Enrolment No./Seat No_______________

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE- SEMESTER–VI (NEW) EXAMINATION – WINTER 2024**

**Subject Code:3160919** **Date:05-12-2024**

**Subject Name:Electric Drives**

**Time:02:30 PM TO 05:00 PM** **Total Marks:70**

**Instructions:**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

| | | | **Marks** |
|---|---|---|---|
| **Q.1** | **(a)** | Define electric drives and state their applications in industrial systems. | **03** |
| | **(b)** | Discuss at least four differences between flux weakening and armature voltage control in DC motors. | **04** |
| | **(c)** | A separately excited DC motor operates from a 220 V supply and runs at a speed of 1000 RPM while drawing 15 A. The armature resistance is 1 Ω. Calculate:<br>(i) Back EMF of the motor at 1000 RPM.<br>(ii) The speed if the armature current is 20 A | **07** |
| **Q.2** | **(a)** | Explain how smooth starting of a DC motor is achieved using a chopper. | **03** |
| | **(b)** | By taking a suitable example discuss how the duty cycle of a chopper affects the speed of a DC motor. | **04** |
| | **(c)** | A separately excited DC motor is fed from a half-controlled single-phase rectifier connected to a 230 V, 50 Hz AC supply. The motor has an armature resistance of 0.3 Ω and operates at 1200 RPM while drawing an armature current of 50 A. The firing angle of the rectifier is set to $\alpha=60^\circ$<br>(i) Calculate the average DC output voltage of the rectifier.<br>(ii) If the motor speed is reduced to 800 RPM while the armature current remains the same, calculate the new firing angle required to maintain the same armature current. | **07** |
| | | **OR** | |
| | **(c)** | A 220 V, 875 RPM, 150 A separately excited DC motor has an armature resistance of 0.05 Ω. The motor is fed from a single-phase fully controlled rectifier with an AC source of 230 V, 50 Hz. Calculate the firing angle required for the motor to produce a torque of 120 Nm at 750 RPM. | **07** |
| **Q.3** | **(a)** | Draw the torque-speed characteristics of an induction motor when operated under varying terminal voltage control. | **03** |
| | **(b)** | Explain the significance of slip regulation in induction motor control. | **04** |
| | **(c)** | A separately excited DC motor operates in regenerative braking mode. The motor is rated for 220 V and 1500 RPM, with an armature resistance of 0.5 Ω. If the motor is running at 1000 RPM and delivering a current of 30 A during braking, calculate the back EMF and braking torque. (Assume back emf at rated condition to be approximately equal to supply voltage.) | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Compare constant flux operation with flux weakening operation in induction motors. | **03** |
| | **(b)** | Discuss the V/f control technique for an induction motor, and mention its advantages. | **04** |
| | **(c)** | Explain with necessary block diagram the closed loop control of dc drive capable of controlling the motor in both above and below base speed regions. | **07** |

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|---|---|---|---|
| **Q.4** | **(a)** | What are the different methods for speed control of an induction motor? Explain one in brief. | **03** |
| | **(b)** | Draw the torque-speed characteristics of an induction motor operated in above and below base speed regions through a v/f control drive. | **04** |
| | **(c)** | A 415 V, 50 Hz, 6-pole, three-phase induction motor has the following parameters:<br>• Rotor resistance referred to the stator: $R_r$=0.5 Ω<br>• Rotor reactance referred to the stator: $X_r$=2.5 Ω<br>• Stator reactance: $X_s$=1.5 Ω<br>• Full-load slip: s=0.05<br>The motor operates under full-load conditions, and the stator resistance is negligible.<br>(i)Calculate the rotor current at full load.<br>(ii) Determine the developed torque if the rotor current is found to be 35 A. | **07** |
| | | **OR** | |
| **Q.4** | **(a)** | Draw the equivalent circuit of a three-phase induction motor and explain the function of each component. | **03** |
| | **(b)** | Explain the role of power electronics in the speed control of induction motors. | **04** |
| | **(c)** | A 440 V, 50 Hz, 6-pole, slip ring induction motor has a rotor resistance of Rr=0.3 Ω, and an external rotor resistance of $R_{ext}$=2 Ω. The motor runs at a speed of 960 RPM under full-load conditions with an external rotor resistance connected. The total rotor current is 50 A, and the rotor slip at full load is 0.04.<br>(i) Calculate the power dissipated in the external rotor resistance.<br>(ii) Determine the torque produced by the motor at full load. | **07** |
| **Q.5** | **(a)** | Compare 120° conduction Mode and 180° conduction mode of inverter for induction motor drive. | **03** |
| | **(b)** | Discuss the role of rotor resistance in slip-ring induction motor drives and its impact on motor performance. | **04** |
| | **(c)** | Explain the space vector PWM technique for controlling voltage source inverters. | **07** |
| | | **OR** | |
| **Q.5** | **(a)** | What is slip power recovery? Explain its significance in slip ring induction motors. | **03** |
| | **(b)** | Draw and explain the speed-torque characteristics of a three-phase induction motor under different rotor resistances. | **04** |
| | **(c)** | Explain closed-loop V/f control of an induction motor and its significance in maintaining constant torque. | **07** |

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