivalent circuit parameters. 5 + 5 + 5



10. a) Why is it necessary to write the phasor group in the name plate of a 3-phase transformer? What is meant by Yd ll. Draw the phasor and connection diagram of Yzl.
- b) State the condition of parallel operation of 3-phase transformers.
- c) A set of Scott connected transformers is supplying two single phase loads at 100 V. Load across teaser secondary is 350 kW at *upf* and the load across main secondary is 250kW at 0.8 pf lagging. For 3-phase line to line voltage of 6600 V, calculate primary line currents. Neglect magnetising current and leakage impedance drops. (1 + 2 + 3) + 3 + 6
11. Write short notes on any *three* of the following : 3 × 5
- a) Three point starter
 - b) Three winding transformer
 - c) Swinburne's test
 - d) Commutation in *dc* machines
 - e) Starting of squirrel cage induction motor.

