

M.E. DEGREE EXAMINATIONS: OCTOBER / NOVEMBER- 2008

Second Semester

POWER ELECTRONICS & DRIVES

P07PE202 – Solid State DC Drives

Time: Three hours

Maximum Marks: 100

Answer ALL questions:-

PART A (20 x 2 = 40 Marks)

- The speed of a DC motor falls from 1400 rpm on no-load to 1100 rpm on full-load. Name its type
 - Shunt motor
 - Differentially compound motor
 - Series motor
 - Cumulatively compound motor
- The network equation related to DC motor armature circuit is
 - $U_a = E_b - I_a R_a$
 - $E_b = U_a - I_a^2 R_a$
 - $E_b = U_a - I_a R_a$
 - $E_b = U_a + I_a R_a$
- Which of the following DC motors is best suitable for traction applications?
 - shunt motor
 - series motor
 - cumulative compound motor
 - differentially compound motor
- Total torque demanded by the machine is given by
 - $T_L = T_r + (T_m - T_r) \left(\frac{N}{N_r} \right)^x$
 - $T_L = T_r + (T_m - T_r) \left(\frac{N}{N_r} \right)$
 - $T_L = T_r + (T_m - T_r) \left(\frac{N_r}{N} \right)$
 - $T_L = T_r + (T_L - T_r) \left(\frac{N}{N_r} \right)^3$
- Forward and Reverse motoring requires
 - One Quadrant operation
 - Two quadrant operation
 - Four quadrant operation
 - Both Two & Four quadrant operations
- In a 3-phase semi converter for a firing angle equal to 90° and for continuous conduction, freewheeling diode conduct, for
 - 30°
 - 60°
 - 90°
 - zero degree
- In an un-controlled AC-DC converter fed DC drive

Statement (1): the effect of source inductance is responsible for the rise in the output voltage with increasing Current

Statement (2): the source resistance is responsible for distortion in the AC line distribution system

 - 1-is true
 - 2-is true
 - 1 & 2 are false
 - 1&2 are true
- A 3-phase Semi converter fed DC drive can work as
 - converter for $\alpha=0^\circ$ to 180°
 - converter for $\alpha=0^\circ$ to 90°
 - inverter for $\alpha=90^\circ$ to 180°
 - inverter for $\alpha=0^\circ$ to 180°
- In a single phase semi converter, if α and β are the firing and extinction angles, the armature current of DC motor is
 - discontinuous if $(\beta - \alpha) < \pi$
 - discontinuous if $(\beta - \alpha) > \pi$
 - discontinuous if $(\beta - \alpha) = \pi$
 - continuous if $(\beta - \alpha) < \pi$

10. In a 3 - phase fully converter fed DC drive the output voltage pulsates at a frequency equal to
 A. Supply frequency (f) B. 2f C. 3f D. 6f
- 11 In PWM method of controlling the average output voltage in a chopper fed DC drive, the on-time is ----- but the chopping frequency is -----
 A. varied, varied B.varied, kept constant
 C. kept constant, varied D.kept constant, kept constant
12. In four quadrant chopper fed DC drive the armature voltage is raised from positive maximum to negative maximum by varying Time ratio of chopper from
 A. 0 to 1 B. 1 to 0.5 C. 0.5 to 1 D. 1 to 0
13. In a step down chopper the load current ripple can be reduced by
 A. Increasing the value of L B. Increasing chopper frequency
 C. Increasing both D. Decreasing both
14. During the regenerative braking of a Chopper-based DC drive, energy transfer takes place
 A. from the load at high voltage to the source at low voltage.
 B. from the source at high voltage to the load at low voltage.
 C. from the source at low voltage to the load at high voltage.
 D. from the load at low voltage to the source at high voltage.
15. Which of the following system is preferred for chopper drive?
 A. Variable frequency system B. Constant current system
 C. Constant frequency system D. Constant voltage system
16. Choppers can be used in future electric automobiles
 A. for speed control only B for speed control and braking
 C. for braking only D. for change the direction of rotation only
17. The closed loop control drive requires
 A Current sensor B. Speed sensor C. Both D. Any one
18. The speed regulation of Phase Locked Loop control drive is
 A.0.5 % B.1.5% C.1% D.0.002%
19. A DC drive has the speed feedback in the ----- loop and current feedback in the ----- loop.
 A. inner, outer B. outer, inner C. Inner, open D. open, outer
20. In a closed loop drive, the functions performed by the microcomputer are
 A. speed measurement, current control, and error detection
 B. current measurement, speed control, and error detection
 C. current control, speed control, and error detection
 D. current control, speed control, and current measurement.

PART B (5 x 12 = 60 Marks)

21. (a) (i) From electrical characteristics, derive the mechanical characteristic of DC series motor. (6) 25. (b) (i)
- ii) Compare the relative merits and demerits of armature control and field control of speed of DC shunt motor. (6)

(OR)

21.(b) (i) Explain the different classes of Motor duty with the equations. (6)

(ii) Describe the components of load Torques with the necessary diagrams. (6)

22.(a)(i) Derive the expression for armature current of a DC motor fed by 1-phase fully controlled converter. (6)

(ii) The speed of 15 hp, 220 V, 1200 rpm series motor is controlled by a 1-phase semiconverter. The combined field and armature resistance is 0.3Ω . Motor constants are $K_{af} = 0.02 \text{ N-m} / \text{A}^2$ and $K_{res} = 0.08 \text{ V-s} / \text{rad}$. The supply voltage is 230 V. Assuming continuous and ripple-free current, compute the following for a firing angle $\alpha = 30^\circ$ and speed $N = 1200$ rpm. (i) Motor torque, (ii) Motor current. (6)

(OR)

22.(b) With the neat waveform explain continuous current mode of the 3-phase closed loop fully controlled converter drive. (12)

23.(a)(i) Explain the operation of time ratio control and frequency control scheme of chopper drive. (6)

(ii) A DC series motor is supplied by a battery of 420 V with a DC chopper interposed between the battery and the motor. It has a mean armature current of 120 A. The $R_a = 0.05 \Omega$, $R_f = 0.065 \Omega$, $K_b = 0.72 \text{ V} / (\text{Wb rad} / \text{s})$, and $\phi_f = 0.016 I_a$. Compute Speed and Torque of the motor. (6)

(OR)

23. (b) With the neat diagram and waveform explain the Four quadrant operation of closed loop Chopper fed DC drive. (12)

24.(a) (i) Derive the transfer function of separately excited DC Motor (6)

(ii) Draw and explain the current and speed loops of DC drive. (6)

(OR)

24.(b) (i). With the block diagram explain the operation of closed loop speed control of Multi motor drive. (6)

(ii). Compare the performance of P, PI, PID controller response in a DC drive. (6)

25. (a) Describe the operation of Microprocessor based converter fed reversible DC drive with the necessary block diagram and flow chart. (12)

(OR)

25. (b) (i) Explain the Phase locked loop speed control of DC motor (8)

(ii) State the advantages and disadvantage of microprocessor based motor control. (4)
