(3 Hours)   **Total Marks: 80**

NB: (1) Question **No. 1** is **compulsory**
(2) **Answer** any **THREE** questions out of the remaining **FIVE** questions.
(3) Assume suitable data if **necessary** and **justify** them
(4) **Figure** to the **right** indicates **marks**

1 (a) What are the main factors which decide the choice of electrical drive for a given   5
.   application?
  (b) State and explain with neat sketches the three main classes of motor duty cycle   5
  (c) With speed torque characteristics, explain the stator voltage control of induction   5
      motor.
  (d) Compare vector control and direct torque control of an induction motor   5

2 (a) Choose an application and explain with neat diagrams the multi quadrant   10
.   operation of an electrical drive. Mention the speed torque conventions in all the
      four quadrants.
  (b) A drive has the following equations for motor torque (T) and load torque (T$_l$).   10
      T = -1-2ω_m; T$_l$ = -3$\sqrt{\omega_m}$ where ω_m is the motor speed in rad/s. Obtain the
      equilibrium points and determine their steady state stability.

3 (a) Derive the thermal model of motor for heating and cooling and draw the heating   10
.   and cooling curves.
  (b) Half hour rating of a motor is 200 kW. Heating time constant is 80 min. The   10
      maximum efficiency occurs at 75% of full load. Determine the continuous duty
      rating of the motor.

4 (a) With a neat block diagram explain closed loop speed control with an inner   10
.   current control loop in an electric drive.
  (b) Draw the circuit diagram of a four quadrant chopper drive for a DC separately   10
      excited motor and explain in detail its operation with necessary diagrams in
      forward motoring mode and regenerative braking mode.

5 (a) With the speed torque characteristics explain V/f control of induction motor. In   10
.   the speed torque characteristics, include the region below base speed as well as
      above base speed.
  (b) A 3-phase, 440 volt, 50 hertz, 6 pole star connected induction motor has following   10
      parameters referred to stator: R$_s$ = 0.5 Ω, R$_r$' = 0.6 Ω, X$_s$ = X$_r$'= 1Ω. Stator to rotor
      turns ratio is 2. If the motor is used for the regenerative braking, determine
       (i) Maximum overhauling torque it can hold and the range of speed in which it
       can operate safely.
       (ii) The speed at which it will hold a load with a load torque of 160 N-m

6 (a) Draw the block diagram and explain in brief the direct torque control of three   10
.   phase induction motor. What is voltage vector switching table?
  (b) What do you mean by vector control or field oriented control of induction motor?
      Explain with necessary phasor diagram the working principle of vector control   10

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