MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

EE-701

ELECTRIC DRIVE

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.
All symbols are of usual significance.

GROUP A
(Multiple Choice Type Questions)

1. Answer any *ten* questions. 10×1 = 10

(i) Fourth quadrant operation of electric drive gives
(A) forward motoring (B) forward braking
(C) reverse braking (D) reverse motoring

(ii) In constant torque operation of DC Motor
(A) field flux is proportional to speed
(B) field flux is inversely proportional to speed
(C) field flux is proportional to square of speed
(D) field flux remains constant

(iii) The ripple frequency is six times of the supply frequency in case of
(A) single phase full converter (B) three phase semi converter
(C) three phase full converter (D) single phase semi converter

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(iv) A three-phase induction motor operates at a constant rotor frequency when the stator frequency is varied from zero to rated value. The torque developed by the motor is
(A) constant from zero to rated speed (B) proportional to speed
(C) inversely proportional to speed (D) proportional to cube of speed

(v) For application in traction
(A) dc series motors are suitable (B) dc shunt motors are suitable
(C) dc compound motors are suitable (D) synchronous motors are suitable

(vi) For slip power recovery method for negative Pr, where Pg = Pr + Pm, the induction motor will run at
(A) sub synchronous speed (B) synchronous speed
(C) super synchronous speed (D) none of these

(vii) In a dual converter, the circulating current
(A) increases the response time but allows smooth reversal of load current
(B) decreases the response time but does not allow smooth reversal of load current
(C) improves the speed of response and also allows smooth reversal of load current
(D) makes performance of the converter worse

(viii) During lowering of an over hauling load, braking takes place is
(A) regenerative braking (B) dynamic braking
(C) plugging (D) none of these

(ix) PWM Control, when applied to a three phase voltage source inverter, introduces
(A) low order harmonic voltages on the dc side
(B) low order harmonic voltages on the ac side
(C) higher order harmonic voltages on the ac side
(D) higher order harmonic voltages on the dc side

(x) For multi-motor drives
(A) current source inverters are used (B) voltage source inverters are used
(C) both inverters are used (D) none of these

(xi) A three phase line commutated converter, when operating in the inverter mode
(A) draws both real and reactive power from ac supply
(B) delivers both real and reactive power to ac supply
(C) delivers real power to ac supply but draws reactive power from ac supply
(D) delivers real power to dc side but draws reactive power from dc side

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(xii) In self controlled synchronous Motor drive, where Load Commutated Inverter is used, synchronous Motor is necessary to operate at

(A) lagging pf (B) unity pf (C) leading pf (D) none of these

GROUP B
(Short Answer Type Questions)

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

2. Describe with suitable diagram plugging operation of DC Machine. 5

3. A motor has a thermal heating time constant of 50 minutes. When the motor runs continuously on full load, its temperature rise is 100°C in 90 minutes. 2+3
   (a) Find the maximum steady state temperature.
   (b) How long will the motor take for its temperature to rise from 70°C to 95°C, if it is working on same load?

4. Describe with suitable diagram dynamic braking operation of Induction Machine. 5

5. Describe with neat diagram four quadrant operation of a motor driving hoist load. 5

6. Why variable voltage variable frequency method of speed control of three phase induction motor is preferable over fixed voltage variable frequency control method? Explain with typical speed-torque curves for both the methods. 5

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. (a) 230 Volt, 1200 rpm, 200A separately excited motor has an armature resistance of 0.06 ohm. Armature is fed from a three phase dual converter with circulating control. The available ac supply has line-line voltage of 440 Volt with supply frequency 50 Hz. When motor operates in forward motoring, converter A works as a rectifier and converter B as an inverter. Determine firing angles of converters A and B for 8+7
   (i) Motoring operation at 90% of rated motor torque and 900 rpm speed.
   (ii) Braking operation at 120% of rated motor torque and 1000 rpm speed.

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

8. (a) A 2.8 kW, 440 Volt, 50 Hz, 4 pole 1390 rpm, delta connected squirrel cage induction motor has following parameters referred to the stator: 8+5+2
   $R_s = 3\ \Omega$, $R_r' = 6\ \Omega$, $X_s = 4.5\ \Omega$, $X_r' = 5.5\ \Omega$, $X_m = 75\ \Omega$. Motor speed is controlled by stator voltage control. When driving a fan load it runs at rated speed at rated voltage. Calculate motor terminal voltage, current and torque at 1230 rpm.
   (b) Describe regenerative braking operation of DC Machine.
   (c) What do you mean by 'classes of motor duty'?

9. (a) Explain the principle of slip power recovery scheme of controlling the speed of induction motor, using static Scherbius Drive. 7+8
   (b) Describe with suitable diagram the self-controlled synchronous motor drive using load-commutated inverter.

10. (a) A 230 Volt, 960 rpm and 60 Amp separately excited dc motor has an armature resistance of 0.1 ohm. and field resistance of 20 ohm. 9+6
   The motor armature is fed from two quadrant chopper capable of operating in first quadrant and second quadrant with dc source voltage of 300 Volt. The motor field circuit is fed from first quadrant chopper with dc source voltage of 300 Volt. Speeds below rated value are controlled by armature voltage control with full field flux and speeds above rated are controlled by field control at rated armature voltage. Assume continuous conduction.
   (i) Calculate duty cycle of chopper connected to motor armature and duty ratio of chopper connected to motor field circuit for motoring operation at 750 rpm and 1.2 times rated torque.
   (ii) Calculate duty cycle of chopper connected to motor armature and duty ratio of chopper connected to motor field circuit for forward braking operation at 800 rpm speed and 75% of rated torque.
   (iii) Calculate duty ratio of chopper connected to motor field circuit for motoring operation at 1000 rpm speed and rated torque.
   (b) Explain with suitable diagram variable voltage and variable frequency control of three phase induction motor.

11. Write short notes on any *three* of the following: 3×5
   (a) Three phase Rectifier fed dc drive
   (b) Drive for Textile Mills
   (c) Current Source Inverter fed Induction Motor drive
   (d) Electric drives and its components
   (e) Buck-boost method of speed control of dc motor.

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