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Code No: 156CJ

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year II Semester Examinations, January/February - 2025

POWER SEMICONDUCTOR DRIVES

(Electrical and Electronics Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: i) Question paper consists of Part A, Part B.
ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.
iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A

(25 Marks)

1.a) Why supply power factor is more with a semi-converter than with a full-converter? [2]

b) What are the drawbacks of ripple content in the armature current in converter fed D.C. Motor? [3]

c) A 1-phase dual converter is used in a DC drive. Map the four quadrants of operation of dual converter and DC motor with V-I plot, indicating the converter operating mode and range of firing angle in each quadrant. [2]

d) What is the operation of four quadrant DC chopper drive? [3]

e) Why stator voltage control is suitable for speed control of induction motors in fan and pump drives? [2]

f) What are the advantages of PWM control used in 3-ϕ induction motors? [3]

g) What are the advantages of static Scherbius drive? [2]

h) Why is the power factor of the slip power recovery scheme of speed control of induction motor low? [3]

i) What are the advantages of self-controlled mode synchronous motor? [2]

j) What are the benefits of load commutation used in synchronous motor control over forced commutation? [3]

PART – B

(50 Marks)

2.a) The speed of a 120 kW, 600 V, 1800 rpm, separately-excited DC motor is controlled by a three-phase fully-controlled converter (6-pulse converter). The converter is operating from a three-phase 400 V, 50 Hz supply. The rated armature current of the motor is 80 A. The motor parameters are: Ra = 0.08 Ω, La = 7.5 mH , $K_e\Phi$ = 0.278 V/rpm. Determine the no-load speed at firing angles $\alpha = 60°$. Assume that, at no-load, the armature current is 10% of the rated current and is continuous.

b) Explain single phase semi controlled converter fed DC series motor operation in continuous and discontinuous conduction modes and draw the speed torque characteristics. [5+5]

OR

3.a) A 220V, 1500rpm, 50A separately excited d.c motor with armature resistance of 0.5Ω, is fed from a 3-phase fully controlled rectifier. Available ac source has a line voltage of 440V, 50Hz. A star delta connected transformer is used to feed the armature so that motor terminal voltage equals rated voltage when converter firing angle is zero. Assume continuous conduction. Calculate transformer turns ratio and also determine the value of firing angle when motor is running at 1200rpm and rated torque.

b) Explain single phase fully controlled converter fed separately-excited DC motor operation in continuous and discontinuous conduction modes and draw the speed torque characteristics. [5+5]

4.a) A 220V, 1400 rpm, 40A separately excited motor with armature resistance of 0.5 ohms, is fed from a circulating current three phase dual converter with AC source voltage (line) =200 V. Determine converter firing angles for motoring operation at rated motor torque and 800rpm and braking operation at rated motor torque and 800rpm.

b) Draw the four quadrants operation of motor driving a hoist load. Depict the directions of load torque, motor torque and motor speed. [5+5]

OR

5.a) A200 V, 870 rpm, 150A dc separately excited motor has an armature resistance of 0.08 Ω. It is braked by plugging from an initial speed of 1200rpm. Calculate resistance to be placed in armature circuit to limit braking current to twice the full load value and braking torque.

b) Explain the operation of chopper fed DC separately excited dc motor in motoring and regenerative braking operation. [5+5]

6.a) A 400 V, 50 Hz, 4 pole, 1370 rpm, star connected squirrel-cage induction motor has following parameters referred to the stator:
$R_s = 2\ \Omega$, $R'_r = 3\Omega$, $X_s = X'_r = 3.5\ \Omega$
Motor speed is controlled by Voltage Source Inverter (VSI) fed induction motor drive at constant (V/f) ratio for motoring operation. Determine the motor break down torque at 60 Hz.

b) How would you compare the operation of Voltage Source Inverter (VSI) and Current Source Inverter (CSI) fed induction motor drive? [5+5]

OR

7.a) A 440V, 3-ø, 50Hz, 6 pole, 945 rpm, star connected induction motor has following parameters referred to the stator.
$R_s = 2.0\ \Omega$, $R_{r'} = 2.0\ \Omega$, $X_s = 3\ \Omega$, $X_{r'} = 4\ \Omega$
The motor speed is controlled by stator voltage control and load torque is proportional to speed. Determine Motor terminal voltage, current and torque at speed of 800rpm.

b) How would you describe the control of three phase Induction Motor by AC Voltage Controllers? [5+5]

8.a) A 440 V, 50 Hz, -pole, Y-connected wound rotor resistance has the following parameters: $R_s=0.5\Omega, R'_r=0.4\Omega, X_s=X'_r=1.2\Omega, X_m=50\Omega$
Stator to rotor turns ration is 3.5.
Motor is controlled by the static rotor resistance control. External resistance is chosen such that the breakdown torque is produced at stand still for a duty ration of zero. Calculate the value of external resistance and how duty ratio should be varied with speed so that the motor accelerates at maximum torque.

b) How would explain with neat circuit diagram static Kramer drive control of Induction motor drive? And also explain why has static Kramer drive a low range of speed control? [5+5]

OR

9.a) Why the rotor resistance control is preferred in low power crane drives? How does the resistance control help during counter torque braking?

b) A 3-ø, 440V, 6-pole, 970rpm, 50Hz, Y-connected induction motor has the following parameters referred to the stator
$R_s=0.1\ \Omega$, $R'_r=0.08\ \Omega$, $X_s=0.3\Omega, X'_r=0.4\ \Omega$,
The stator to rotor turns ratio is 2
The motor speed is controlled by Static Scherbius Drive. The drive is designed for a speed range of 20% below synchronous speed .The maximum value of firing angle is 165^0. Calculate.
i) Turns ratio of the transformer
ii) Torque for a speed of 780 rpm and $\alpha = 140^0$.
Dc link inductor has a resistance of 0.01**Ω.** [5+5]

10.a) How would you describe cycloconverter controlled synchronous motor drive is preferred over inverter controlled synchronous motor for low speed applications.

b) A 500 kW, Three phase, 3.3 kV, 50Hz, 0.8(lagging) pf, 4 pole star connected synchronous motor has a following parameters.
Xs=15 ohm, Rs=0, rated field current is 10A calculate
Determine the following for regenerative braking operation
i) Braking torque and field current for machine operation at rated current and unity power factor
ii) Armature current and power factor for 500 kW and output at 15A filed current. [5+5]

OR

11.a) A 500 kW, Three phase, 3.3 kV, 50Hz, 0.8(lag) pf, 4 pole star connected synchronous motor has a following parameters.
Xs=15 ohm, Rs=0, rated field current is 10A calculate
i) Armature current at half the rated torque and rated field current
ii) Power factor at half the rated torque and rated field current

b) With neat block diagram, explain closed loop control operation of synchronous motor drives. [5+5]

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