

Q 8293

M.E. DEGREE EXAMINATION, MAY/JUNE 2006.

Second Semester

Power Electronics and Drives

PE 1653 — SOLID STATE AC DRIVES

(Regulation 2005)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. A squirrel cage induction motor is to be fed from a non sinusoidal supply. It is preferred to use a motor with large leakage reactance. Why?
2. A 3-phase, 400V, 50Hz, 4 pole delta connected squirrel cage induction motor has a full load torque of 48.13 N-m. Motor speed is controlled by stator voltage control. When driving a fan load it runs at rated speed at rated voltage. Calculate the motor torque at 1200 rpm.
3. What is the role of variable frequency drives in the context of energy conservation?
4. In an independent dc link current and slip control scheme of a CSI fed induction machine, why the machine has to be operated in a statically unstable region of torque-speed curve?
5. What is the similarity of a vector controlled induction motor drive and a separately excited dc motor drive?
6. For high performance, stator or rotor flux linkage information is required in the vector controlled drive, why?
7. What is a DTC scheme?
8. List the special features of DTC control scheme.
9. What is self-controlled mode operation of a synchronous motor drive?
10. Why the load commutated inverter fed synchronous motor drive found suitable for high speed and high power applications?

PART B — (5 × 16 = 80 marks)

11. (i) What is pole amplitude modulation? How it is achieved by coil inversion and coil omission and omission. (5)
- (ii) A 440V, 50Hz, 6 pole, Y-connected wound rotor motor has the following parameters (referred to stator): (6)

$$R_s = 0.5 \Omega, R_r' = 0.4 \Omega, X_s = X_r' = 1.2 \Omega, X_m = 50\Omega.$$

Stator to rotor turn ratio = 3.5. Motor is controlled by static rotor resistance control. External resistance is chosen such that the break down torque is produced at standstill for a duty cycle of zero. Calculate the value of external resistance. How duty cycle should be varied with speed so that the motor accelerates at maximum torque.

- (iii) Write a brief note on Static Kramer drive. (5)
12. (a) (i) Discuss with schematic diagram the closed loop V/f control of induction motor by slip regulation. (8)
- (ii) How induction motor is controlled using phase voltage controller. With speed-torque characteristic discuss the advantages, limitations and application of this method. (8)

Or

- (b) (i) Find maximum slip and the relation between the dc link voltage and stator frequency for the closed loop implementation (with offset voltage) of a V/f inverter fed induction motor drive. The motor parameters are as follows: (4)
- 5HP, 200V, 60Hz, 3-phase, Y-connected, 4 pole, 0.86 pf and 0.82 efficiency. $R_s = 0.277 \Omega$, $R_r = 0.183\Omega$, $X_{1s} = 0.554 \Omega$, $X_{1r} = 0.841\Omega$.
- (ii) With schematic diagram discuss the closed loop speed and flux control of a CSI fed induction motor drive. (12)
13. (a) Explain the direct vector control scheme of induction motor drive with block diagram. How rotor flux can be estimated using voltage model and current model.

Or

- (b) An induction motor with following data is to be used with an indirect vector controller:
- 5 hp, Y-connected, 3-phase, 60hz, 4 poles, 200V, rated speed = 1766.9rpm.
 $R_s = 0.277 \Omega$, $R_r = 0.183\Omega$, $L_m = 0.0538 \text{ H}$, $L_s = 0.0553 \text{ H}$,
 $L_r = 0.05606 \text{ H}$, $J = 0.01667 \text{ kg-m}^2$.

Find the rated rotor flux linkages and torque commands and the corresponding torque producing components of the stator current command, the stator current phasor command, the torque angle command and the slip speed command. The drive is assumed to be a torque amplifier. (Use synchronous reference frame).

4. (a) (i) Derive an expression for torque and incremental torque with stator and rotor fluxes applicable to DTC with phasor diagram. (12)
- (ii) What is torque pulsation? What are their effects at low and high speeds in ac drives. (4)

Or

- (b) With block diagram and flux vector trajectory explain the principle of Operation of DTC strategy.
15. (a) (i) A 6 Mw, 3-phase .11KV, Y-connected, 6-pole, 50Hz, 0.9 (leading) pf synchronous motor has $X_s = 9 \Omega$ and $R_s = 0$. Rated field current is 50A. Machine is controlled by variable frequency control at constant V/f ratio up to base speed and at constant Voltage above based speed determine. (8)
- (1) Torque and field current for the rated armature current, 750 rpm and 0.8 leading power factor.
- (2) Armature current and power factor for half and rated motor torque, 1500 rpm and rated field current.
- (ii) Explain the operation of a open loop V/f control of multiple synchronous motor with schematic diagram. (8)

Or

- (b) (i) What is Brushless dc motor. Explain its operation with inverter in PWM voltage and current control mode. (10)
- (ii) A synchronous motor is controlled by a load commutated inverter, which in turn is fed from a line commutated converter. Source voltage is 6.6. KV, 50 Hz, load commutated inverter operates at a constant firing angle α of 140° and when rectifying $\alpha = 0^\circ$. Dc link inductor resistance $R_d = 0.1\Omega$. Drive operates in self control mode with constant V/f ratio. Motor has the following details : 8 MW, 3-phase, 6600V, 6 pole, 50Hz, unity power factor Y-connected, $X_s = 2.8\Omega$, $R_s = 0\Omega$. Determine the source side firing angle when motor operates at the rated current and 500 rpm. What will be the power developed by motor? (6)