



Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/B.Tech/CHE(N)/SEM-5/CHE-504A/2012-13**

**2012**

**ELECTRICAL MACHINES DESIGN**

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 )**

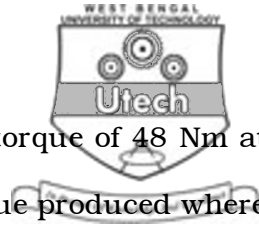
1. Choose the correct alternatives for the following :  $10 \times 1 = 10$

i) DC motor gives maximum power when

- |                               |                        |
|-------------------------------|------------------------|
| a) $V = 2E_b$                 | b) $V = \frac{E_b}{2}$ |
| c) $V = \frac{E_b}{\sqrt{2}}$ | d) $V = E_b$           |

ii) A 50 kVA transformer has a core loss of 500 W and a full load copper loss of 1000 W. Maximum efficiency occurs at ..... per cent of full load.

- |         |         |
|---------|---------|
| a) 50   | b) 37.5 |
| c) 70.7 | d) 100. |



iii) A 230 V DC shunt motor develops a torque of 48 Nm at an armature current of 12A. The torque produced where the armature current is 15A, is

- a) 48 Nm                                      b) 36 Nm
- c) 60 Nm                                      d) 72 Nm.

iv) A three-phase squirrel cage induction motor of 1.2 kW rating is usually started with full load by

- a) Star-Delta starting
- b) Direct switching
- c) Auto-transformer starting
- d) None of these.

v) A hydroelectric power plant will have

- a) a non-salient pole type alternator
- b) a salient pole type alternator
- c) a small number of poles of the alternator
- d) none of these.



- vi) An arc welding generator is
- a) *DC* shunt generator
  - b) *DC* differential compound generator
  - c) *DC* series generator
  - d) none of these.
- vii) The interpole winding is connected in series with the
- a) armature
  - b) field coils
  - c) shunt field winding
  - d) none of these.
- viii) The point starter is used to start the
- a) *dc* shunt motor
  - b) series motor
  - c) universal motor
  - d) induction motor.
- ix) The silica gel becomes .....after absorbing moisture.
- a) yellow
  - b) blue
  - c) brown
  - d) green.



x) The overexcited synchronous motor ..... the power factor of the system.

- a) maintains the same      b) decreases
- c) improves                      d) none of these.

**GROUP – B**

**( Short Answer Type Questions )**

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

2. A *dc* shunt motor has the following data :

- a) Rated voltage = 230 V
- b) Speed = 100 rpm
- c) Armature resistance =  $0.2 \Omega$ .

Calculate the value of resistance required to be inserted in the armature circuit to reduce the speed to 800 rpm at an armature current of 20 A.

3. Derive the condition of maximum efficiency of the transformer.



4. The supply frequency of a six-pole induction motor is 50 Hz. The frequency of the rotor is 2 Hz. Determine the speed of the motor and the slip. 3 + 2
  
5. Deduce the distribution factor and the pitch factor of a three-phase machine. 3 + 2
  
6. Explain the build-up process of voltage of a *dc* shunt generator.

### GROUP – C

#### ( Long Answer Type Questions )

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

7. a) A four pole, three-phase, 50 Hz induction motor is running at a slip of 4%. Determine the frequency of the rotor and its speed. 2 + 3
  
- b) A 400 V, three-phase, star-connected induction motor has a stator impedance of  $( 0.06 + j 0.30 ) \Omega$  and an equivalent rotor impedance of  $( 0.06 + j 0.30 ) \Omega$  per phase. Determine the maximum gross power output and the slip at which it occurs. The exciting current may be ignored. 6 + 4
  
8. a) Develop the torque equation of the *dc* motor. 4
  
- b) Why a series motor must never be allowed to run at no-load even accidentally. 4



c) A dc series motor has the following data :

(i) Total resistance of the motor =  $0.5 \Omega$

(ii) Input current = 65A

(iii) Rated voltage = 480 V

(iv) Load torque  $\propto N^3$  where  $N$  is the speed.

Determine the resistance needed for reducing the speed by 20%. 7

9. a) Deduce the voltage equation of a transformer. 4

b) How do you develop the equivalent circuit of a single-phase transformer ? Explain in detail. 4

c) A 12 kVA single-phase transformer has the voltage ratio 2200 V/425 V at no-load. The resistances and leakage reactance are defined as stated below :

Primary winding :  $R_1 = 6 \Omega$ ,  $X_1 = 12 \Omega$

Secondary winding :  $R_2 = 0.52 \Omega$ ,  $X_2 = 0.8 \Omega$

Calculate the approximate value of the secondary terminal voltage when it is fully loaded at 0.9 power factor lagging and the primary voltage.

10. a) What is the basic difference between the pole and the non-salient pole synchronous generator ? 3



- b) Describe the EMF method for calculation of voltage regulation of synchronous generator. 4
- c) A synchronous machine delivers full-load current of 105 A when it is shortcircuited and the required field excitation is measured as 2.6A. The same excitation develops 500 V on open circuit. Determine the voltage regulation at rated condition at 0.85 power factor leading. The rated voltage of this single-phase alternator is 2200 V. Assume the armature resistance to be  $0.85 \Omega$ . 8
11. a) Describe the different types of excitations of *dc* generators. 5
- b) Describe the torque-slip characteristic of three-phase induction motor. 5
- c) How do you start a three-phase induction motor ? What are the different methods of its starting ? 5
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