Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(EE)/SEM-7/EE-701/2011-12

2011

ELECTRIC DRIVES

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 : $10 \times 1 = 10$

   i) In tram cars the electric motor used is

      a) a *dc* separately excited motor

      b) a *dc* series motor

      c) a squirrel cage induction motor

      d) a synchronous motor.

   ii) In case of a 3-phase full controlled converter the ripple frequency on the *dc* side is (if the *ac* side supply frequency is taken to be f)

      a) f b) $2f$

      c) $3f$ d) $6f$,

iii) In our domestic 230V ceiling fans, the motor used is

a) 3-phase induction motor

b) 1-phase conventional induction motor

c) 1-phase hub-type induction motor

d) synchronous motor.

iv) The regulator of our domestic ceiling fans effectively cause

a) rotor resistance control

b) armature voltage control through variation of series resistance

c) *ac* 1-phase variac type voltage control

d) none of these.

v) The zone of an electric drive below base speed is known as

a) constant power zone b) constant torque zone

c) constant voltage zone d) none of these.

vi) In plugging of an electric motor effectively we apply

a) a reverse voltage on the armature

b) double voltage on the armature

c) zero voltage on the armature

d) zero magnetisation current.

vii) The motor most suited to crane application is

a) *dc* series motor

b) *dc* shunt motor

c) 1-phase induction motor

d) stepper motor.

viii) PWM switching schemes are used in inverter based drives in order to

a) get output power greater than input power

b) reduce harmonic content in the load current and hence torque

c) reduce input side power density

d) none of these.

ix) In V/f control of an induction motor the peak torque

a) can be reduced at will

b) will remain almost constant with speed

c) can be increased with speed

d) none of these.

x) The term 'slip power recovery' is associated with

a) *dc* shunt motors

b) 3-phase slip-ring induction motors

c) 3-phase cage rotor induction motors

d) both (b) and (c).

xi) Cycloconverters have typical application in

a) synchronous motor drives

b) *dc* motor drives

c) brushless *dc* motor drives

d) stepper motor drives.

GROUP – B

(Short Answer Type Questions)

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

2. With appropriate characteristic curves explain the dynamic braking operation of a *dc* series motor.

3. With approximate speed-time curves explain the operation of a traction drive related to urban train services.

4. With appropriate diagrams describe the four quadrant operation of a hoist drive.

5. Derive the expression for energy required to start an induction motor against constant load torque. What should be the relative magnitude of the load torque w.r.t. the inherent starting torque of the motor ?

6. Explain with appropriate diagram the operation of a static Scherbius drive.

GROUP – C
(Long Answer Type Questions)

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

7. Write short notes on any *three* of the following : 3 × 5

   a) Four quadrant operation of an electric motor drive

   b) DC chopper based electric drives

   c) Disadvantages and advantages of inverter fed AC drives

   d) Armature voltage control *vs* rotor resistance control methods of speed control in W.R.I.M.

8. a) Explain with relevant circuit diagrams and characteristics how V/f control is achieved in induction motor drives. 6

   b) Can this method be applied for both wound rotor and cage rotor motors ? 2

   c) What may be the difficulty faced in principle, while implementing V/f at starting or at low speeds ? How can this be overcome ? 3

   d) Can this method be applied to synchronous motors also ? Justify. 2

   e) Which method of speed control is valid only for wound rotor I.M. and which one only for cage motor I.M. ? 2

9. a) Explain a *dc* chopper-based scheme for bidirectional speed control of *dc* separately excited motor. Draw the circuit diagram and clearly show how the four quadrants of drive operation can be handled by this scheme. 7

b) A 220V, 150A, 875 rpm *dc* separately excited motor has an armature resistance of $r_a = 0 \cdot 06\,\Omega$. It is fed from a signal phase full-controlled converter with an *ac* source side voltage of 200V, 50Hz. Assuming continuous current in the armature, calculate

i) firing angle for a motor torque of 650 Nm

ii) motor speed at a firing angle of 120°.

Draw the waveforms for

iii) armature terminal voltage and

iv) v_{AK} for any one of the thyristors. 8

10. a) Explain with proper circuit diagram and characteristic curves etc. the static Krämer drive. 6

b) What is its effect on the overall power factor ? 2

c) A *y*-connected cage rotor induction motor has the following parameters as given below (per phase) :

$r_1 = 2\,\Omega, r_2' = 3\,\Omega$, $x_1 = x_2' = 6 \cdot 5\,\Omega$ and $x_m = 55\,\Omega$, where symbols have their usual significance. The ratings are 400 V, 50 Hz, 4 pole and its rated speed is 1430 rpm. If *V*/*f* control is effected, calculate

i) the motor torque, speed and current when the inverter frequency is 30 Hz and slip is rated

ii) inverter frequency and stator current at rated torque and motor speed of 1300 rpm. 7

11. a) With the help of torque-speed characteristics discuss the different methods of braking an induction motor in appropriate details. 5

b) A weight of 500 kg is being raised at a uniform speed of 1000 rpm. The moments of inertia of motor and the winch are 0·5 kg-m^2 and 0·3 kg-m^2 respectively. Calculate

i) the motor torque and

ii) the equivalent moment of inertia referred to the motor shaft.

In the absence of any weight the motor develops a torque of 100 N-m when running at 1000 rpm. 10

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