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B.E / B.Tech (Full Time) DEGREE END SEMESTER EXAMINATIONS, APR / MAY 2014

ELECTRICAL & ELECTRONICS ENGINEERING

Seventh Semester

EE 9401 Solid State Drives

(Regulation 2008)

Time : 3 Hours | Answer ALL Questions | Max. Marks 100

PART-A (10 x 2 = 20 Marks)

1. Write down the mechanical dynamic equation for the rotating shaft of a motor-load system?
2. "A dual converter fed DC motor drive can decelerate faster than a half-controlled converter fed DC motor drive." – Reason out.
3. Why should the value of V/f ratio be maintained constant in an Induction Motor drive?
4. Draw the circuit diagram of an ASCI(current source inverter) fed Induction Motor drive?
5. What do you understand by 'Electronically Commutated Motor'?
6. What is the motor used in the ceiling fans? What is the speed controller employed in it?
7. A single-phase half controlled converter fed separately excited DC motor is rated for 220V, 1500rpm. The firing circuit is applied with voltage in the range of (0-5V), as available from the digital controller. Obtain a model for the converter?
8. Considering a first order plant, show that using a PI controller leads to zero steady-state error.
9. A 220V, 1500rpm, 10A separately excited DC motor has an armature resistance of 0.75Ω. It is applied with an armature voltage of 100V, with its field current maintained at the rated value. Evaluate the running speed? Assume rated load.
10. A 220V, 1500rpm, 10A separately excited DC motor has an armature resistance of 0.75Ω. It is applied with rated armature voltage of 220V, and speed controlled with its field current. Evaluate the running speed, when the field current is 80% of the rated value? Assume load on the shaft to be half of the rated load.

Part – B (5 x 16 = 80 marks)

11. What do you understand by 'equilibrium operating point' of a drive? State and prove the condition for the steady-state stability of the equilibrium point? Also use this concept to solve the problem: A motor having a suitable control circuit develops a torque given by $T_D = aw + b$, where a and b are positive constants and w – is the running speed. It is driving a load whose torque can be given as $T_L = c\,w^2 + d$, where c and d are some other positive constants. The rated inertia of the rotating masses as reflected to the shaft is 'J'. Determine the relations among these constants in order that the motor can start together with the load and have an equilibrium operating speed. Will the drive be stable at this speed? Also determine the maximum acceleration of this drive.

EEE

12. a) i) Discuss the operation of a V/f control based VSI fed 3-Φ Induction Motor drive working on closed loop operation.
ii) What do you understand by 'field weakening mode', in an adjustable speed 3-Φ Induction Motor drive. Elaborate (10 + 6)

OR

b) i) What is stator voltage control of a 3-Φ Induction Motor? How is it implemented? Also obtain the Torque speed characteristics of such a drive.
ii) What is an 'energy efficient drive'? How can we achieve energy efficient operation in a stator voltage controller based 3-Φ Induction Motor drive? (10 + 6)

13. a) Along with detailed block diagram, discuss the operation of a self-control based synchronous motor drive working on either margin angle control or power factor control mode?

OR

b) i) In an open-loop V/f control based Induction motor drive, the motor alone is replaced by a synchronous motor of suitable rating. Assume damper windings and soft-start algorithm. What would be the load regulation? Discuss the operation of this scheme.
ii) Discuss the speed control methods applicable to Permanent Magnet Synchronous Motors. (8 + 8)

14. a) A 220 V,1500 rpm, 10 A, separately excited DC motor has R_a = 2 Ω. L_a = 70 mH. Inertia of the motor- load combination is 0.07 Kg-m^2. The friction is 0.1 Nm-sec/rad. The motor is fed from a 3-Φ fully-controlled converter which is supplied from a 200 V, 50 Hz, 3-Φ a.c. mains. Mention any other data that you may be assuming and design PI controllers for the inner current loop and outer speed loop. Given that the tacho-generator has a transfer function of 0.07 / (1 + 0.002 s)

OR

b) i) Obtain the transfer functions for the armature voltage control based separately excited DC motor drive.
ii) What is 'symmetric optimum function' with reference to the design of the speed controller for a DC motor? Elaborate. (10 + 6)

15. a) Write short notes on ANYTWO of the following:
i) 1-Φ dual converter fed separately excited DC Motor drive,
ii) SCR chopper fed separately excited DC Motor drive on 'Current Limit Control',
iii) 3-Φ half-controlled converter fed separately excited DC Motor drive. (8 + 8)

OR

b) A 12.2 kW, 230 V, 850 rpm, 56 A separately excited DC motor is fed from a 3-Φ fully-controlled converter which itself is supplied from a 180 V, 50 Hz, 3-Φ a.c. mains. Its R_a is 0.3 Ω. Assume continuous conduction mode of operation. i) Find the rectifier firing angle for the rated torque and rated speed operation? ii) Also find the inverter firing angle for the rated braking torque and a speed of 600 rpm in the reverse direction? Also discuss the operation corresponding to the regenerative braking case.