EE-701

ELECTRIC DRIVES

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
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. Answer any *ten* questions. $10 \times 1 = 10$

(i) In case of power failure, while a crane is in operation, the preferred electrical braking technique is

(A) regenerative (B) dynamic
(C) counter current (D) none of these

(ii) To get speed higher than the base speed of 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) Speed control by varying the armature voltage offers

(A) constant power drive (B) constant torque drive
(C) variable power drive (D) variable torque drive

(iv) Intermittent duty rating of electric motor

(A) is equal to name plate rating
(B) is less than name plate rating
(C) is greater than name plate rating
(D) has no bearing to its name plate rating

(v) The heating time constant of an electrical machine gives an indication of its

(A) cooling (B) rating
(C) overload capacity (D) short time rating

(vi) The speed of an induction motor can be varied by means of variable frequency supply from a static power converter. A simultaneous voltage variation is also effected in order to

(A) avoid saturation and provide optimum torque capability
(B) the torque pulsations decrease if supplied from variable voltage supply
(C) to limit the peak value of stator current
(D) to minimize the additional losses

(vii) A three phase induction motor having a combination of diode rectifier and line commutated inverter in the rotor circuit can give

(A) speeds below synchronous speed only
(B) speeds above synchronous speed only
(C) both sub and super synchronous speeds
(D) speeds varying from 0 to 50% of synchronous speed

(viii) A Regenerative braking in a squirrel cage induction motor takes place when

(A) the overhauling load drives the rotor at a speed greater than synchronous speed
(B) the stator frequency is reduced so that synchronous speed is below the rotor speed
(C) both (A) and (B)
(D) none of these

(ix) By self control of a synchronous motor we mean that

(A) elimination of torque ripple
(B) the speed of the motor is varied in steps
(C) the speed of the motor is a function of input frequency
(D) the input frequency is controlled from the speed of the motor

(x) The ripple frequency is twice the supply frequency in the case of

(A) single phase half wave converter (B) single phase dual converter
(C) three phase full converter (D) three phase semiconverter

(xi) The free wheeling diode is needed with inductive load in

(A) single phase half converter drive only

(B) single phase semi converter drive only

(C) single phase full converter drive and single phase dual converter drive

(D) both single phase half converter drive and single phase full converter drive

(xii) When operated with variable frequency, a synchronous motor has an advantage over an induction motor in

(A) that it is free from torque oscillations

(B) that it has very good effiency

(C) that the line power factor can be improved by varying excitation

(D) that in certain cases the inverter can be of simpler configuration due to the possible load commutation

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. How does the braking resistance control the dynamic braking torque in dc separately excited motor? How to employ dynamic braking in dc series motors? 4+1

3. 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? 3+2

4. Show that the torque to inertia ratios referred to the motor shaft and to the load shaft differ from each other by a factor of i, where i is the gear ratio. 5

5. A motor of smaller rating can be selected for a short time duty. Correct and/or justify. 5

6. The temperature rise of a motor after operating for 30 minutes on full load is 20°C, after another 30 minutes on the same load the temperature rise becomes 30°C. Assuming that the temperature increases according to an exponential law, determine the final temperature rise and the time constant. 5

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GROUP C
(Long Answer Type Questions)

Answer any *three* questions 3×15 =

7. (a) A 220 V, 50 A, 1500 rpm separately excited motor with armature resistance of 0.5 ohm is fed from a 3-phase fully controlled rectifier. A vailable ac source has line voltage of 440 V, 50 Hz. A star/delta connected transformer is used to feed the converter so that motor terminal voltage equals rated voltage when converter firing angle is 0°

(i) Calculate turns ratio of the transformer.

(ii) Determine firing angle when (a) motor is running at 1200 rpm and at rated torque, (b) motor is running at-800 rpm and at twice the rated torque.

(b) Explain 4-quadrant operation of de motor controlled by dual converter operating in non-circulating mode.

8. (a) Deduce the expression of loss of energy during starting of a separately excited DC motor.

(b) A motor driving a mining equipment has to supply a load rising uniformly from zero to a maximum of 1500 kW in 20 seconds during acceleration period, 1000 kW for 50 seconds during the full-load period and during acceleration period of 10 seconds when regenerative braking takes place, the kW returned to the mains falls from an initial value of 500 kW to zero uniformly. The interval for decking before the next load cycle starts is 20 seconds. Estimate a suitable kW rating of the motor, based on rms power.

9. (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 rating and parameters: 400 V, 50 Hz, 4-pole, 1410 rpm, $R_r = 2\Omega$, $R_r' = 3\Omega$, $X_s = X_r' = 3.5\Omega$. 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 rpm.

10. (a) Describe with suitable diagram the "self-controlled mode" of speed control operation of a synchronous motor using load commutated inverter.

(b) Explain how cyclo-converter can be used to control the speed of synchronous motor drives.

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

(a) Induction motor speed control by rotor resistance control

(b) Regenerative braking for dc motor

(c) Series-parallel speed control technique for DC series motor.

(d) Chopper fed drives

(e) Switched Reluctance motor

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