

**ELECTRIC DRIVES
(ELEC 3211)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

***Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.***

Candidates are required to give answer in their own words as far as practicable.

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) In four quadrant operation of a hoist 4th quadrant represents
(a) reverse motoring (b) reverse braking
(c) forward braking (d) forward motoring.
 - (ii) A motor has a thermal heating constant of 35 min. When the motor runs continuously on full load, its final temperature rise is 70°C. What would be the temperature rise after 45 min if motor runs continuously on full load?
(a) 55.4°C (b) 50.6°C (c) 49.5°C (d) 51.5°C.
 - (iii) To save energy during braking _____ braking is used.
(a) dynamic (b) plugging
(c) regenerative (d) mechanical
 - (iv) Four quadrant operation of Electric drive is possible for
(a) Class A chopper (b) Class C chopper
(c) Class D chopper (d) Class E chopper
 - (v) Which speed control method preferred for constant torque drive?
(a) Field control (b) Armature voltage control
(c) Mechanical loading (d) None of the above.
 - (vi) The slip at which maximum torque occurs
(a) $R_2 = X_2$ (b) $R_2 = sX_2$ (c) $R_2 < sX_2$ (d) $R_2 > sX_2$.
 - (vii) The advantages of V/f method of speed control of an induction motor are
(a) wide range of speed control (b) smooth variation of frequency
(c) starting torque high (d) all of the above.
 - (viii) What is the range of slip when an induction motor is operated in plugging mode?
(a) $0 \leq s \leq 1$ (b) $1 \leq s \leq 2$ (c) $s < 0$ (d) $s > 0$.

- (ix) In BLDC motor field winding is kept on _____.
(a) stator (b) rotor
(c) can be placed anywhere (d) absent.
- (x) Which of the following is not an advantage of BLDC motor over conventional DC motor?
(a) Less maintenance
(b) Long life
(c) No risk of explosion or possibility of RF radiation
(d) Low cost.

Group - B

2. (a) Explain the four quadrant operation of electric drive.
[[C01](Understand/LOCQ)]
- (b) A motor drives two loads, one has rotational motion. It is coupled two motor through a gear with teeth ratio of 0.2 and efficiency of 90%. Moment of inertia and torque for this load are 10kg-m² and 10N-m respectively. Other load has linear motion, having 1000kg to be lifted up at a speed of 1.5m/s. Coupling between load and motor has efficiency of 85%. Motor has moment of inertia 0.2kg-m² and runs at speed of 1420 rpm. Identify equivalent moment of inertia and torque.
[[C01](Analyse/IOCQ)]
6 + 6 = 12
3. (a) With the help of suitable diagram explain the various classes of motor duty.
[[C01](Remember/LOCQ)]
- (b) A rolling mill is driven by a thyristor converter fed DC motor and operates on a speed reversing duty cycle. Motor current is assumed to be constant at rated value. Moment of inertia referred to motor shaft is 10000kg-m². Duty cycle consists of
- (i) Rolling at full speed (200 rpm) at constant torque of 20000 N-m for 10 sec.
 - (ii) No load for 1sec.
 - (iii) Speed reversal from 200 rpm to -200 rpm in 5 sec.
 - (iv) No load for 1 sec.
 - (v) Rolling at full load of 25000 N-m for 15 sec.
 - (vi) No load for 1 sec.
 - (vii) Speed reversal from -200 rpm to 200 rpm in 5 sec.
 - (viii) No load for 1 sec.
- Determine the torque and power rating of the motor. [[C01](Evaluate/HOCQ)]
6 + 6 = 12

Group - C

4. (a) Explain the Ward-Leonard method of speed control for DC motor.
[[C02](Remember/LOCQ)]
- (b) A 250 V, 3.73 kW, 1000 rpm, 20A DC series motor having a motor resistance of 2.385 Ω gives the natural characteristics as follows:

i(pu)	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
I(A)	8	12	16	20	24	28	32	36
V(pu)	2	1.3	1.09	1	0.9	0.82	0.78	0.72
N(rpm)	2000	1300	1090	1000	900	820	780	720

Now this motor lowering a load with plugging at an armature current of 1.5 times of nominal at a speed of 200 rpm in one case and at 300rpm in another. Identify the value of additional resistance required to be inserted in the circuit.

[(CO2)(Analyze/IOCQ)]

6 + 6 = 12

5. (a) Explain with the help of proper diagrams how the motoring and Braking is done by using chopper fed DC drive. [(CO2) (Analyze/IOCQ)]
- (b) A 220 V, 1500 rpm, 10 A separately excited DC motor is fed from a single phase fully controlled rectifier with an AC source voltage of 230 V, 50 Hz. Armature resistance of the motor is 2 Ω . Conduction can be assumed to be continuous. Evaluate the firing angles for:
- (i) Half the rated motor torque and 500 rpm.
- (ii) Rated motor torque and -1000 rpm.

[(CO2)(Evaluate/HOCQ)]

6 + 6 = 12

Group - D

6. (a) Explain why the linear region in the torque slip characteristics of a three phase induction motor is called stable region of operation. [(CO3)(Understand/LOCQ)]
- (b) Analyze the operation of static Kramer drive. [(CO3)(Analyze/IOCQ)]
- (c) A 3- ϕ , 400 V, 50 Hz, 6-pole star connected induction motor has the following parameters: $R_1 = 2 \Omega$, $R'_2 = 3 \Omega$, $X_1 = X'_2 = 4 \Omega$. The motor is controlled by a voltage source inverter at constant V/f ratio. Calculate the starting torque and current. [(CO3)(Evaluate /HOCQ)]
- 3 + 4 + 5 = 12**
7. (a) What are the advantages and disadvantages of speed control of an induction motor by stator voltage control? [(CO3)(Remember/LOCQ)]
- (b) Analyze V/f method of speed control when speed control below base speed is required. [(CO3) (Analyze/IOCQ)]
- (c) A 440 V, 50 Hz, 970 rpm, 6-pole, Y-connected, 3-phase wound rotor induction motor has the following parameters referred to the stator:
- $R_s = 0.3\Omega$, $R'_r = 0.06\Omega$, $X_s = 0.7 \Omega$, $X'_r = 0.3 \Omega$
- The stator to rotor turns ratio is 2.
- Motor speed is controlled by Static Scherbius Drive. Drive is designed for a speed range of 30% below the synchronous speed. Maximum value of firing angle is 150° . Calculate
- (i) Transformer turns ratio.
- (ii) Torque for a speed of 800 rpm and $\alpha = 140^\circ$. [(CO3)(Evaluate/HOCQ)]
- 3 + 4 + (1 + 4) = 12**

Group - E

8. (a) Explain the various modes of variable frequency control. [(C04)(Understand/LOCQ)]
 (b) Examine the operation of closed loop speed control of load commutated inverter synchronous motor drive. [(C04) (Analyse/IOCQ)]
6 + 6 = 12
9. (a) Explain duty cycle of traction drives. [(C04)(Understand/LOCQ)]
 (b) A train service consists of following:
 i. Uniform acceleration of 5 kmphps for 30 sec.
 ii. Free running for 10 min.
 iii. Uniform braking at 5 kmphps to stop.
 iv. A stop of 5 min.
 Evaluate (i) Distance between stations
 (ii) Scheduled speed. [(C04)(Evaluate/HOCQ)]
6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	37.5	33.33	29.17

Course Outcome (CO):

After the completion of the course students will be able to

- CO1. Understand the stable steady state operation and transient dynamics of motor-load system.
- CO2. Learn characteristics, control and operation of solid state DC Motor drives.
- CO3. Appraise various control methods of Induction Motor drives and understand its operation.
- CO4. Analyze various synchronous motor drives and traction drives in detail.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question