Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

ME Semester –I Examination Feb. - 2012

Subject code: 710709N **Date: 21/02/2012**

Subject Name: Electrical Drives

Time: 10.30 am – 01.00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Draw and explain block diagram of an electric drive and significance of each block. **07**

(b) Derive the condition for steady state stable operation of an electric motor and explain its significance with suitable examples for ac and dc motors. **07**

Q.2 **(a)** Explain the non-simultaneous control mode operation of a dual converter. Hence, discuss the four quadrant closed-loop control of a DC separately excited motor employing the dual converter. **07**

(b) Explain the multi quadrant operation of DC motor for armature current reversal technique. **07**

OR

(b) (i) Explain the Time Ratio Control(TRC) of DC series motor. List down also the assumptions if any made for analysis of TRC. **07**

(ii) A 220-V, 100A DC series motor has an armature resistance and an inductance of 0.06 Ω and 2 mH, respectively. The field winding resistance and inductance are 0.04 Ω and 18 mH, respectively. Running on no load as a generator, with the field winding connected to a separate source, it gives the following magnetizing characteristic at 700 rpm:

Field current(A)	25	50	75	100	125	150	175
Terminal Voltage(V)	66.5	124	158.5	181	198.5	211	221.5

The motor is controlled by a chopper operating at 400 Hz and 220V. Calculate the motor speed for a duty ratio of 0.7 and a load torque equal to 1.5 times the rated torque.

Q.3 **(a)** Derive an expression for critical speed for $\alpha < \gamma$ of a separately excited DC motor fed from a single-phase half-controlled rectifier. **07**

(b) A 220 V, 1500, 11.6A rpm separately excited dc motor is controlled by a 1-phase fully controlled rectifier has the armature resistance and inductance of 2 ohm and 28.36 mH respectively. Calculate the motor torque for $\alpha = 55°$ and speed = 950 rpm. Also draw the waveform for the same. **07**

OR

Q.3 **(a)** Write a brief note on the various current control schemes used controller fed DC motor. **07**

(b) Explain the effect of armature current ripple on the performance of DC motor controlled by a rectifier. **07**

Q.4 **(a)** Derive the following equation for a voltage source fed induction motor operating with constant V/f ratio: **07**

$$T = \frac{3}{\omega_{ms}} \left[\frac{V_{rated}^2 \, R_{r'} / (ks)}{\left(\frac{R_r'}{k} + \frac{R_r'}{ks} \right)^2 + \left(X_r' + X_s \right)^2} \right]$$

where the notations have usual meanings. Also draw the speed torque characteristics for different values of k, where $k < 1$.

(b) Discuss the operation of an induction motor in super-synchronous modes when a voltage is injected in the rotor circuit. **07**

OR

Q.4 **(a)** With neat diagram explain closed-loop slip-speed control for controlling the speed of a VSI fed induction motor. Clearly explain the function of each block used. **07**

(b) Why an Induction motor fed by current source must be operated on the portion of the speed-torque characteristics that is generally considered statically unstable? Justify your answer with relevant discussion and characteristics. **07**

Q.5 **(a)** Write a brief note on braking methods for synchronous motor. **07**

(b) A 3-phase, 400-V, 4 pole, 50 Hz, 1370 rpm, Y-connected, squirrel cage induction motor has following ratings and parameters: **07**

$X_s = X_{r'} = 3.5\Omega$, $R_s = 2\Omega$, $R_{r'} = 3\Omega$

When operating with V/f control calculate the following for

(i) Speed for a frequency of 30 Hz and 80% of full load

(ii) Frequency for a speed of 1000 rpm and full-load torque

(iii) Torque for a frequency of 40Hz and speed of 1100 rpm.

OR

Q.5 **(a)** Write a brief note on static rotor resistance control for controlling the speed of a slip ring induction motor. **07**

(b) Derive the equation of torque for a wound field salient pole synchronous motor operating from a voltage source of constant frequency. Hence, draw the torque-angle characteristics for the same. **07**

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