BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: MTECH **SEMESTER: II**
BRANCH: EEE **SESSION: SP/19**

SUBJECT: EE559 ELECTRIC DRIVES

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) What is an electrical drive? Draw the block diagram of an electrical drive. Give a classification of different types of load torques. [5]

Q.1(b) A 6 pole, 50 Hz, 3-phase wound rotor induction motor has a flywheel coupled to its shaft. The total moment of inertia of motor-load-flywheel is 1000 kg-m^2. Load torque is 1000 N-m of 10 sec duration followed by a no load period which is long enough for the drive to reach its no load speed. Motor has a slip of 3% at a torque of 500 N-m. Calculate (1) maximum torque developed by the motor (2) Speed at the end of deceleration period. [5]

Q.2(a) Draw speed torque characteristics for armature voltage control and field flux control of a dc separately excited motor. Explain the chopper control of a separately excited dc motor for motoring and regenerative braking operations. Draw the circuit, waveforms and speed torque characteristics. Write the governing equations. [5]

Q.2(b) A 200V, 875 rpm, 150A separately excited dc motor has an armature resistance of 0.06Ω. It is fed from a 1-Φ fully controlled rectifier with an ac source voltage of 220V, 50Hz.Assuming continuous conduction, calculate (i) firing angle for rated motor torque and 750 rpm (ii) firing angle for rated motor torque and (-500) rpm (iii) motor speed for firing angle α= 160° and rated torque. [5]

Q.3(a) Explain open loop and closed loop Volts/Hz voltage fed inverter control of a induction machine. Draw the block diagrams, speed-torque characteristics of the drive and effect of load torque variation. [5]

Q.3(b) A 440V, 50Hz, 6-pole, Y- connected squirrel cage induction motor has following parameters: Rs=0.6Ω, R_r' =0.3Ω, Xs=Xr'=1Ω. The normal full load slip is 0.05. The motor is fed from a voltage source inverter, which maintains a constant V/f ratio. For an operating frequency of 10Hz, (i)calculate the breakdown torque as a ratio of its value at the rated frequency. (ii) What should be V/f ratio at 10Hz so that the breakdown torque at this frequency remains same as at rated frequency. (iii)If the inverter frequency range is from 60 to 5Hz, calculate the starting torque and current of this drive as a ratio of their values when the motor is started at the rated voltage and frequency. [5]

Q.4(a) Draw the principle of vector control of induction machine block diagram? Elucidate about the direct or feedback vector control method including the flux vector estimation using voltage model. [5]

Q.4(b) A 440V, 50Hz, 6-pole, Y-connected wound rotor induction motor has the following parameters: R_s= 0.5Ω, R_r'=0.4Ω, X_s= X_r'=50Ω. Stator to rotor turns ratio is 3.5. Motor is controlled by static rotor resistance control. External resistance is chosen such that the breakdown torque is produced at standstill for a duty of zero. Calculate the value of external resistance. How duty ratio should be varied with speed so that the motor accelerates at maximum torque. [5]

Q.5(a) Explain constant V/f of a wound field synchronous machine. In variable frequency of a synchronous motor why V/f ratio is maintained constant up to a base speed and V constant above the base speed. [5]

Q.5(b) A 6MW, 3-Φ, 11kV, Y-connected, 6-pole, 50Hz, 0.9(leading) power factor synchronous motor has X_s=9Ω, and R_s= 0. Rated field current is 50A. Machine is fed by voltage source inverter (VSI) and controlled by variable frequency control at constant V/f ratio up to the base speed and constant V above base speed. Determine (i) Torque and field current for the rated armature current, 750rpm and 0.8 leading power factor (ii) Armature current and power factor for half the rated motor torque, 1500rpm and rated field current. (iii) Armature current and power factor for regenerative braking power output of 4.2 MW at 750 rpm and rated field current. [5]

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