Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.TECH (EE)/SEM-7/EE-701/2012-13

2012

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)   The slip *s* for plugging is

   a) $s - 1$ b) $2s - 1$

   c) $2 - s$ d) $2 + s$.

   ii)   To get the speed higher than the base speed of a *dc* shunt motor

   a)   armature voltage control is used

   b)   field control is used

   c)   armature resistance control is used

   d)   frequency control is used.

iii) In constant torque drive

    a) power is proportional to speed

    b) power is proportional to the square of the speed

    c) power in inversely proportional to speed

    d) power is independent of speed.

iv) In constant power drive

    a) torque is proportional to speed

    b) torque is proportional to the square of speed

    c) torque is inversely proportional to the speed

    d) torque is independent of speed.

v) Second quadrant operation of electric drive gives

    a) forward motoring   b) forward braking

    c) reverse braking   d) reverse motoring.

vi) For application in cranes

    a) *dc* shunt motors are suitable

    b) *dc* series motor are suitable

    c) induction motors are suitable

    d) synchronous motors are suitable.

vii) The frequency of voltage generated by an alternator having 4 poles and rotating at 1800 rpm is

    a) 60 Hz   b) 7200 Hz

    c) 120 Hz   d) 450 Hz.

viii) Induction generator runs at

    a) super synchronous   b) sub-synchronous

    c) synchronous speed   d) none of these.

ix) Average output voltage from three phase full control converter is

a) $\dfrac{3V_m}{\pi}\,Cos\alpha$

b) $\dfrac{3V_m}{\pi}\,(1+Cos\alpha)$

c) $\dfrac{V_m}{3\cdot\pi}\,Cos\alpha$

d) $\dfrac{V_m}{3\cdot\pi}\,(1+Cos\alpha)$.

x) A three phase induction motor is started by means of a star/delta starter. The starting current is

a) three times the current with DOL

b) $\dfrac{1}{3}$ times the current with DOL

c) $\sqrt{3}$ times the current with DOL

d) $\dfrac{1}{\sqrt{3}}$ times the current with DOL.

xi) A fully controlled line commutated converter operates as an inverter

a) in the range of firing angles $0\le\alpha\le90°$

b) in the range of firing angles $90°\le\alpha\le180°$

c) in the range of firing angles $90°\le\alpha\le180°$ with a suitable *dc* source in the load

d) when it supplies RLE load.

xii) Starting current of a motor is kept low

  a)   to avoid excessive heating

  b)   to safeguard the life of the motor

  c)   to reduce the fluctuation in supply voltage

  d)   to reduce the acceleration time.

GROUP – B
(Short Answer Type Questions)

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

2. Explain, how regenerative braking is done in a 3-phase induction motor, show graphically the four quadrant operation of the motor. What is the slip during plugging of an induction motor ?

3. Derive mathematically the (a) torque *vs* current and (b) torque *vs* speed characteristics of dc series motor. Draw the characteristics and explain practical significance.

4. The temperature rise of a motor when operating of 25 min or full load is 25°C and becomes 40°C when the motor operates for another 25 min on the same load. Determine heating time constant and the steady state temperature rise.

5. Derive the expression for loss of energy during starting of a separately excited *dc* motor. Discuss the result.

6. 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 ?

GROUP – C

### (Long Answer Type Questions)

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

7. a) With the help of relevant torque speed characteristics, discuss different methods of braking of *dc* shunt motor.

   b) A 250V, 1000 rpm, 80A dc separately excited motor has an armature resistance of 0·1 Ω. It is braked by plugging from an initial speed of 1000 rpm. Calculate

      i) Resistance to be placed in armature circuit to limit braking current to 1·5 times of the full load value

      ii) Braking torque

      iii) Torque when the speed has fallen to zero.

      $7 + (3 + 2 + 3)$

8. a) Draw and explain the scheme for closed-loop speed control of a three phase induction motor by V/F control drive.

   b) A star connected squirrel-cage induction motor has the following ratings and parameters : 400 V, 50 Hz, 4-pole, 1410 rpm, $R_r = 2$ Ω, $R'_r = 3$ Ω, $X_s = X'_r = 3·5$ Ω. It is controlled by a current source inverted at a constant flux. Calculate (i) motor torque, speed when operating at 30 Hz and rated slip speed, (ii) Inverter frequency for rated motor torque at a speed of 1250 rpm. $6 + 9$
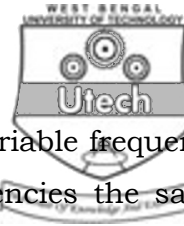
9. Compare VSI and CSI drives. Show that a variable frequency induction motor drive develops at all frequencies the same torque for a given slip-speed when operating at constant flux. A Y-connected squirrel cage induction motor has the following ratings and parameters : 400 V, 50 Hz, 4 pole, 1370 rpm, $R_s = 2\ \Omega$, $R'_r = 3\ \Omega$, $X_s = X'_r = 3.5\ \Omega$, $X_m = 55\ \Omega$, where symbols have their usual meanings. It is controlled by CSI at a constant flux. Calculate

    i) Motor torque, speed and stator current when operating at 30Hz and rated slip speed

    ii) Inverter frequency and stator current for rated motor torque and motor speed for 1200 rpm.   3 + 5 + 7

10. a) Explain the operation of Ward-Leonard drive system with suitable diagram. Mention the advantages and disadvantages of it.

    b) A 200 V, 875 rpm, 150 A, separately excited dc motor has an armature resistance of 0.06 Ω. It is fed from a single phase full controlled rectified with a source voltage of 220 volt, 50 hz. Assuming continuous conduction, calculate

        i) firing angle for rated motor torque and 750 rpm

        ii) motor speed for firing angle of 160° and at rated torque.   8 + 7

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

    a)   Drive for Textile mills

    b)   V/f control of Induction Motor

    c)   Stepper motor

    d)   Multiquadrant operation of electric drive.

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