Name : .....

Roll No. : .....

Invigilator's Signature : .....

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

2012
ELECTRICAL 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) A typical active load is

a) Hoist b) Blower

c) Pump d) Lathe.

ii) Crane drives are the example of

a) continuous duty

b) intermittent duty

b) short time duty

d) continuous duty with periodic speed changes.

iii) Second quadrant operation of electric drive gives

a) Forward motoring

b) Forward braking

c) Reverse braking

d) Reverse motoring.

iv) Short time rating of an electric machine is

a) equal to name plate rating

b) less than the name plate rating

c) greater than the name plate rating

d) not related to its name plate rating.

v) It is required to drive D.C. motor at different speeds in, both the direction (forward and reverse) and also to brake it in both the directions. Which one of the following would you use ?

a) A half controlled thyristor bridge

b) A full controlled thyristor bridge

c) A dual converter

d) A diode bridge.

vi) For an electric locomotive in the downward direction in a hilly region the economical braking system will be

a) counter-current braking

b) dynamic braking

c) regenerative braking

d) mechanical braking.

vii) The slip of an induction motor during *dc* rheostatic braking is

a) s b) 1 – s

c) 2 – s d) 2.

viii) In a 3-phase controlled bridge rectifier, with an increase of overlap angle, the output *dc* voltage

a) decreases

b) increases

c) does not change

d) depends on load inductance.

ix) When a line commutated inverter operates in inverter mode

a) It draws both real and reactive power from ac supply

b) It delivers both real and reactive power from ac supply

c) It delivers reactive power from ac supply

d) It draws reactive power from ac supply.

x) PWM switching scheme is used with a 3-phase inverter to

a) Reduce total harmonic distortion with modest filtering

b) Minimize load on *dc* side

c) Increase life of batteries

d) Reduce low order harmonics and increase high order harmonics.

xi) Resonant converters are basically used to

a) Generate large peaky voltage

b) Eliminate harmonics

c) Reduce switching losses

d) Convert a square wave to sine wave.

GROUP – B

(Short Answer Type Questions)

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

2. Derive the condition for achieving stability of a motor load combination under steady state condition of operation.

3. Show the method to calculate the equivalent inertia of the system referred to the motor shaft considering loads with rotational motions only.

4. Describe the four quadrant operation of a dual converter fed DC motor.

5. Deduce the expression of loss of energy during starting of a separately excited DC motor.

6. Why VVVF method of speed control of 3-phase induction motor is preferable over frequency control method ? Draw typical speed-torque curves for both the methods.

GROUP – C

(Long Answer Type Questions)

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

7. a) What do you mean by 'classes of motor duty' ? 2

   b) "A motor with smaller rating can be selected for intermittent periodic duty". Justify the statement by calculating the ratio of rated power P_r to P_x corresponding duty cycle. 8

   c) A motor has the heating time constant of 60 min and cooling time constant of 90 min. When run continuously on full load of 20 kW, the final temperature rise is 40°C. If it is on an intermittent load of 10 min followed by 10 min shut down, what is the maximum value of load it can supply during the on load period ? 5

8. a) A separately excited *dc* motor generates an open circuit voltage of 220 V at 1500 rpm and with a field current of 0·5A. The machine parameters are : R_a=1 ohm, $L_a = 0$. The combined inertia of the motor with load is 2 kg m^2. The motor drives a constant load torque, T_t = 20N.m. The armature terminals are suddenly connected to 220 V *dc* supply, when the field current is 0·5A.

(i) Derive the expressions for the speed ω_m and the armature current i as a function of time.

(ii) Determine the steady-state values of speed and armature current. 9

b) Explain equivalent current, torque and power methods to determine the motor rating for intermittent loads. 6

9. a) Draw and explain the scheme for closed-loop speed control of a three phase induction motor by V/F control drive. 7

b) A 2·8 kW, 400 V, 50 Hz, 4 pole, 1370 rpm delta connected squirrel-cage induction motor has the following parameters referred to stator : $R_r = 2\Omega$, $R_r^{\prime} = 5\Omega$, $X_s = X_r^{\prime} = 5\Omega$. Motor speed is controlled by stator voltage control. When driving a fan load it runs at rated speed at rated voltage. Calculate (i) motor terminal voltage and torque at 1200 rpm, and (ii) motor speed and torque for a terminal voltage of 300 V. 8

10. a) Explain the principle of operation of self-controlled synchronous motor drive. 6

b) A star connected squirrel-cage induction motor has the following ratings and parameters : 400V, 50 Hz, 4-pole, 1410 rpm, $R_r = 2\Omega$, R_r'= 3Ω. $X_s = X_r^{\prime} = 3 \cdot 5\ \Omega$ It is controlled by a current source inverter 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 rmp. 9

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

a) Buck-boost method of speed control of DC motor

b) Soft starting of 3-phase induction motor

c) Regenerative braking of DC motor

d) Operation of a variable reluctance stepper motor from a unipolar drive

e) Slip power revovery.