Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER 2012

Subject code: 710709N **Date: 16-01-2013**

Subject Name: Electrical Drives (Power Electronics Group)

Time: 02.30 pm – 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.**

Q.1 **(a)** Derive the criteria for judging the steady state stability of an electric drive. **07**

(b) A separately excited DC machine is fed from a 1-phase fully controlled rectifier bridge. Draw the waveforms representing the output voltage and current of the converter (inputs to machine) when the machine is operating in Motoring mode. Discuss these modes in brief. **07**

Q.2 **(a)** Derive an expression for the critical speed ω_{mc} of a separately excited DC motor fed from a single-phase half-controlled rectifier. **07**

(b) What is the significance of controlled fly-wheeling? How do the speed-torque characteristics for a 1-phase fully controlled converter fed DC separately excited motor differ when controlled with fly-wheeling operation from that when operated with conventional control (without fly-wheeling) ? Show the characteristics for different values of firing angle. **07**

OR

(b) List the sequence of steps required for identifying the modes of operation of a separately excited DC motor fed by single phase fully controlled converter. **07**

Q.3 **(a)** Draw and explain continuous and any one discontinuous mode of operation of a 3-Phase fully controlled rectifier fed dc motor. **07**

(b) A 230V, 500 rpm, 90A separately excited DC motor has the armature resistance and inductance 0f 0.115Ω and 11mH respectively. The motor is controlled by a two quadrant (class C) chopper operating from a voltage source of 230V. If the switching frequency is 400 Hz, calculate (i) motor speed for a motoring operation at $\delta = 0.5$ and half the rated torque (ii) motor speed for regenerating operation at $\delta = 0.5$ and rated torque. **07**

OR

Q.3 **(a)** Which harmonics are dominant in the output voltage of a six-step inverter? Discuss the effects of these harmonics on the performance of an induction machine fed from a six-step inverter. **07**

(b) What is a Dual converter? Draw and explain how the circulating current is controlled in dual converter with simultaneous control. **07**

Q.4 **(a)** For an induction motor fed from variable-voltage variable-frequency supply, derive the equation for torque. With necessary analysis and waveforms, justify that the torque to current ratio remains same even if the speed changes. **07**

(b) The stator current for a 230V, 50Hz induction motor is $40\angle -30°$A. Its stator to rotor turns ratio is 4. A static Scherbius drive is employed for speed control. If the desired control range is synchronous speed to 80% of **07**

synchronous speed, determine the turns ratio for transformer, line current and system power factor. If the transformer is not used determine line current and system power factor. Assume any data if required and mention the assumptions clearly.

OR

Q.4 **(a)** Draw the speed-torque characteristics of a current-fed induction motor. Compare the same with the characteristics when the motor is fed by a voltage source. Comment on what portion of the characteristics the motor should be operated. Why? **07**

(b) Why a transformer is desired in a Static Scherbius drive? Comment on the power factor of the drive in this method and hence, mention the criteria for maximizing the power factor. **07**

Q.5 **(a)** What is the effect on the motor efficiency and the current drawn from the source, when speed control of an induction motor is achieved by varying the stator (terminal) voltage (with fixed frequency)? Discuss in brief the various AC voltage controller configurations that can be employed for the stator voltage control technique. **07**

(b) Discuss the method of injection of voltage in the rotor circuit to control the speed of an induction motor in a super-synchronous region. **07**

OR

Q.5 **(a)** Discuss the operation of a cylindrical rotor synchronous motor operating from a current source. **07**

(b) (i) Which type of braking is more common in case of a synchronous motor? Why? **07**

(ii) An induction motor is fed from a six-step inverter which in fact is fed from a diode bridge rectifier. Just show the scheme (using blocks) to obtain motoring as well as regenerative operation.

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